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on

THE MECHANISM

of the

SECOND STAGE OF HUMAN PARTURITION

by

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LATERAL OBLIQUITY.

By lateral obliquity is meant a rotation of the fetal head about an axis which is antero-posterior relative to the head, and horizontally transverse or oblique relative to the pelvic canal. That is to say, lateral obliquity may happen when the head is in a transverse or an oblique position, but it cannot occur, according to the definition, in a head which lies directly antero-posteriorly within the canal. From the historical point of view it remains an open question.

SECTION IV.

LATERAL OBLIQUITY in the study of lateral obliquities of the fetal head. In the course of time, opinions have varied in this subject, as in other subjects, but it is doubtful if they have consolidated. It may even be just to inquire how far some of the statements which have been made are deductions based on clinical or experimental observations, how far they are only expressions of opinion. Suspicion is justified when to compare the numerous and careful descriptions of the mechanism of engagement in a flat pelvis with the still more numerous, but with certain exceptions vague and unsatisfactory, accounts of the mechanism in a normal pelvis. The former bear clear evidence of observation at first hand; the latter, as a rule, convey the impression/

LATERAL OBLIQUITY.

§I. By lateral obliquity is meant a rotation of the fetal head about an axis which is antero-posterior relative to the head, and horizontally transverse or oblique relative to the pelvic canal. That is to say, lateral obliquity may happen when the head is in a transverse or an oblique position, but it cannot occur, according to the definition, in a head which lies directly antero-posteriorly within the canal. From the historical point of view it remains an open problem whether or not real progress has been made, since the days of NAEGELE, in the study of lateral obliquities of the fetal head. In the course of time, opinions have varied in this subject, as in other subjects, but it is doubtful if they have consolidated. It may even be just to inquire how far some of the statements which have been made are deductions based on clinical or experimental observations, how far they are only expressions of opinion. Suspicion is justified when we compare the numerous and careful descriptions of the mechanism of engagement in a flat pelvis with the still more numerous, but with certain exceptions vague and unsatisfactory, accounts of the mechanism in a normal pelvis. The former bear clear evidence of observation at first hand; the latter, as a rule, convey the impression/

impression of inference based on circumstances not met with in the pelvic canal. An explanation of the difference is ready to hand, and though it may not be charitable to make the suggestion, it justifies itself by its validity. In the flat pelvis, engagement generally happens in labour: in the normal pelvis, as is well known, the head usually descends into the pelvis some considerable time before the onset of labour is recognised. In the latter case, how many observers have carefully noted the course of events? The mechanism of engagement does not strictly fall within the limits of a paper devoted to the second stage. But, as I have just implied, engagement may be a phenomenon of the expulsive period, even in a normal pelvis. Whether or not the mode of engagement, with reference to the occurrence of lateral obliquity, is the same in pregnancy and in the first and second stages is a matter for consideration.

2. § Prior to the date of NAEGELE'S paper synclitism*./

* The head is said to be synclitic when its base coincides with the plane of the brim i.e. the plane of the true conjugate, or with any parallel plane of the pelvis. The base may be tilted one way or other. When the inclination extends from before downwards and backwards, the head is said to have Litzmann's or posterior obliquity. When the converse is present the condition is called Naegele's or anterior obliquity.

synclitism appears to have been considered normal at the brim. According to VARNIER 1900, ROEDERER, SOLAYRES, and LEVRET held this view. BAUDELOCQUE, LACHAPELLE, and DUBOIS senior, it is said, described synclitism (AUVARD 1894). VARNIER argues that the ready assumption of synclitism at the brim, subsequent at any rate to the year 1766, depends upon a misinterpretation of a passage in LEVRET'S work published at that time, and which was taken to mean that LEVRET believed the axes of uterus, fetus, and brim to coincide with one another. There is, however, a weightier reason, as will be shown, why belief should be so general in synclitism at the brim. According to PINARD and VARNIER 1892, (and it is apparent in the plates reproduced in the latter's *Obstétrique Journalière*). SMELLIE and CAMPER (1774) figured LITZMANN'S obliquity at the brim, and SMELLIE described the same obliquity to be present when the waters break. I have been unable, however, to discover any passage in the New Sydenham Society's Edition of Smellie's work bearing on this matter. And indeed, my impression is that SMELLIE had no views on this subject at all.

The parts of NAEGELE'S historic paper which have given rise to so much discussion in the present connection are briefly these. The most frequent presentation/

presentation is the right parietal bone i.e. the right parietal is deeper than the left. The higher the head is the more oblique it is, so that the ear may be the more readily touched behind the pubic bones. The description implies an anterior obliquity of the head through the pelvis and also at the brim, as NAEGELE elsewhere makes clear. The obliquity has since been known by the name of its author. NAEGELE'S view was accepted without objection being raised, by STOLTZ (1826), DUBOIS (1834) (who, however, made some reservations), MOREAU (1841), JACQUEMIER (1846), TYLER SMITH (1858), and no doubt others. VELPEAU (1835) on the other hand adhered almost alone to synclitism. In 1857, WEST ventured to dispute NAEGELE'S views and argued for the synclitic mode of entry, at the same time suggesting that NAEGELE was "Mistaken in his tactile estimate of the centre of the canal". LEISHMAN (1864) took a similar view to WEST and asserted that NAEGELE was ignorant of the inclination of the brim which, as BARNES (1885) observed, is not correct. DUNCAN (1868) held with LEISHMAN and KÜNECKE (1866) that asynclitism is not observed. NAEGELE'S description (for DUNCAN) is more applicable to the antero-posterior position than/

than to the oblique. The finger cannot reach the sagittal suture in the axis of the brim, and it cannot be felt until it comes lower down within the pelvis. Hence NAEGELE committed an error in attributing observations to the level of the brim, though they were really made lower down. Further DUNCAN, and in this BARNES (1885) agreed, did not admit that the higher the head is, the more oblique it is. Part of NAEGELE'S argument was derived from the position of the caput succedaneum, and this also did not meet with DUNCAN'S approval as according to the latter the passages dilate downwards and forwards, while the force is directed downwards and backwards. Naturally, DUNCAN, holding the views he did, could find no mechanism to account for NAEGELE'S obliquity, and he held that, if by any chance obliquity does appear, it is corrected by the uterine contractions. NAEGELE claimed a mechanical advantage for the oblique mode of entry. DUNCAN, from whose paper I have quoted this statement, (I don't think it occurs in the 1819 paper) admitted the advantage, but asserted, without giving any kind of proof of so strong a statement that Nature does not always take the/

the easiest way. He then proceeds to show that, though the head is synclitic at the brim, it has NAEGELE'S obliquity in the cavity, and he accounts for this, as did NAEGELE, STOLTZ, LEISHMAN, and HODGE (1864), by the nature of the resistances and the curved course which the head was supposed to follow. In 1869, KÜNECKE extended the views of his 1866 paper by postulating a "synclitic" descent of the head, whereby the sagittal suture always leads, and the head rotates evenly around the pubis. HODGE (1870) took a similar view, and states that VELPEAU, CASEAUX, and DEWEES also described it. (HODGE in his textbook of 1864 admitted the occurrence of the slight amount of lateral flexion during the descent of the head). DUNCAN then (1870) defines his position more exactly. The head is synclitic at the brim and remains synclitic until it is arrested by the pelvic floor, when NAEGELE'S obliquity appears. Under synclitism the anterior parietal would need to be pushed under the posterior, but the opposite is the rule. Shears, according to DUNCAN, are an argument against synclitism.

So far then we have three serious indictments of NAEGELE'S position; first, a mistake in estimating the position of the centre of the canal (WEST); secondly/

secondly, ignorance of pelvic inclination (LEISHMAN); and thirdly, a misinterpretation of the level at which the observations were being made (DUNCAN). There is still the other side of the problem.

BARNES argues in favour of the occurrence of NAEGELE'S obliquity from the brim downwards. In 1883 he attributes the obliquity to the lumbo-sacral curve. In 1885, he says the head enters the brim with NAEGELE'S obliquity which is maintained and increased in the second stage by the action of the abdominal muscles. The author makes a good point when he says that LEISHMAN, KÜNECKE, and DUNCAN rely on the coincidence of the uterine, fetal, and pelvic axes, which most certainly has not been proved. Secondly, he disbelieves that NAEGELE was ignorant of the inclination of the brim. As NAEGELE'S paper on the pelvis appeared in 1825, and as it contains the results of the examination of no less than 800 women, it is highly probable that this research was in progress, if not indeed well advanced, at the time of the publication of the earlier paper. BARNES then proceeds to advance his views on the effect of the lumbo-sacral curve and the width of the bi-parietal diameter of the head relative to the pelvis/

pelvis. In so far as these are concerned, they are not good arguments for NAEGELE, and the lumbo-sacral curve founded on the evidence of frozen sections is, when the clinical aspect of uterine activity is considered, certainly wrong. BARNES, in addition, asserts that the caput persists on the right parietal and occipital bones from the beginning to the end of traction in instrumental labours, and he quotes RIGBY that the head is laterally oblique from the inlet to the outlet of the pelvis and is never synclitic.

With regard then to NAEGELE, whom, it is said, von SIEBOLD in a moment of enthusiasm described as the coryphée of the obstetric art, I firmly believe that NAEGELE described correctly in all respects whatever he felt or observed. NAEGELE noted the occurrence, in the cavity, of the obliquity which goes by his name. He observed its presence at the brim, and he records the fact that the magnitude of the obliquity is proportional to the height of the head relative to the brim. These observations were described with conviction, and the evidence which they show of the care and accuracy of their author evokes admiration to this day. NAEGELE was not/

not troubled with theoretical conceptions of the mechanism, and he did not go beyond whatever his fingers felt. Later writers evolved ideas regarding the mechanism which were difficult of direct proof. Nonetheless, the writers clung tenaciously to the theories, no doubt, on the mistaken principle that an a priori argument is of greater value than any number of contradicting observations. Thus, WEST'S and DUNCAN'S objections, which depended ultimately on the circumstance that WEST and DUNCAN, like many others, were welded to the "coincidence of the three axes", go overboard in the absence of proof better than that advanced. LEISHMAN'S criticism history disposes of in a satisfactory way. That being the position as I understand it, why should there still be differences of opinion? The answer is suggestive. NAEGELE'S observations at the brim were made when from any cause engagement was delayed until after the onset of labour. Opportunities of observing the mechanism of engagement in pregnancy a fortnight, or it might have been six weeks, before labour did not often occur; or if they did occur, only because something had gone wrong.

The two common causes of delayed engagement are flat pelvis and pendulous belly. Both result in/

in an obliquity of the uterus and of the head, which is almost invariably anterior. NAEGELE described the mechanism of engagement which he observed, and if he erred at all the error lay in extending the observed mechanism to cover all engagements whether in pregnancy, or in labour. But, in as much as NAEGELE'S paper was written from the practical point of view, and is, as has been freely admitted long after its publication, a statement and not a theory of the mechanism, the mechanism of engagement described by NAEGELE is the mechanism which is to be met with in practice, and is therefore, as I believe, a correct description of the mechanism as it is commonly to be observed. That serious stumbling block of the critics - the higher the head the greater the obliquity - is also correct in practice, either in flat pelvis or in pendulous belly. In the one, the description of NAEGELE corresponds to the more frequent and more favourable mechanism at the brim, to which I shall afterwards refer: in the other, the higher the head the more the fetus lies forwards on the pendulous abdominal wall which, as the head descends, becomes less and less propendent.

NAEGELE'S description of the caput and of the changes/

changes in position which it undergoes are, as DUNCAN admitted, and as I suppose everyone admits, correct. They are not, however, good evidence of the presence of anterior obliquity, though not for the reason which DUNCAN asserted. There is no cause, so far as I am aware, why the caput in the positions given by NAEGELE cannot co-exist with posterior obliquity of the head. NAEGELE'S positions of the caput are, however, as I hope to show, evidence of a form of anterior obliquity which by NAEGELE and his successors is confounded with the obliquity as I have defined it, but which seems to merit a separate name and description, as it has a distinctive nature and origin.

3. § In later times, the appearance of NAEGELE obliquity at the brim and its persistence through the normal pelvis has been supported by a minority, as the normal mechanism - by, among others, GARRIGUES (1902) who attributes the obliquity under ordinary conditions to gravity, and when excessive to pendulous belly which may, however, be a factor leading to posterior obliquity by lateral flexion of the fetus. FRITSCH (1875 and 1894), GALABINI (1875), SCHAEFFER (1899), and AHLFELD (1903), so far as I am able to judge/

judge, support NAEGELE but with reservations. FRITSCH states that NAEGELE'S obliquity is present at the inlet owing to the projection of the promontory and the smoothness of the anterior wall provided the head is large enough. Otherwise the mode of entry is synclitic. GALABIN found NAEGELE'S obliquity not infrequent at the brim. An angle of inclination of 15° to 20° gives the greatest mechanical advantage. GALABIN made experiments with a model pelvis and a wooden head. The head entered the pelvis synclitically, if the relative proportions were easy. But, if the resistance was at all great, the right parietal region descended before the left, i.e. with NAEGELE'S obliquity. SCHAEFFER considers that NAEGELE'S obliquity occurs in one-third of all labours at the brim, and that in anycase the right parietal becomes deeper than the left during the descent into the pelvis. AHLFELD believes anterior obliquity to be the commonest inclination at the brim, posterior obliquity being rare.

Synclitism at the normal brim is the accepted condition of most recent obstetricians, of whom I may instance LITZMANN (1871-2) who quotes SCANZONI for the same view, SPIEGELBERG (1882), SCHROEDER (1886)/

(1886), CHARLES (1887), WINCKEL (1887), WEIDOW (1888) WERTH (1888), ZWEIFEL (1889), MUELLER (1889), DODERLEIN (1895), DUHRRSEN (1896), JELLETT (1905), FEHLING (1908), and FABRE (1910).

The following besides DUNCAN, WEST, HODGE (1864), and LEISHMAN, adhere to synclitism at the brim, and add that anterior obliquity appears in the cavity - RITCHIE (1865), TARNIER (1865), HART (1879), PLAYFAIR (1880), TARNIER and CHANTREUIL (1882), LUSK (1891), OLSHAUSEN and VEIT (1893), PAZZI (1895), EDGAR (1903), GALABIN and BLACKER (1910), and according to DE SEIGNEUX (1901), WIENER. KÜSTNER (1885) implies the occurrence of synclitism at the brim by his observations on the axis of the uterus, and he states that lateral obliquities of the head depend "genetically" on variations of the direction of the uterine axis. PLAYFAIR believed the right side of the head to descend more rapidly, so that the head becomes flexed on the right shoulder. AUVARD (1894) held lateral obliquity to be normal at the brim, and to be increased with descent, synclitism being unfavourable to engagement. DUHRRSEN (1896) states that posterior obliquity may occur in the normal pelvis, but is unfavourable as to the prognosis of the/

the labour. JELLETT (1905) mentions circumstances preventing the occurrence of synclitism, NAEGELE'S obliquity being produced by relative disproportion, pendulous belly, and lateral flexion of the fetus. Posterior obliquity is rarer. WINCKEL (1887), however, held posterior obliquity to be commoner than the anterior variety in the normal pelvis. GALABIN (1910) considers that there must be lateral flexion of the head on the trunk before an obliquity can appear, it being assumed that the axis of the child is at right angles to the brim. The anterior parietal always lies deeper than the posterior relative to the horizon, owing to the oblique position of the head and the brim. But the head is synclitic to the brim notwithstanding. NAEGELE'S obliquity appears later during the descent. Lateral flexion is then not rapid enough to keep the parietal eminences level with reference to the planes of the canal.

SCHMIDT (1893) affirms NAEGELE'S obliquity to be abnormal both in the brim and through the canal.

A novel idea was originated in France by FARABEUF (1886) who postulated posterior obliquity as the normal attitude of the head, when it is passing/

passing the brim. He showed by experiment, in direct opposition to GALABINI (1875), that the head passes the brim more easily when it is inclined on the hinder parietal. In 1894, FARABEUF reaffirmed his view. PINARD (1887) followed and described posterior obliquity as the normal mode of entry, when the form of the abdomen is normal. If, however, anteflexion is present, then the head enters the brim with NAEGELE'S obliquity. DE SEIGNEUX, in 1896 and more completely in 1901^{ab}, exposed his researches on the mode of entry. His results are derived mostly from pregnancy, that is, they refer to the mechanism of engagement before labour begins. Much of the nature of DE SEIGNEUX'S work has been described already (Sect. II). The author found in 80 examples that 40 entered the brim with posterior obliquity, 18 with anterior obliquity, while 18 were synclitic with the brim. Only eight out of the total were in abnormal pelves, and of the group of anterior obliquities 14 were associated with pendulous belly. Though the mode of entry is thus variable, the head passes into a state of anterior obliquity with descent. After further analysis of the positions, DE SEIGNEUX concludes that in primiparae the rule is posterior parietal/

parietal entry, and in multiparae anterior parietal entry. PINARD and VARNIER (1892) describe posterior asynclitism which is corrected on engagement, after which anterior obliquity appears. If engagement is delayed until the onset of labour, uterine contractions increase the degree of the LITZMANN'S obliquity and finally produce the anterior obliquity. For PINARD and VARNIER, synclitism is momentary when it appears just below the mid pubic plane. VARNIER (1900) repeats these conclusions after further experience. SCHATZ (1901) in taking a similar view, attributes the later appearance of anterior obliquity to a bending forward of the uterus. He also mentions some curious conditions when there are twins in the uterus, and when one of them lies anteriorly and across the other, this one must have LITZMANN'S obliquity because it cannot bend. The same happens to a single child when the bladder of the mother is full. So also, when the back of the fetus looks much to behind, LITZMANN'S obliquity occurs. DEMELIN (1903) accepts the views initiated by FARABEUF and developed by PINARD and VARNIER.

4. § The writings of the various obstetricians, I have just cited, are a sufficient testimony to the bewildering/

bewildering variety of opinions that have been held and are still maintained not only on the exact mode of entry to the brim, but also on the causes which operate to produce the various modes of entry.

Further evidence seems desirable, and there are at least three ways in which it may be procured, namely, from frozen sections, from the published accounts of the mechanism of contracted pelves (especially flat pelves), and from what is known of moulding.

BARBOUR (1899), in a series of frozen sections with the head presenting, finds that, in not one, is the head synclitic at the brim. The sagittal suture is usually anterior to the axis of the brim, that is, the heads show posterior obliquity. These appearances are the main grounds for the view of PINARD and VARNIER. DE SEIGNEUX discounts them for reasons, which BARBOUR and others have exposed, that the attitude of the head is corrected by the assumption of the erect attitude in pregnancy, and by the appearance of uterine contractions in labour. BARBOUR further shows that in nine sections the head is inclined on the anterior shoulder in 5, and on the posterior shoulder in 4, thus giving a slight preponderance to LITZMANN'S obliquity. KEHRER(1907) asks if lateral flexion has ever been observed within/

within the pelvis in labour? NAEGELE, it is said, described lateral flexion, but the lateral flexion of later authors may possibly have been a hypothetical mechanism, invented to account for the discrepancy existing between the assumed direction of uterine pressure and the observed occurrence of NAEGELE'S obliquity after engagement. In any case, there is good reason to believe that the lateral flexion of the frozen section does not correspond to the lateral flexion which may occur within the pelvis, during a pain.

The mechanism of the flat pelvis seems a good avenue of approach, partly because the movements have been well described, and partly for the reason that a sufficiently long series of heads and pelvis would with great certainty show a close gradation of the phenomena between the movements taking place where the head and the pelvis are proportional to each other, and the movements in a well marked flat pelvis. That is to say, ultimately the normal pelvis and the flat pelvis are inseparable: no dividing line can be drawn which will separate the mechanism of the one from the mechanism of the other. Apart from what may be called adventitious circumstances, about which there are differences of opinion, two /

two mechanisms are described for the flat pelvis; one in which the head revolves around the pubis and the posterior parietal region comes down first, the other in which the head pivots on the promontory and the anterior parietal descends before the posterior.

According to TARNIER and BUDIN (1898), MICHAELIS (1851) who, if not the first, was one of the earliest writers on the mechanism of the flat pelvis held the anterior parietal to come down first as a rule. LITZMANN (1871) first described the obliquity which is known by his name, but he did not give it the position of greater frequency. LITZMANN found only twenty-three examples of posterior obliquity in 1800 births, and one in every ten labours in flat pelvis. The obliquity changes with uterine contractions or with artificial aid, and engagement is effected. TARNIER (1865), it is said, stated posterior parietal entry to be the rule, a view which he endorsed in 1887, when he gave as the cause the occurrence of lateral flexion of the head on the trunk. Subsequently, the primary descent of the anterior parietal region was admitted by nearly all writers on the subject to be the more frequent, and also the more favourable. Such was the view of SPIEGELBERG (1873 and 1882), KLEINWÄCHTER (?1876), STEELE/

STEELE (1874), who believed NAEGELE'S obliquity often to be so slight as to escape notice until labour comes on, and then with difficulty when only one side of the brim is contracted, FRITSCH (1875), GALABIN (1875), GOODELL (1875) who gives this order of occurrence:- first, NAEGELE, secondly LITZMANN, and finally NAEGELE obliquity on the completion of engagement, DUNCAN (1878), HART (1879), VEIT (1879), PAZZI (1895), GOENNER (1894) who found LITZMANN'S obliquity only 8 times in 2400 births, and of these eight, 7 were in contracted pelves and one was in a normal brim, but the head was hydrocephalic, DUHRRSEN (1896), MOTTA (1897), TARNIER and BUDIN (1898) who state that NAEGELE'S obliquity appears other things being equal, when the conjugata vera falls to or below 95 mm., BARBOUR (1899), BOLLENHAGEN (1900), who observed only 8 examples of LITZMANN'S obliquity in 1500 births, ZANGEMEISTER (1902) who had 10 of LITZMANN'S obliquity in 2250 births, OLSHAUSEN (1903) who considers LITZMANN'S obliquity evidence of a high degree of contraction, GALABIN and BLACKER (1910) and FABRE (1910).

On the other side, STEPHENSON (1880) favours LITZMANN'S obliquity. He says the posterior parietal/

parietal is deeper than the anterior: the posterior parietal rolls on the promontory: and the head becomes synclitic on engagement. JARDINE (1903) states that it is more common in flat pelvis to find the sagittal suture nearer the pubis, when the head is above the brim. The anterior parietal region comes down first, however, and then the posterior is forced round the promontory, until the head is synclitic and engaged. JARDINE further explains that the rounding of the symphysis is more difficult than the rounding of the promontory, because the area of resistance on the pubic bones is greater than that on the promontory. DE RIBES and BOUFFE (1908), in a single case of flat pelvis with a conjugata diagonalis of 90 mm., observed a primary LITZMANN'S and a secondary NAEGELE'S obliquity. Forceps were applied before an opportunity was given for further developments.

There is also some information to be derived from the behaviour of an aftercoming head in a flat pelvis, and also from a study of the mechanism invoked to deliver it. MUELLER, as far back as 1885, in advocating suprapubic pressure to force the head into a flat pelvis, recommended pressure to be so directed/

directed as to drive the anterior part of the head past the symphysis first, and to roll the whole head on the promontory. GOODELL (1875) advised the opposite method, namely, to pull forward after getting the head nipped by the conjugate as near the roof as possible, so that the pubic side of the head is tilted upwards from the inlet, while the sacral side passes down over the promontory; then to push the neck backwards while pulling as before, so that the pubic side of the head comes down. DUNCAN (1878) made experiments with an aftercoming head in a flat pelvis, and obtained better results by first bringing the posterior side of the head down and the anterior afterwards, there being a revolution around the promontory. Thus the evidence here is more in favour of primary LITZMANN'S obliquity, while with the oncoming head in a flat pelvis there is an overwhelming weight of opinion for primary NAEGELE'S obliquity. That this opinion is to some extent vitiated is evident when regard is had to the moulding of the head which is always considerable at the brim of a flat pelvis of any consequence.

DOHRN (1864) showed that the anterior side of the head is deeper than the posterior, which is flattened/

flattened by the pressure of the posterior wall of the pelvis. DOHRN attributed the pressure mainly to the promontory, and though this view no longer holds good for the normal pelvis it is still tolerably correct for the flat pelvis. BARNES (1865) held similar opinions. OLSHAUSEN (1870) attributed lateral moulding to the pressure of the middle part of the posterior pelvic wall, and claimed to have found pressure marks more on the posterior than the anterior side of the head. DUNCAN (1870) gave a similar explanation of the appearance in part of NAEGELE'S obliquity in the lower part of the cavity. Pressure is greater on the anterior half of the head and resistance is greater on the posterior. He implies indirectly that the pushing of the posterior parietal under the anterior is evidence of NAEGELE'S obliquity. This is DUNCAN'S vertical shear. OLSHAUSEN, MARTIN, and KREIS (ex litt. ad DE SEIGNEUX 1901a) all found that the posterior parietal is pushed under the anterior more often than the reverse, OLSHAUSEN in the proportion of 2:1. LABAT (1881) takes the unusual view that the posterior parietal remains in statu quo, while the anterior is displaced backwards over it. For RUNGE (1890) the anterior parietal/

parietal region is bulged and the posterior is flattened. It is due to the pressure of the pelvic walls and of the pelvic floor. BARBOUR (1899) states that there is a marked bulging of the anterior parietal region, because it is not supported by the soft parts. HART (1912) implies as much from stating that the factors of the moulding of the head are the resistant sacral segment and the concave anterior wall.

There is here plenty of evidence for the belief that the form of the head, when it is palpated per vaginam, creates the impression of NAEGELE'S obliquity. Such an idea is spurious and the form alone is no evidence of this obliquity. NAEGELE himself avoided the difficulty, intentionally or otherwise, by describing the relations of the sagittal suture at a time when moulding is seldom in evidence, and also by using the ear as an index. The ear is an infallible guide to the grosser forms of obliquity. DE SEIGNEUX also escaped this difficulty, but he set out to determine minute variations of the position of the sagittal suture with reference to the brim. In as much as a variation of the direction of uterine pressure amounting to 10° has a theoretical/

theoretical effect of displacing the sagittal suture, it may be, 5 mm. only and certainly less than 10 mm., the chances of DE SEIGNEUX being right or wrong are about equal. At any rate the difficulty of observation which he gave no satisfactory evidence of having overcome, militates considerably against the value of his long continued work. When the head is completely engaged and the cervix is little opened up, then the chances are that no moulding will have taken place (cf LABAT 1331), and the head will certainly present the appearance of synclitism. But here again the appearances are no trustworthy guide to the presence or absence of real obliquities. At a later stage moulding confers on the head all the appearances of NAEGELE'S obliquity; but it is now still more improbable, more than at any previous period, that the form of the head and the position of the sagittal suture afford any information as to the true attitude of the head. Indeed the evidence derived from palpation at this stage and in this connection, is practically worthless. In flat pelvis, where the moulding of the head is exaggerated at the brim, the form which the head takes is of little use in determining the inclination of the base of the fetal skull. DE SEIGNEUX draws attention to the fact/

fact that the breech in WALDEYER'S section shows NAEGELE'S obliquity. This is true in so far as the moulding gives that portion of the breech which overlies the pelvic canal, the appearance of NAEGELE'S obliquity. When however the entire breech is considered, the moulding gives the breech the appearance of LITZMANN'S obliquity.

§5. It is on lines such as these that we find an effective explanation of the enormous discrepancies of opinion/the inclination of the head in normal and in abnormal pelves, at the brim and in the pelvic cavity. And to avoid further confusion, it becomes necessary to differentiate two forms of obliquity, taking subordinate rank to those described by NAEGELE and LITZMANN. In the one, the base of the skull (the shoulder girdle or the pelvic girdle) is inclined laterally relative to the brim, or to any parallel plane of the pelvis. That is a true lateral obliquity. In the other, the base of the skull may or may not be synclitic, but the moulding of the head (the shoulders or the breech) is such as to give rise on palpation or on section to an appearance of obliquity. That is apparent lateral obliquity. Thus NAEGELE'S/

regarding

NAEGELE'S or LITZMANN'S obliquity may be either true or apparent, or it may be both apparent and true. Further, there is nothing in this view to prevent the probability of the simultaneous concurrence of one form of true obliquity with an opposite form of apparent obliquity— of true LITZMANN'S obliquity with apparent NAEGELE'S obliquity and vice versa. Synclitism may co-exist with an apparent anterior or posterior obliquity.

The cause of apparent obliquity is, as I have already indicated, the occurrence of moulding. The form which the moulding takes depends on the nature and distribution of the resistances. These I have described in some detail in Section III. The essential point is that resistance is least in the anterior and greatest in the posterior moiety of the canal. In consequence, apparent obliquity is probably invariably of NAEGELE'S type, when once the head has descended into the canal. Normally, no obliquity of this kind appears until the second stage is in progress, that is, after the rupture of the membranes, dilation of the os uteri, and descent of the head into the lower part of the cavity of the pelvis. Hence, after engagement is complete and so long as the os has little more than begun to dilate/

dilate, synclitism is apparent. Apparent NAEGELE'S obliquity may, however, appear at an earlier period as during descent, when relative disproportion of the head and the canal exists, and it is then due to the soft parts of the canal and the surrounding bones of the pelvis pressing on the head through the cervix. It appears at the brim in a flat pelvis, and also in a normal pelvis at the brim, under at least two conditions which readily occur to the mind. When a fairly advanced state of pendulous belly is present, the head is propelled, either by the forces concerned during pregnancy, or by the forces active during labour in the production of engagement, against the lumbar bodies and the sacral promontory against which the posterior side of the head is flattened, while the anterior side bulges into the area where "active dilation" has opened the way. The moulding which here results and which produces apparent anterior obliquity plays an important part, according to my experience, in facilitating the entry of the head into the pelvis. Secondly, whenever the head or the breech impinges on the upper border of the pubic bones and remains there for even a few moments, either during late pregnancy or in labour, apparent LITZMANN'S/

LITZMANN'S obliquity is produced without at the same time a true obliquity appearing of necessity. The anterior side of the head (or the breech) is submitted to pressure, while the posterior side overlies an area of least resistance; and the form into which the parts are moulded is in itself favourable to them gliding into a proper position either through pressure or by gravity, and before the development of a true inclination is rendered imperative.

A true obliquity whether LITZMANN'S or NAEGELE'S may arise from two principal causes. The one is independent of the resistances: the other cannot operate without them. The first is an inclination of the axis of the uterus, or of the sum of the pressures uterine and abdominal, away from an imaginary line drawn at right angles to the conventional base line - the conjugata vera. The second is the appearance of latero-flexion of the fetus with or without latero-flexion of the uterine system. Strictly speaking I suppose it is due to an incapacity of the uterus and child, or more probably of the fetus alone, to maintain a rectilinear attitude between the superimposed pressure and the underlying excessive resistances/

resistances. Alternatively, the cause lies in a retro-or ante-flexion of the uterus which may exist in gradually lessening degree during the period in which the uterus is being brought into line with, or is seeking the area of least resistance. While that condition is probably existent in the intervals its occurrence or persistence during the pains is perhaps doubtful, and therefore it does not rank of the same value, as an explanation, as the former alternative. In addition, the two principal causes may be co-existent, and between them they may lead to the production of an obliquity which is the opposite of what one would be led to expect judging from the direction of uterine pressure alone. Thus strong anteversion of the uterus predicates true NAEGELE'S obliquity. A simultaneous and masked latero-flexion of the fetus may produce true LITZMANN'S obliquity in spite of the anteversion of the uterus. Inasmuch as this true posterior obliquity, if it arises, will be associated with apparent NAEGELE'S obliquity, the position becomes distinctly complex.

At the very foundation of all possible explanations of lateral obliquity lies the direction of uterine pressure. This direction, as I have been at some trouble to point out, is unknown. We may/

may arrive at a probability which is founded on premises that have their origin in the pelvis or elsewhere, but the fact remains that the direction of uterine pressure during labour has not been determined by direct measurement. Evidence derived from the intra-pelvic position of the sagittal suture is of value only in recognising the grosser forms of true lateral obliquity, and then only before moulding has occurred. After that has taken place, the movements of the parietal bones hide all but the severer degrees of true obliquity, and these can be better estimated by the position of the ear. Moulding certainly invalidates deductions regarding the normal direction of uterine force, and also, as I have said before, inferences regarding the inclination of the base of the skull relative to the pelvis. KÜSTNER'S views are palatable, because they are in accordance with preconceived notions, but I maintain that the proof which is attached to them is of no greater value than that produced by PINARD and VARNIER in favour of posterior parietal entry. OLSHAUSEN arrives at conclusions precisely contradictory to those of KÜSTNER, while DE SEIGNEUX after a trial of similar methods seeks a compromise. Frozen sections give no satisfactory evidence alike in/

on the direction of uterine pressure, the presence of latero-flexions of the fetus, and the occurrence of true obliquities of the head. To sum up, it may be said, in general, that the form and position of the head within the pelvis, in the dead as well as in the living, and all methods so far employed to determine the position of the axis of the uterus afford no trustworthy indications either of the direction of uterine pressure, or of true lateral inclination of the fetal head.

That being so, it is possible to formulate an opinion on the mode of descent of the head only on premises that are similar in origin to those of most obstetricians. The reasons which appear of greatest moment are the form of the canal, alternatively the direction in which the soft parts tend to dilate; the excentricity of the area of least resistance; the direction of uterine pressure; and the position of the centre of pressure within the head. I have given reasons for believing that the anterior and the antero-lateral walls of the pelvic canal are inclined normally at an angle of about 100° away from the plane of the conjugata vera, and that, when such is not the case, the line of descent is/

is determined, as it probably is determined ultimately in every labour, by the direction in which the soft parts tend to dilate not at right angles to the plane of the conjugate, but probably at an angle of about 100° downwards and forwards from it. The area of least resistance lies within the anterior moiety of the canal (Section III) and is perhaps the principal factor in determining the direction of uterine pressure, though the appropriate direction is governed by other causes. The position of the centre of pressure lies, there is reason to believe, though it is at present impossible accurately to locate, in the anterior half of the head, when the direction of uterine pressure is inclined into the area of least resistance, and midway between the mesial plane of the head and the mesial plane of the pelvis, when the direction of uterine pressure is normal and the head is flexed or extended.

According to my experiments the excentric position of the centre of pressure does not disturb the inclination of the head when the relations of the head and the pelvis are average or easy. The head then descends evenly between the antero-lateral and the opposite postero-lateral wall of the canal (oblique position/

position), or between the two antero-lateral walls on the one hand and the two postero-lateral walls on the other (transverse position), without showing any tendency to dip laterally either the one way or the other. The even descent continues until the head is within the lower division of the upper part of the canal and is on the point of undergoing internal rotation. When however the resistance is more severe, as at the brim of a flat pelvis, and is indeed so great that the base of the head cannot pass the brim without first being tilted, then the anterior position of the centre of pressure determines the occurrence of true anterior obliquity at the brim. If in the other and rarer event the centre of pressure is situated in the posterior half of the head, then true LITZMANN'S obliquity will occur. (In this connection it may be well to repeat that though the centre of pressure is known to be able to move about and the conditions associated with the movement are also well recognised, the reason why the centre of pressure is able to move is, so far as I am aware, unknown).

The normal inclination downwards and forwards of the direction of uterine pressure which my premises/

premises demand, if not at the brim in all cases, at any rate in the majority after engagement is completed, implies a slight degree of true LITZMANN'S obliquity during descent. Even before moulding occurs, I doubt if the corresponding displacement of the sagittal suture is able to be recognised per vaginam. After moulding has begun to appear, the primary LITZMANN'S obliquity, if it occurs, is totally hidden by the production of apparent NAEGELE'S obliquity which goes on enlarging up to the moment at which internal rotation begins. When, however, the direction of uterine pressure is perpendicular to the plane of the conjugate, then the descent of the head is truly synclitic with a subsequent development of apparent NAEGELE'S obliquity; and when uterine pressure is inclined posteriorly, there is true NAEGELE'S obliquity, with as before a subsequent apparent anterior obliquity. The head descends into the lowest part of the upper portion of the canal without any true dipping, so long as the relations of head and pelvis are normal, as indeed they are in most labours. I question the development of true NAEGELE'S obliquity during the latter part of the descent before internal rotation ~~445^a~~. I am unable however to give a negative answer: the high degree of apparent NAEGELE'S obliquity which then arises totally masks the true inclination of the head.

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Fig 8.

Tracing of section by VON MARS to show slight true LITZMANN'S obliquity and marked apparent NAEGELE'S obliquity (after DE SEIGNEUX).

INTERNAL ROTATION.

Ever since it became known that the head of the brain of the pelvis occupies a different position in a horizontal sense to that which it holds at the inlet, almost every possible circumstance has been invoked to account for the change. The case has since sixty or one hundred and seventy years since the discovery of the oblique position of the head at the inlet have witnessed at least thirty eight distinct or separate potential causes of internal rotation, while the

SECTION V.

INTERNAL ROTATION.

number of theories has grown to still greater dimensions by means of the most varied combinations of the separate factors. It goes without saying that the various theories have had their supporters and their detractors, and that, on the whole, criticism has been more plentiful than praise. Further, as dynamic is growing knowledge, a good proportion of the theories has been modified more or less by their authors, and in at least one instance the author even discarded his own theory. In attempting to review this - the historical aspect of the subject, I have largely followed the method adopted by VASTORTA, in spite of its inherent defects, the principal of which is that the grouping of congenial theories is liable/

P A R T I.

INTERNAL ROTATION.

liable to obscure individual points of view. By its use, however, one is able to cover the ground

§ I. Ever since it became known that the head at the brim of the pelvis occupies a different position in a horizontal sense to that which it holds at the outlet, almost every possible circumstance has been invoked to account for the change. The one hundred and sixty or one hundred and seventy years which have elapsed since the discovery of the oblique or transverse position of the head at the inlet have produced at least thirty eight distinct or separate potential causes of internal rotation, while the number of theories has grown to still greater dimensions by means of the most varied combinations of the separate factors. It goes without saying that the various theories have had their supporters and their detractors, and that, on the whole, criticism has been more plentiful than praise. Further, so dynamic is growing knowledge, a good proportion of the theories has been modified more or less by their authors, and in at least one instance the author even discarded his own theory. In attempting to review this - the historical aspect of the subject, I have largely followed the method adopted by VALTORTA, in spite of its inherent defects, the principal of which is that the grouping of congeneric theories is liable/

liable to obscure individual points of view. By its use, however, one is able to cover the ground within a moderate compass.

§ 2. The posterior inclined plane and the sides of the pelvis theory.

SOLYRÉS (1771), BAUDELOCQUE (1781), CAPURON (1811), NAEGELE (1819), LACHAPELLE (1821), GARDIEN (1824), VELPEAU (1835), HUBERT (1858), MILNE (1879).

The slope downwards and forwards of the posterior and inferior parts of the canal, together with the sides of the pelvis in some instances, is held to be the cause of rotation.

SCHMITT (1804), it is said, denied the effective resistance of the lateral walls of the pelvis. GUILLEMOT (1837) attributed rotation to the pressure of the sides of the pelvis. In LIHOTSKY'S patient the sacrum, part of the ligaments and muscles of the pelvic floor had been removed: in the labour which followed the occiput rotated forwards (EDGAR 1893).

The mechanism is adequate to account for all rotations, even under certain conditions for the rotation/

rotation of a well flexed malrotating head in the occipito-posterior position, provided all rotations are admitted to occur at one level. This is not the case. In the occipito-anterior position the theory implies the vertex strikes the postero-inferior part of the canal very far back, a view which has often been held as a necessary consequence of the accepted direction of uterine pressure. If the vertex does strike far back, let us say the lower part of the sacrum, where does the forehead go?

§3. The lateral inclined planes theory.

TYLER SMITH (1858 and earlier) SCANZONI (1853), LEISHMAN (1864), DAVIS (1865), RAMSBOTHAM (1867), HUBERT (1878), PLAYFAIR (1880), NORRIS and DICKINSON (1896), REYNOLDS (1897).

The study of the lateral walls of the bony pelvis was pursued by TYLER SMITH, LEISHMAN, and also by HODGE. In effect, the posterior planes exercise a force directed backwards and inwards, while the anterior planes act forwards and inwards, the result being that an obliquely placed head is compelled into an antero-posterior position.

§4. The lateral inclined planes and ischial spines/

spines theory.

TYLER SMITH (1858), LEISHMAN (1876),
PLAYFAIR (1880), DAVIS (1896).

The ischial spines are called upon to overcome the difficulty of long rotation. When the head is well flexed, the occiput passes down in front of the ischial spine of the same side and long rotation follows: when the head is not well flexed, the occiput passes behind the ischial spine, and short rotation results. In the left occipito-anterior position the spines prevent malrotation. DAVIS added the general configuration of the canal, as an additional factor.

The objections to the inclined planes and the ischial spines are partly anatomical and partly clinical. SCANZONI did not believe in the effective action of the pelvic walls, because a small head rotates. DEPAUL (1872) took a similar view. FRITSCH (1875) considered the pelvis did not act alone, though it formed one of his factors. TARNIER and CHANTREUIL (1882) held the inclined planes to be inapplicable to occipito-posterior positions, as did PARVIN (1895) who also argues that rotation occurs at/

at different levels. HART (1885) says "mere change of shape in the bony pelvis will not cause rotation". It results in a distortion of the head but not in rotation. On the other hand, TARNIER (1882) held the deformation of the head to be an important factor for internal rotation. HART advances the breech as an exception to pelvic rotation, and the mechanisms of rickety and kyphotic pelvises as negative evidence for the inclined planes. Much has been made especially in recent years (VEIT 1887, VARNIER 1888, and many others) of the incapacity of the bony pelvis to act on the well flexed fetal head. I doubt not the fact, but the interpretation, and shall return to it later. GUZZI denies all pelvic factors and VALTORTA (1912) who quotes the former objects to the inclined planes for the following reasons :- the shoulders sometimes rotate before the head; rotation according to the theory takes place at too high a level as compared with the level of that generally observed; the planes are more apparent than real.

The ischial spines do not project to the extent implied by the theory. The tense sacro-sciatic ligaments are continuous with the spines in a direct line on each side, and preclude the passage of/

of the occiput behind a spine. The level of rotation is still further defined. Even if the spines be held in a given case to prevent malrotation, the explanation of long rotation still devolves on the inclined planes.

§ 5. The lateral inclined planes and the pelvic floor theory.

HODGE (1864), while relying mainly on the inclined planes of the pelvis, states either that rotation is completed by the floor, or that the two lateral halves of the floor are continuations of the lateral planes, and further rotation in the same manner. In 1870, HODGE added as an important factor the form of the fetal head, and he asserted that a spherical object is incapable of rotation in the canal. JONES (1906) combined the single plane theory with the lateral planes, and added the pelvic floor à la HILDEBRANDT.

As regards the canal the absence of rotation in a sphere appears to be indisputable. The exponents of the curved canal theories have, however, shown that a sphere will rotate. My experiments indicate that the floor can rotate a body having no advantage in one diameter over another.

§6. The lateral inclined planes, ischial spines and pelvic floor theory.

RITCHIE (1865), PLAYFAIR (1886), GRANDIN and JARMAN (1895), GARRIGUES (1902).

RITCHIE states that the ischic-pubic ramus is a bevelled edge. The occiput slips over it and has no tendency to return. So also the sacro-sciatic ligaments prevent the sinciput coming forward. The ischial spines further control the direction which the head takes. The perineum operates only when the above methods have failed, and then the head accommodates itself to the groove of the dilated perineum. Here RITCHIE may be said to have anticipated HILDEBRANDT. The former also anticipated HART, and was himself preceded by WEST, in formulating the rule that the first part to strike the pelvic floor rotates forwards. In the occipito-posterior position, according to RITCHIE, the sacrum, coccyx, ligaments and perineum act in a direction forwards and inwards on the occiput, while the sinciput is pressed backwards and inwards, the result being long rotation. If these forces are directly opposed, the forehead descends, the result being short rotation. It is further pointed out that, if the head is small, rotation may be delayed until the level of the vulva, and/

and that in any case long rotation is nearly impossible at the level of the ischial spines. PLAYFAIR, in the 1886 edition of his textbook, describes the three methods of rotation, and finally admits that the pelvic floor theory forms an easier explanation than any of its predecessors.

A special interest is attached to the paper of the late Dr PEEL RITCHIE, both in the present connection and in his anticipation of Laŕs's theory of the general-contents pressure. In both instances he evolved a new idea, and yet failed alike to attain a clear detailed view of the principles implied and also to carry conviction, perhaps for that very reason, in his exposition of the then novel views. It is, of course, impossible that the pelvic ensemble can distinguish occipito-anterior from occipito-posterior positions, and it is therefore, idle to postulate two different true causes of rotation at the same level. RITCHIE does not explain how his two forces come to be sometimes directly opposed, nor does he show why in the occipito-anterior positions the occiput does not return to its original position on the ischio-public ramus.

§7. The general configuration of the pelvis theory/

theory.

As the head descends through the bony pelvis, it meets with diameters which contract transversely and enlarge antero-posteriorly. These changes in combination with one or two other factors are sufficient to account for internal rotation.

SMELLIE (1752) laid greatest weight on the pelvis, at the same time emphasising the contraction of the transverse diameters more than the increase of the antero-posterior. He also recognised the area of least resistance as a factor for internal rotation. Van SOLINGEN (1801) adopted the changes of the pelvic diameters and added the shape of the rotated part, meaning thereby its oval or elliptic asymmetry. SPIEGELBERG (1882) also relied on the change of form within the bony pelvis, as the principal factor, but he accepted a number of other factors, for example, the inclined planes of the pelvis, the ischial spines, the pelvic floor, and the primary rotation of the body of the child.

HART (1885) and BÄCKER (1891) object that mere change in shape of the bony pelvis will not cause rotation, but will result in a distortion of the head by pressure. As however the resistance of the pelvic floor is in nature essentially the same as/

as the resistance arising from the bony pelvis, the objection does not amount to much. Further, if the base of the head overlaps the bones of the pelvis to any degree either rotation or tilting of the head must occur. A weightier objection lies in the fact that the supporters of the pelvis theory (and this applies also to the inclined planes and the ischial spines) have not been at sufficient pains to show the diameters of the head are sufficiently large, or are so disposed that the bony pelvis is able to operate upon them. HART instances the breech as being too small relative to the pelvic diameters for the latter to affect it, and at first sight the objection seems sound.

§8. The screw-line and direction of pressure theory. SCHATZ (1870, first published 1868).

This theory might almost have been placed in the category of primary rotation of the body, but the two factors designated by the heading give it an especially unique character. The interest of the theory is purely historical, and its ingenuity alone entitles it to be remembered.

After pointing out why rotation is necessary, SCHATZ asserts that the direction of the expulsive/

expulsive powers is inclined backwards against (that is downwards and forwards towards) the plane of the inlet, so that each of the two lateral halves of the linea innominata forms an inclined plane, or more correctly a screw line, directed against the expulsive forces. SCHATZ then argues that the uterus embraces the fetus so firmly that a ridge of the chest projects over the screw-line on one side and a ridge of the nape over the screw-line on the other. The ridge which is larger and better supported is moved forwards towards the symphysis. The lesser projection is formed on the nape, the larger on the chest. The latter is on the convex side of the fetal column and is therefore better supported: the former disappears. Thus the former gains the victory and leads to the chest rotating towards the symphysis, and incidentally carries the head into the antero-posterior position within the pelvis. SCHATZ says that in animals the effect of body rotation is even more evident than in man, for in the former rotation proceeds at a time when the head is not in the circular canal of the pelvis.

In the discussion which followed HEGAR considered that the direction of pressure had not been proved to be inclined as SCHATZ asserted, and that in fact the direction was otherwise. Under these circumstances/

circumstances the screw mechanism failed. SCHATZ, in his reply, admitted that his mechanism is not the only one, but is the principal, the pelvic factors being always subsidiary

LAHS (1870) also considered SCHATZ had not proved the backward inclination of the direction of fetal-axis pressure. FRITSCHE (1875) in a more general connection considered the direction of pressure not only undetermined but also indeterminate. It might also be argued, as it probably has been already, that the existence of the ridges has not been satisfactorily demonstrated. SCHATZ himself may be said to have settled the matter, when twenty-two years later he was controverting the primary rotation of the body.

§9. STEPHAN'S theory.

STEPHAN (1877) founded his theory on a postulated increase of the bend of the trunk of the fetus during labour, a resistance opposed to the shoulders where the large pelvis meets the small pelvis at an angle, and a special form which he considered the uterus to assume during labour. As STEPHAN attributes rotation to the trunk his theory might properly be classed with the body-first theories/

theories. But in other respects the theory holds a place of its own. STEPHAN found experimentally that, when two ends of an elastic rod are neared, the rod rotated until it was in the same plane as that of the pressure. The uterus becomes more ball-formed during the first stage. As a consequence it becomes shorter, and as the shoulders are resisted by the margins of the large pelvis the trunk becomes more curved. During the second stage abdominal pressure forces the fundus backwards. The anterior part of the uterus then remains of a rounded form, but the posterior is flattened against the spinal column. The result of the operation of these various factors is that the fetal trunk, which takes up an oblique position towards the end of pregnancy, is rotated into the direct position and carries the head within the pelvis along with it.

§10. The lower part of the sacrum theory.

FABBRI (quoted in extenso by HEGAR (1870) from HYERNAUX (1866)) appears to have attributed rotation to the lower part of the sacrum, but he also admitted the action of the pelvic floor and of the body of the child as a rotator. According to FABBRI, the forehead fixes itself on the lower part of/

of the sacrum, when the head is in the occipito-anterior position. The fixation of the forehead leads to the occipital pole going deeper and rotating under the pubic arch. KÜNECKE (1869) expressed a similar idea, but in a slightly different form. The head by its descent is laid lengthwise on the lower end of the sacrum to which it forms an equally-armed lever. The tuber parietale is the pivot of rotation. There is more pressure directed against the occiput (fetal-axis-pressure), and in consequence this part of the head is moved and rotated towards the anterior pelvic wall. Long rotation is, however, due to the general resistances of the canal and the apposition of the nape to the hollow of the sacrum, which latter circumstance leads to an increase of pressure on the occiput. When the resistances of the canal are deficient short-rotation is the result.

This theory does not agree very well with ordinary clinical findings. In the normal event, only a small part of the head, either occiput or sinciput, comes into contact with the lower part of the sacrum before rotation is begun. Afterwards, in many cases, when rotation is completed, the large circumference of the head is already below the level of the apex of the sacrum.

LAHS/

LAHS (1870) translates KUNECKE'S views into a leverage of the head under the symphysis, that is "a bending on the knee of the canal," as the cause of internal rotation. I cannot say that this completely represents KUNECKE'S views. It is, however, delicate ground.

§ 11. The pubic arch theory.

KIWISCH (1846) believed that the pubic arch had an influence in determining the occurrence of the occipito-posterior positions. When the anterior fontanelle comes low, the forehead is able to escape forwards under the pubic arch and the occipito-posterior position results. According to BERTHAUT (1908), the pubic arch is the most important factor for internal rotation, but is not the only one. The head descends to the inferior end of the sacrum and the posterior perineum. The resistance of these structures pushes the head forwards, but is not able to rotate it. The rotation occurs when the head in the oblique position is projected against the anterior pelvic wall, where the arcade of the pubis "intervenes passively to make the head turn in a manner favourable to delivery." The head passes under the arcade, because the resistance of the pelvic floor is obliquely opposed to the uterine pressure/

pressure, and the area of least resistance lies forwards. BERTHAUT doubts the efficiency of uterine pressure to turn the occiput forwards, after it has been turned directly backwards. Apparently the long rotation of the direct occipito-posterior position has been observed always to begin at the brim. BERTHAUT further states that the centre of rotation is situated approximately where the spine is joined to the occiput, and that, if the head is not fully flexed in the occipito-posterior positions, the ischial spines may prevent the occurrence of long rotation. My experiments confirm, in part at least one of BERTHAUT'S observations. When the perineum is relaxed, if not too much, it favours rotation by the pubic arch. Ordinarily the perineum resists the uterus until rotation is completed. The perineum, however, is distended during long rotation (BERTHAUT). Thus BERTHAUT admits three factors and possibly a fourth - the pubic arch, the floor, the area of least resistance, and in certain cases the sciatic spines. The influence of the pubic arch is approved by GIGLI (1905), but he accords it only a subordinate position.

The pubic arch is able to produce internal rotation both in occipito-anterior and occipito-posterior positions under appropriate conditions.

But/

But it is not the sole cause, nor even a factor in the occurrence of all rotations, and the combination of factors given by BERTHAUT is inadequate for the production of internal rotation, even at a low level in the canal.

§ 12. The pelvic floor theory.

BOIVIN (1824), STOLTZ (1826), CASEAUX (1840), SIMPSON (1846), JACQUEMIER (1846), SIEBOLD (1859), HYERNAUX (1866), COHNSTEIN (1871), SCHROEDER (1875), NAEGELE and GRENSER (1880), LOCHARD (1881), HART (1885), SCHROEDER (1886), FARABEUF and VARNIER (1886), CROUZAT (1887), CHARPENTIER (1889), BUDIN (1891), RUTHERFORD (1893), JEWETT (1899), COLES (1899), SCHAEFFER (1899), HIRST (1900), DAKIN (1900), FOTHERGILL (1900), VARNIER (1900), AHLFELD (1903), WILLIAMS (1903), RUSSELL (1904), HERZFELD (1905), HERMAN (1905), HARDY (1907), DORLAND (1907), APFELSTEDT (1908), TWEEDY and WRENCH (1910).

The list includes those who either rely entirely on the action of the pelvic floor or give it chief place and regard other admitted factors as of small value. The following also account the pelvic floor as of great importance, but give considerable prominence to other factors. DUBOIS (1834) HILDEBRANDT/

HILDEBRANDT (1866), LAHS (1870), TARNIER and CHANTREUIL (1882), INVERARDI (1886), WINTER (1887), CHARLES (1887), MARX (1892), EDGAR (1893), PARISOT (1893), DEMELIN (1903), PARAMORE (1909^{ab}), EDEN (1911), RICE (1912), VALTORTA (1912). Others admit the importance of the pelvic floor, but decline to regard it as the principal cause of rotation.

Although the pelvic floor theory is nearly one hundred years old, CASEAUX (1840) appears to have been the earliest writer to expound clearly a method by which the floor might be supposed to act. Generally, the cause of internal rotation lies in the form and direction of the canal, and in the shape and size of the head. Adapting the "reflected force" of SOLAYRÉS CASEAUX (the idea seems to have been reached independently by SIMPSON in 1846) considers that the uterine pressure acts downwards and backwards, and is opposed by the resistance of the pelvic floor which acts upwards, forwards, and inwards on the first part of the head to strike. As a result, the occiput usually is moved forwards and inwards to the anterior part of the pelvic canal. Ordinarily the head meets with no resistance from the bones: resistance first comes from the pelvic floor.

The cause of internal rotation, according to/

to HILDEBRANDT (1866) is the soft parts of the pelvic floor, above all the levator ani, the musculus coccygeus, and the fascia. These, when pressure is exerted upon them, form a funnel whose long axis is directed downwards and forwards towards the outlet. In addition, they are divided by or enclose a cleft which runs sagittally. The effect of the funnel-shaped form and the sagittal cleft is to compel an obliquely or transversely placed head to take up a position in which the mesial plane of the head nearly coincides with that of the pelvis. The head turns with the occiput forwards whenever the latter strikes the floor. The effect continues in the intervals of the pains owing to the elasticity of the extended parts. Rotation is delayed when the pelvis is flat, when the head is round, and when the soft parts of the floor are deficient in strength. HILDEBRANDT, however, did not consider the pelvic floor to be the sole cause of rotation, and acknowledged the influence of the shoulders on the rotation of the head in the upper half of the pelvis.

§ 13. HART (1885), divides the pelvic canal and floor into two parts - an anterior or pubic segment which is smooth, and a posterior or sacral segment/

segment which is strong, elastic, and resistant. It is divided arbitrarily into right and left lateral halves, each of which acts at right angles to its line of insertion and parallel to the anterior wall. Owing to the relative shortness of the anterior wall as compared with the relative length of the posterior wall, the anterior portion of the presenting body reaches the floor before the posterior portion. An initial SOLAYREAN obliquity being postulated, the more advanced part strikes one lateral half of the sacral segment and is compressed and pushed forwards, before the less advanced part is able to reach the opposite lateral half of the sacral segment. The corresponding pubic ramus is admitted to have an influence in determining the course of the head. All rotation ceases when the head is placed symmetrically in the pelvis. Rotation usually takes place below the level of the ischial spines. DR HART then formulates several laws for internal rotation the principal of which had been anticipated, as I have pointed out by CASEAUX, by HILDEBRANDT, RITCHIE, and WEST. The most important is that the first part of the presenting body to strike the pelvic floor is rotated forwards. Arising out of that law is the corollary that no part ever rotates directly backwards/

backwards. In the short rotation of the occipito-posterior position, it is incorrect to say that the occiput rotates backwards, what does happen is that the sinciput rotates forwards.

§14. FARABEUF and VARNIER (1886) (and the latter 1888) first of all quote the average dimensions of the outlet of the bony and ligamentous pelvis, in repose and in activity, from the figures given by many authors from BANDELOCQUE to DEPAUL. They compare these figures with the usually accepted measurements of the diameters of the fetal head, namely, sub-occipito bregmatic and biparietal, pointing out at the same time that the head is oval and not round (FARABEUF), the former diameter being 9.5 cm., the latter 9.2 cm.. In the static pelvis, the three diameters are each 11 cm., in the dynamic pelvis the antero-posterior diameter is enlarged till it measures 13.5cm. VARNIER, therefore, concludes that the bony and ligamentous outlet does not determine internal rotation. Further, as VARNIER believes the sub-occipito-frontal to be the diameter engaged, he measured this diameter in 221 infants after birth, and found it to average from 10.2 cm. to 10.5 cm. so that, according to VARNIER, the maximum diameter engaged/

engaged is still inferior to the minimum diameter of the outlet. If the classical figures are correct, the coccyx is not repulsed by the head; there is no need for rotation, except at the vulva. It is well known clinically that the coccyx is repulsed, and VARNIER found that, whenever the S.O.F. diameter equals 10.5 cm., rotation is completed before the frontal region passes the coccyx. VARNIER next details how a true antero-posterior diameter of 8.5 cm., was discovered, and shows that it is capable of an average increase of 2 cm. As the transverse diameter is 11 cm. the deduction drawn is that rotation ought to take place into a transverse position the more so as the coccyx is as hard and resistant in pregnancy as it is in a nullipara. FARABEUF and VARNIER, in order to find another cause, made a series of very interesting experiments. They eviscerated the pelvis of an adult multipara, and introduced a stomach filled with water and ligatured at both ends. The large end was applied to the pelvic floor, and pressure was exercised on the small end. Looking from below they saw a hernia of the stomach in the pelvic floor. It was oval with the small diameter transverse. The antero-posterior diameter increased 10-20 mm. Hence, a buttonhole existed in the pelvic/

pelvic floor, and the opening always tended to be longer than broad. The margins of the buttonhole seized the stomach and never yielded sufficiently to cause pressure on the ischial tuberosities. The more the coccyx was repulsed, the more tense became the margins of the buttonhole. The authors repeated the experiment with a balloon distended with air, and spherical in shape, being about the size of the fetal head. In passing through the buttonhole the sphere became flattened transversely. According to SAVAGE and FARABEUF'S dissections, the buttonhole is formed by the pubo-coccygeal fibres of the levator ani, and this is the true cause of internal rotation. VARNIER thinks that the buttonhole, in addition to producing rotation, also directs the occiput forwards.

§ 15. PARAMORE (1909^{ab}) takes an altogether different view of the mechanism of the pelvic floor. The pelvic floor under pressure forms a broad gutter inclined downwards and forwards towards the outlet. It is incapable of producing rotation, and its principal function is to project the head downwards and forwards towards the outlet. Incidentally it furnishes to the head a point d'appui for the development of internal rotation. This fulcrum is necessary to rotation/

rotation: in its absence rotation does not occur. Two other factors are postulated:- the excentric position of the axis of pressure in the flexed or extended head, and the form of the pelvis towards the outlet. PARAMORE shows that the axis of pressure in a well flexed head extends from the anterior margin of the foramen magnum to a point on the surface of the head a little in front of the posterior fontanelle. In its lower part the axis is concentric with the circumference of the head, but higher up it becomes excentric, and at the uppermost part the frontal pole lies twice as far from the axis as the occipital pole. The pelvic canal diminishes in size transversely and increases antero-posteriorly from above downwards towards the outlet. The position of the forehead is excentric relative to the pelvis. In the left occipito anterior position, vertex presentation, the vertex strikes the pelvic floor in the region of the coccyx. The occiput is projected forwards, while the sinciput falls in behind, mainly owing to the drift inwards of the postero-lateral wall of the corresponding side. In the well flexed occipito-posterior position, the vertex strikes first and is impelled forwards: the sinciput is compressed against the antero lateral wall high up, where there is/

is more room in the transverse diameter of the pelvis and is compelled to move backwards to the transverse diameter. This movement allows the cranial axial line to move forwards towards the symphysis, because the forehead is excentric, and in consequence more pressure is developed anteriorly to the forehead than behind by the lateral pelvic wall. Pressure and resistance then enforce a continuation of the rotation, and the forehead passes into the hollow of the sacrum. In support of the pelvic factor PARAMORE advances those arguments which were sufficient for HART and others to condemn pelvic rotation, namely, the failure of long rotation in a small round pelvis and in a kyphotic pelvis. The short rotation of the head in the occipito-posterior position with, anterior fontanelle presenting, is also explained. When the floor is absent or not sufficiently resistant, the head may move backwards, forwards or sideways, but it does not rotate.

¶16. SCHROEDER 1836, HIRST, DAKIN, FOTHERGILL, HERZFELD, HERMAN, DORLAND, HARDY, TWEEDY, and WRENCH either declare themselves expressly, or avow themselves by implication followers of Dr BERRY HART.

EDEN/

EDEN and RICE accept HART'S mechanism, but add other factors. EDEN believes the inclined planes to operate whenever there is relative disproportion between the head and the pelvis: RICE adds the direction, or rather the misdirection of uterine pressure, but it is not clear whether he is referring to a true misdirection or only to a transference of the axis of pressure from the occiput to the sinciput. BARBOUR (1895, 1898, 1899) agrees with HART as to the mechanism of the floor, but seems inclined to allow equal value to the mechanism of ZWEIFEL. RUTHERFORD appears to advocate a pelvic floor mechanism similar to that of HILDEBRANDT.

The following place the pelvic floor mechanism first, but add other and indispensable factors. TARNIER and CHANTREUIL (1882) combine with the levering power of the head (as PARAMORE has described it, though it was first announced by TARNIER in 1865, and approved by STEPHENSON in 1881) and the moulding of the head. INVERARDI (1886) adds the leverage of the head to the effect of the floor, as do also PARISOT (1893) and VALTORTA (1912) who admit the general configuration of the canal. MARX (1892) does not exclude the ischial spines from influence /

influence on the head, while DEMELIN includes the plane of the least dimensions. EDGAR (1893) is unable to deny the effect of primary rotation of the body. CHARLES and AUVARD (1894) derive rotation from the floor and the general form of the canal. DUBOIS (1834) adds the law of accommodation and the resistance of the posterior and inferior parts of the canal. For DEMELIN (1903) it is the floor and the sacro-sciatic ligaments. LAHS (1870), in addition to the action of the pelvic floor, gives an important place to the leverage of the head, and admits the general configuration of the canal (namely the bony pelvis), when there is relative disproportion between the head and the pelvis.

LAHS (1870) states that rotation is dependent on the length of the lever arms extending from the sinciput to the vertex and from the vertex to the occiput. If in the occipito-anterior positions, the forehead strikes the floor first, the head will rotate into a transverse position and may be born so. When the pelvic canal is roomy, rotation takes place, after the occiput has passed below the pubis, by means of the pressure of the posterior part of the head acting on the pelvic floor. When, on the other hand, there is some degree of difficulty, the pelvic bones act. In the canal, the long diameters/

diameters change from transverse to antero-posterior during descent, and any object passing through describes a half-spiral, owing to the oval form of the head and the general-contents pressure. WINTER attributes internal rotation to the inclined plane of the pelvic floor. But, in the occipito-posterior positions, another factor comes into play. There is a vacant space on the anterior face of the sacrum. If the little fontanelle goes into this space, short rotation results. If, on the other hand, the little fontanelle comes down a little on one side, so as to touch the coccygeus muscle which constitutes the most raised region of the pelvic floor, then long rotation results, presumably in the manner suggested by VARNIER.

§ 17. General objections to pelvic floor theories.

LEISHMAN (1864), arguing in favour of the inclined planes, objects to perineal rotation as a satisfactory cause. He admits that rotation takes place partly below the level of the bones, and that during rotation the head meets the resilience of the pelvic floor, but that rotation occurs as a rule before the perineum is distended. FRITSCH (1875) holds that rotation is complete in most cases before the/

the head presses on the floor. FABBRI and BERTHAUT (1908) consider rotation to occur before the floor is distended. According to VEIT (1887), the floor does not act in a great number of cases, because rotation often begins before the floor becomes active. CHARPENTIER (1889) asserted that the pelvic floor cannot be the sole cause because it ought not to fail in primiparae in whom the perineum is firm. PARVIN (1895), who quotes CHARPENTIER, adds that rotation may occur before the floor is reached. BUMM (1905) doubts the capacity of the soft parts per se to produce internal rotation, and to this PARAMORE (1909) agrees. PARAMORE further objects to the pelvic floor theory, and quotes HERMAN (1904) that rotation usually fails when the fetal head is small and the ~~pelvis~~ large, - the very conditions under which the pelvic floor is believed to be effective. PARAMORE'S objections based on contracted pelves do not, however, mean necessarily that the floor is not operating, though it may be inoperative. VALTORTA believes the function of the perineal plane is to direct the head forwards, and that, as a rule, rotation results from the leverage of the head between the perineum and the opposite lateral pelvic wall/ margin in order to maintain the oval form of the

wall. The head can rotate without having reached the level of the perineum.

§18. Objections to particular pelvic floor theories.

SCHATZ (1890) criticises that portion of HILDEBRANDT'S theory which refers to the sagittal cleft in the levator ani. This SCHATZ believes to be effective for the left occipito-anterior position, but to fail to explain long rotation from the right occipito-posterior position. Secondly, rotation is often complete before the cleft in the levator ani is effective. BUMM (1905) raises SCHATZ'S first objection against the pelvic floor, when it is supposed to act as a "gutter" with its long axis directed downwards and forwards. PARAMORE (1909^a) denies the effect ascribed to the vulvar outlet by WILLIAMS (1903), and so far as I can see the same criticism is applicable to HILDEBRANDT'S sagittal cleft and VARNIER'S pubo-coccygeus muscle. PARAMORE pointed out that, owing to the nature and arrangement of the parts, the tension at the posterior commissure of the vulva ought to be twice as great as that in the lateral margins, because the posterior commissure has to travel twice as far as either lateral margin in order to maintain the oval form of the/

the outlet. Hence according to PARAMORE, the dilation of the vulvar outlet by the obliquely situated oval head ought to place the latter in a transverse instead of an antero-posterior position. This would be true, if the soft parts external to the lateral margins were of infinite, or at any rate greatly extended, width. It happens, however, that the ischial tuberosities are very near and make themselves felt as a superior resistance long before the soft parts are completely effaced. This resistance is greater than that developed at the posterior commissure of the vulva, or of the pubo-coccygeus muscle, and, therefore, tends to lead the head to the antero-posterior position. The present point of view, of course, supports Dr PARAMORE in that it tends to show that the mechanisms which undoubtedly take place where WILLIAMS, HILDEBRANDT and VARNIER say they occur are not due solely to the form and resistances of the commissures of the pubo-coccygeus muscle, the levator ani and the vulva. VALTORTA affirms that the first part to strike the pelvic floor is not always carried forwards. The same view is found in SCHATZ'S (1890) paper, but is so obscurely worded that it is difficult to grasp SCHATZ'S reasons. PARAMORE (1909^a)/

(1909^a) says there is no proof that the forehead first meets the pelvic floor in a persistent occipito posterior position. The occiput and the forehead meet the floor simultaneously, and PARAMORE holds that, in these cases, the forehead is rotated forwards, not because it strikes the pelvic floor first, but because the usually effective mechanism has failed.

An objection to all pelvic floor theories is that they do not account satisfactorily for long rotation. It is true that the pelvic floor forms an incline with the plane of the brim, and that it will produce long rotation, so long as uterine pressure is applied at right angles to the brim. But it does so under great difficulties, slowly, and with considerable danger to the perineum. Under another direction of uterine pressure, as will be shown, it does not produce long rotation at all. Pelvic floor theories do not account for the occasional short rotation of a well flexed head in the occipito-posterior position, or the more rare long rotation of a well flexed head in the occipito-anterior position. It is not an adequate explanation that the resistance of the pelvic floor is insufficient to produce long rotation/

rotation. If short rotation occurs, there must be, according to the theories, still some resistance, and we would expect it rather to produce an incomplete amount of long rotation than any degree of short rotation. Further, a total absence of resistance ought to mean no rotation at all. In the left occipito-anterior position, the mechanism of the pelvic floor fails to explain the long rotation of the head from the primary left occipito-anterior position, and which is so much more laborious than the ordinary short rotation. The pelvic floor theories break down again in those cases of split pelvis and pelvic section, in which rotation does not occur. The separation of the innominate bones ought to increase the tension of the pelvic floor and so favour the occurrence of internal rotation. That the head sometimes goes back towards its originally oblique position during the recoil, after it has been pressed on the pelvic floor, argues against universal pelvic floor rotation. My experiments show that the movement is manifest only in the pelvic canal. When rotation is produced on the floor alone, the head remains stationary in the sense of internal rotation during the recoil.

§19. I am unable to understand HART'S theory except as the mechanism of a rigid perineum. Dr. HART postulates one part of the head striking the floor before another. He does not say what happens when the other part strikes. Whenever this event happens, then according to the theory the head should be swept into the transverse position, because Dr. HART does not admit the existence of any posteriorly directed force or resistance derived from the pelvic floor. Otherwise the pelvic floor must be so rigid that rotation is over before the later coming parts of the head reach the floor. Such a mechanism is possible but not very probable. A certain amount of movement either forwards or downwards is, I believe, essential to the occurrence of internal rotation. In the presence of the anterior pelvic wall, the scope for forward movement is limited to whatever distance intervenes between the anterior lying pole of the head and the pelvic wall. As a rule, the head descends in close opposition to the pubic bones. Downward movement implies depression of the pelvic floor by the head, and as soon as depression occurs then the other pole of the head comes into contact with the floor. The effect of the floor on this portion of the head is at least as great as it is on the former.

A weighty objection arises from the mechanism of the oncoming shoulders. This point I shall deal with in its proper place. The great value of Dr HART'S views does not lie in the mechanical causes which he propounds - these I believe to be inadequate - but in the laws for internal rotation which he first stated with precision and with some attention to detail. These laws are based on an extreme probability and are therefore likely to prove correct within the average range of experience. But there are rare exceptions to which the laws do not apply, and for which Dr HART has given no mechanical explanation.

The pubo-coccygeus muscle is not an efficient cause of internal rotation. In some labours it is clearly recognisable, in others it cannot be discovered. In the former it undergoes effacement in the course of time. But before it does so, the head descends into it, and time is lost while on the one hand the head is moulded and on the other the muscle is effaced. The resistance which the muscle offers is therefore diminishing at a time when, at least it ought to be maintained. The pubo-coccygeus muscle is intimately connected with the margins of the bony and ligamentous outlet. It does not rise and/

and fall like the pelvic floor under the alternate application and release of pressure. It ought therefore to be considered mechanically as a constituent of the soft parts lining the bony pelvis, and not as part of the pelvic floor. Even though these objections do not stand, the pubo-coccygeus muscle does not account for long rotation. VARNIER says the occiput in the occipito-posterior position strikes the muscle, instead of sinking into the cleft directly and gradually moves forwards. But he does not explain why this should be in the occipito-posterior and not in the occipito-anterior positions, and he does not give any adequate cause forcing the occiput forwards over the muscle.

PARAMORE'S views mark a great advance over those of his predecessors especially by advancing the idea of a central fixation point for the head on the pelvic floor, by restoring in a form more consonant with modern ideas, the excentricity of pressure within the head, and by allotting to the pelvic walls a share of the work of producing internal rotation. The last point is agreeable with clinical experience, and no theory of internal rotation can be satisfactory unless it takes into account the resistance/ is role in the production of internal rotation/

resistance of the normal pelvic walls on the normal head. In other respects, his theory does not differ much from the first part of HILDEBRANDT'S theory, of which indeed it may be said to be the logical continuation; and it is liable, as is HILDEBRANDT'S, to the general objections to all pelvic/theories. Dr PARAMORE'S theory is no better than its predecessors in explaining why a well flexed head in the occipito-posterior position should, apart from purely pelvic causes, sometimes rotate forwards and at other times rotate backwards.

floor/

LAHS'S theory, in so far as it concerns the pelvic floor, resembles BERRY HART'S. LAHS, however, rightly draws the deduction demanded by the theory, that when the forehead strikes first (in the left occipito-anterior position), the head rotates to a transverse position and may be born so. There is no reason in the pelvic floor theory, however, short of impaction, why the forehead should not go on rotating forwards to the pubic arch. But, LAHS also brings in the two-armed leverage of the head, and here he follows TARNIER and approaches rather to PARAMORE'S position. The two-armed leverage of the head is not comprehensive enough. It plays a considerable role in the production of internal rotation/

rotation, but it can easily be shown that the head is acted upon frequently as if it were a single-arm lever. Otherwise, LAHS admits the influence of the pelvis and the pelvic canal. This will be referred to presently.

So far as WINTER appears to be concerned, the entry or non-entry of the head into the vacant space on the sacrum is left to chance whereas, however ignorant we may be, we have every reason to believe that the occurrence of long rotation or of short rotation is governed by definite circumstances.

§20. The experiments of DUBOIS and EDGAR.

DUBOIS (1834) [as quoted by LUSK (1891) from MARTEL] opened the uterus of a woman who had died in child-bed, the opening being extended down to the cervix. The fetus of the woman was then replaced in the uterine cavity and pressed in the direction of the canal, the uterus meanwhile being held open and steadied in a suitable position. The head readily engaged in the pelvis, but more force was required to free the lower strait. Introduced in the right occipito-posterior position, the head rotated to the right anterior position on three occasions./

occasions.. On the fourth it remained posterior. A larger fetus performed a similar rotation twice, but on the third and following attempts the occiput remained posterior.

EDGAR (1893) used the dead body of a woman aged 20 years, and who had given birth to twins. There were no lacerations. A swivel was attached to the head of the fetus half an inch behind the posterior fontanelle (that is presumably on the sin-cipital side). The scalp and the sagittal suture were opened up for this purpose, and afterwards closed. The experiments were made by traction, and not by pressure as in those of DUBOIS. The abdomen and uterus were opened for the introduction of the fetus and for observation. The uterus was held in its normal position with right lateral obliquity and left to right torsion. Twelve experiments were made. The traction was made intermittently and repeatedly, and the greatest care was exercised to ensure that traction was made in the axis of that part of the pelvis where the vertex was. Two experiments were made in the L.O.A. and R.O.A. respectively, then one each in the R.O.P. and L.O.P. positions, the seventh being arranged primitively as a direct occipito/

occipito-sacral position. In the earlier experiments, delivery was not completed. In the first six experiments, rotation appears to have been complete and to have taken place just below the level of the ischial spines when the head was pressing on the pelvic floor. In the eighth to the twelfth experiments traction was repeated with the head in each of the positions. In the eighth (L.O.A.) there was a little rotation, but the head was born obliquely: in the remainder no rotation occurred.

DUBOIS considered that rotation ceased to occur only after the perineum and the vulva had lost "the resistance which had made it necessary, or at least had been the provoking cause of its accomplishment". DUBOIS, however, relied a good deal on the law of accommodation operating between the head on the one hand and the pelvis on the other, especially the posterior and inferior parts of the canal. As far as one can judge, the mechanism of the floor described by DUBOIS approached to that of HILDEBRANDT.

According to EDGAR, his experiments fail to show what effect the rotatory power of the uterus can have. He found that posture can influence the rotation of the head through the trunk, in the right occipito/

occipito-posterior position and in the left anterior, when delayed. EDGAR claims that his experiments demonstrate the sufficiency of the pelvic floor as a cause of internal rotation.

It is said these experiments have been frequently repeated for educational purposes. But it does not appear that the frequent repetitions have added anything to our knowledge of these most interesting phenomena. To some extent a third hand report of DUBOIS'S experiments disarms criticism, although LUSK'S account is given in inverted commas and seems to be of undeniable accuracy. If it be correct, then the account represents a series of experiments which, from beginning to end, were badly observed (cf. TARNIER 1882). In justice to DUBOIS, it must be admitted that the year of the record was 1834. At the same time why were, and if accounts are true why are, experiments of such "crowning" importance consecrated to pupil-midwives and other uncritical, because inexperienced persons, when they should be made the object of elaborate investigation and careful observation by persons of experience, and let it be added of open mind. For in both records the appearance of bias is there - and in favour of/

of the pelvic floor. EDGAR'S record has every appearance of fulness of detail and of the most careful attention. But, when it is more closely examined, we find that data are more prominent, as it were, by their absence than by their presence. There are no records of the successive changes, if any, in the diameters of the pelvic canal, no measurements of the diameters of the head before and after each delivery, no indications of the course which the head took in its successive journeys through the lower part of the canal, and no determinations of the tension-values of the perineum before and after each experiment. All these data are essential before any right conclusion can be formed on the influence of the pelvic floor. There is every reason for believing that changes occurred in the pelvic canal as well as in the pelvic floor, while the method of traction invited changes in the shape of the head, mainly in the direction of destroying its asymmetry and in reducing those diameters that count for pelvic rotation. Lastly, notwithstanding the evident care which Dr. EDGAR exercised to secure traction in the axis of the canal, the means employed cannot be said to have placed axis traction beyond doubt. Of evidence against pelvic floor rotation, the rotation/

rotation of the larger head in DUBOIS'S experiments is to the point. If the perineum was exhausted by the first head, it ought to have failed with the second head as well, that is when the pelvic floor is regarded as the sole cause of internal rotation. DUBOIS it appears, did not go so far as this. Possibly the subsequent failures to rotate in both series of experiments were due more to changes in the form and size of the head than to changes either in the pelvic canal or in the pelvic floor. In any case, the only safe deduction from these experiments, as they are quoted or recorded, is that internal rotation fails to occur on trial after a number of quickly repeated deliveries have taken place.

§21. The Tangential Theory.

SIMPSON (1878) and HART (1879) applied LAHS'S tangential theory to explain internal rotation. FROMMEL (1890) apparently accepts LAHS'S theory in this connection. HART does not rely solely on the theory, but adds the resistance of the posterior and inferior parts of the canal and the presence of the area of least resistance to the anterior wall of the canal.

It/

It is fair to state that Dr HART subsequently (1885) resiled entirely from LAHS'S explanations. The theory I have already described in the portion dealing with Flexion. For internal rotation the tangents are supposed to be drawn to the head in a horizontal plane, and rotation takes place in the direction of the smallest tangential angle. The theory depends essentially on the retention of the primitive wedge-shaped asymmetry of the head, which is largely abolished during long rotation (HART 1879), and which is not very evident in the after-coming head or in a frontal presentation, CROOM (1881) considers that certain lesions of the soft parts which he has observed in the neighbourhood of the right ischial spine, in a right occipito-posterior case, are not evidence for the tangential theory.

FRITSCH'S Theory.

A theory rather like that of LAHS was propounded by FRITSCH (1875). After excluding other possible factors, FRITSCH came to the conclusion that the cause of internal rotation is to be found in the pelvis and the child's head. The head is an unequally two-armed lever of which the longer lever is/

is formed by the sincipital end of the head. The uterine pressure and the resistance from the coccyx give a diagonal resultant to the head which results in forward turning of the occiput. It will be seen that this view also resembles that of CASEAUX and goes back to the reflected force of SOLAYRÉS.

FRITSCH recognised that long rotation could occur at the brim, and his explanation of the occurrence is by adaptation of the child to the uterus and pressure of the parietal tuberosity on the promontory. Otherwise, long rotation occurs within the pelvis and, as NAEGELE showed (?1838), the posterior part of the anterior parietal together with the lambdoida glides forwards and downwards on the ischio-pubic ramus which prevents the occiput passing backwards; or (and here he resembles LAHS) if the angles formed by joining the places of contact with the posterior and the anterior oblique slopes are compared, the posterior angles will be found to be greater, therefore the forehead must turn back. The difference of the angles is often very slight, hence uterine pressure must be considerable before rotation is able to occur. These views are subject to the same criticism as are those of/

of LAHS. In addition, one may point out the inadequacy of the ischio-pubic plane, when applied to the anterior parietal, in preventing short rotation, and to the dubious course of providing separate factors for the occipito-anterior and occipito-posterior positions, at any rate at the same level of rotation.

The lever-arms of the head and the shape of the rotated part have been criticised adversely by several writers. HART (1885) objects to the latter, because the shape is variable. VALTORTA objects to the former that, in the occipito-posterior position, long rotation ought to be facilitated by a relaxed pelvic floor. PARVIN (1895) and LUSK (1891) also relied mainly on the leverage of the head, but both added other factors; the former, the lateral inclined planes, the anterior area of least resistance, and the law of accommodation; the latter, the inclined planes, the anterior area of least resistance, and the pelvic floor.

§22. The General Configuration of the Pelvic Canal Theory.

The pelvic canal takes the form of a screw, and anything passing through has to make a spiral descent/

descent like a bullet in the rifled barrel of a gun.

SCHROEDER (1867), BÄCKER (1891), and DUHRRSEN (1896) attached great, if not entire, importance to this factor. Others have placed the configuration of the canal in the forefront, but have added other factors. LANDIS (1877) admitted the influence of the ischial spines: WEIDOW (1888) followed LANDIS, and at the same time brought in the lateral walls of the bony pelvis: WEBSTER (1903) and JELLETT (1905) considered the general configuration of the canal to operate only on the special shape of the head in the sense of producing the clinically observed rotations, and they were also supporters of HART'S theory of perineal rotation; GIGLI (1905) joined to the canal the special action of the pelvic floor and the intervention of the pubic arch: GALABIN and BLACKER (1910) while placing the configuration of the canal first, added no less than three other factors, the lateral inclined planes of the pelvis, the pelvic floor and the pubo-coccygeus muscle of VARNIER. GOSSETT (1903), while relying mainly on the form of the canal, believed that long rotation of the head in the occipito-posterior position, is begun by the pyriformis muscle; that/

that long rotation begins at a high level and that, if it does not, then the occiput goes down behind the ischial spine, and short rotation follows.

VEIT'S Theory.

Closely allied to the preceding group stands VEIT'S theory (1837) in which the general configuration of the canal has added to it the projection of the obturator muscle. Rotation takes place on a level with the inferior border of the symphysis, and is due to the mass of the obturator internus muscle, which forms an inclined plane guiding the head, and to the special form of the pelvis and the pelvic canal. The latter factor includes the effect of the special planes described by VEIT, and to which I have referred in the first section. According to VEIT the floor does not act in a large number of labours. MAYDELL (1891) argued in favour of VEIT'S theory. In connection with VEIT'S theory, it may be noted that DUBOIS (1849) states that FLAMANT considered contractions of the obturator internus and pyramidalis muscles to modify the position of the head during labour.

ZWEIFEL'S Theory.

ZWEIFEL (1890 and 1893) also finds the cause

of/

of internal rotation in the pelvic canal. Rotation begins in the "parallel BECKENWEITE" and ends in the "BECKENENGE". Both of these levels are oval in the bony pelvis: the presence of the soft parts makes them more so, mainly by the projection of large muscular masses which compel the head to assume an antero-posterior position, the transverse diameter of the head (88.5 mm.) being less than the sub-occipito-frontal (91.5 mm.). The diameters of the canal in the BECKENGE are oblique 87.5 mm. and transverse 77.5 mm. It will be observed that ZWEIFEL does not postulate a large head. The measurements indeed are comparatively small, and from the close approach to rotundity which they exhibit measurements after birth are suggested. It is possible that the reductions by the soft parts are excessive; the measurements of the bony pelvis, however, leave little freedom.

WILLIAMS (1903) and VALTORTA (1912) hold that the shape of the canal is unnecessary to rotation, that the outlet is in fact nearly circular. FEHLING (1903) objects to the canal being a cause of rotation, mainly on account of the observed impermanence of artificial head rotation, when the shoulders/

shoulders are not turned at the same time. WINTER (1837) denies VEIT'S theories, and SCHATZ (1890) considers they fail to account for long rotation.

BARBOUR (1899) accepts ZWEIFEL'S conclusions, mainly on the invaluable evidence which ZWEIFEL brought forward by his series of transverse sections. But Dr. BARBOUR regards the theory as being too limited, and argues in favour of the pelvic floor as a factor of importance.

It cannot be doubted that ZWEIFEL'S theory of the action of the canal is so far convincing, partly because it rests on a very perfect exposition of the anatomy of the parts, and partly because it is representative of the highest development of all the theories which have been based on the shape of the canal. It is defective, however, in three important matters. No evidence is adduced to show to what extent, if any, the muscles are capable of being effaced by pressure, and therewith how far the backing of bony material modifies or supplements the action of the muscles. Secondly, ZWEIFEL'S theory and all the theories which I have placed in this group, are incapable of determining the direction of internal rotation, that is to say, they do/

do not give any explanation of the occurrence of long rotation. Thirdly, and perhaps this is most important, the head descends into the region in which it is going to rotate. As a rule, it remains there a long time before rotation begins, and during the act of rotation the amount of descent is not very great (slow pitch of JONES 1906). Under these circumstances, the long gradual change of the diameters from the BECKENWEITE to the BECKENENGE (ZWEIFEL), and the still longer change from the inlet to the outlet of other authors, are not in themselves adequate to account for internal rotation as it is clinically manifest.

The iliacus and psoas muscles theory.

BARNES (1835) gives as the cause of rotation the lateral inclined planes of the pelvis, the adaptive forward movement of the trunk of the fetus and the action of these muscles on the occiput. The second factor is the main cause of long rotation. According to VALTORTA (1912), DASARA CAO, while placing most reliance on the pelvic floor, considered, like BARNES, that the iliacus and psoas muscles projected into the canal and were the cause of long rotation. DASARA CAO'S views became clearer when/

when regard is had to VALTORTA'S objections. From these it is apparent that the author cited held the iliacus and psoas muscles to bend the uterus from right to left and also to twist it on its axis, so as to compel the trunk of the fetus to rotate into a dorso-anterior position. VALTORTA raises the objection to this that rotation then ought always to fail in the left occipito-posterior position, or rather would necessitate a rotation of the head in the same direction as that of the head in the right occipito-posterior position, that is, through five-eighths of a circle. DASARA CAO evidently attributed short rotation to paralysed psoas muscles, in addition to those other factors which are universally quoted.

§23.

The rotation of the uterus theory.

According to LEISHMAN (1864) SCHMITT (1804) held this view, and gives the rotation of the head in the occipito-posterior position without a simultaneous rotation of the body and without a uterine pain, as an argument in support of the theory.

The leverage of the uterus theory.

SCHMIDT (1893 a b) views the uterus as a
two/

two-armed lever with its fulcrum on the promontory. The upper and longer arm is pressed towards the spine by abdominal pressure, while the lower and shorter arm is pressed forwards against the anterior pelvic wall, and causes the occiput to come forward. Then the head itself is a two-armed lever, the occipital arm being the shorter. The anterior wall slopes away from the symphysis. Two components can be made out of the pressure to which the head is exposed; the one parallel and the other perpendicular to the anterior wall. The greatness of the effect of uterine pressure depends on the size of the angle which the anterior wall makes with the head; the larger the angle the quicker the rotation, and vice-versa. In flat pelvis there is frequently a deep transverse position; the power then has no value and short rotation results. Hence also when abdominal pressure fails, we have short rotation. In reply to an objection by ZWEIFEL (1893) that SCHMIDT did not recognise the erection of the uterus during a pain and regarded the uterus as bending on the promontory, SCHMIDT admitted that the movement of the uterus might be more apparent than real, and that no bending occurred.

The/

The portion of SCHMIDT'S theory depending on a certain angle invites comparison with FRITSCH'S view and with LAHS'S tangential theory. It is open to similar objections. When abdominal pressure fails there ought to be no rotation at all, or as SCHMIDT asserts only short rotation. Rotation forwards occurs however in paraplegics (TARNIER 1882, ROUTH 1897, and others).

The first part of ZWEIFEL'S criticism is no better than what was criticised. The erection of the uterus is more apparent than real. The second part is an unjustifiable inference and ought not to have been read into SCHMIDT'S first paper. By way of contrast to SCHMIDT'S views, GILLESPIE (1903) affirmed that posterior obliquity of the uterus causes the head to be pressed against the anterior wall of the pelvis, and thus leads to the occiput rotating backwards to the transverse or right oblique positions.

The torsion of the fetus theory.

SUTUGIN (1875 and 1887) found that in pregnancy the back of the child is usually directed posterolaterally. In the beginning of a pain, in the left occipito-anterior position the back turns to/

to the side, whereby the occiput lies forward and to the left, the shoulders are antero-posterior and the breech is directed rather posteriorly. SUTUGIN quotes SCHROEDER that the fetus has a double torsion on its long axis during early labour, the head, the shoulders and the breech gradually turning forwards and in that order. SCHROEDER and STRATZ (1886) give diagrams to illustrate the torsion of the fetus. In one, the breech is transverse, while the head and the shoulders are in the left occipito-anterior position (at the end of the first stage). In another the head is in the right occipito-anterior position, while the shoulders are left dorso-anterior. The canal also, according to SUTUGIN, forms a descending spiral, but he asserts that the spiral torsion of the fetus is much greater than that of the canal; and further that the greatness of spiral torsion of the fetus is in direct proportion to the greatness of the pelvic resistances. SUTUGIN attributes rotation partly to the torsion of the fetus, but I have no note of any other factors. The torsion of the fetus depends possibly on the torsion of the uterus, and both may be due to the laws of growth, concerning which SUTUGIN quotes in support FISCHER'S interesting article (1887).

The/

The mechanism which SUTUGIN describes is one that could possibly be subjected to experiment. But it may be condemned on a priori grounds that the torsion begins below and extends upwards. If torsion were a cause of rotation, one would expect the breech to turn forwards first, or the fetus to grow in a form in which the breech is turned forwards. If the back is turned backwards in the beginning, then the natural mode of undoing the torsion would be to rotate the head backwards, that is, if the pelvic canal has as little influence as SUTUGIN seems to imply. As a matter of fact, it is impossible to deny the resistance which the pelvic canal affords. It is always appreciable and is often considerable. The torsion of the delicate body of the fetus, on that account, seems to be an inadequate cause of internal rotation.

§24/

§24. The rotation of the head by the trunk theory.
 LITZMANN (it is said), MATTEI (1855), KEHRER (1860-1906), OLSHAUSEN (1888, 1899, 1901-3-6), WILSON (1897), FEHLING (1903), BUMM (1905). As one, but not the only factor - FABBRI (1857-1878), HILDEBRANDT (1866), SPIEGELBERG (1882), BARNES (1885), REY (1891), EDGAR (1893), OSTERMANN (1894), and MASSINI (1907).

REY adds the lateral inclined planes:

MASSINI regards the position and state of the large intestine as of importance, but he probably takes into account other factors as well. For OSTERMANN, the primary rotation of the shoulders fills only a subsidiary part in the mechanism.

According to PARVIN (1895), LITZMANN and KEHRER upheld the theory which is usually associated with the name of OLSHAUSEN, whom PARVIN also quotes, as accounting for internal rotation, by a progressive flattening of the uterus shifting the body from a lateral to an anterior position, and therewith the head within the pelvic canal. PARVIN himself believes that the head is moved from the oblique to the transverse position (right occipito-posterior position) by the projection of the promontory against the/

the curved back of the fetus. As this is not strictly due to contractions of the uterus I have elsewhere in recording PARVIN'S views interpreted it as part of the law of accommodation also postulated by the Author. OLSHAUSEN, in his later papers, argues that the turning of the body is in part adaptive to the uterus, and it is partly in this way that he explains long rotation. The form and elasticity of the pelvic floor are an additional factor, and the mechanism which OLSHAUSEN gives is essentially that of HILDEBRANDT. BUMM (1905) states that the flattening of the uterus during labour causes the trunk of the fetus to rotate forwards so that the head also tends to rotate forwards, the twisting force being communicated by the neck which resists torsion. FEHLING (1903) brought forward evidence to show that, when the head is deep in the pelvis, the turning of the shoulders by internal manipulation is sufficient to produce long rotation of the head. He held that, in consequence, the pelvis could not be the cause of rotation, and hence was led to approve of OLSHAUSEN'S theory. FEHLING gives as additional reasons the rotation of a five-month's fetus, of the head within the forceps, and of fetuses of dogs which rotate before they enter the pelvis. According to WILSON (1897)./

(1897), the rotation of the shoulders at the inlet causes the head to rotate. The reasons given are external rotation, incompressibility of the fetus, and the condition of the fetus as "an inflexible compact unit which is forced to rotate en masse." "The compression exerted by the pelvis makes co-rotation of the head and body as one possible." OSTERMANN (1894) draws attention to the influence of the flattened and rotated body of the uterus on the body of the fetus during the rotation of the head, showing that the pressure to which the body is exposed tends to rotate the body in the proper direction.

§25. Objections to the rotation of the body first theory.

DUBOIS (1834) showed that exceptionally the body does not rotate with the head. DEPAUL (1872) from clinical observation decided that the head rotates before the body. FABRE (1896) states that the shoulders descend in an oblique diameter of the pelvis until external rotation occurs and therefore the/

the head rotates by torsion of the neck. FRITSCH (1875) held the neck of the fetus to be too mobile for the rotation of the body to influence the head. Schatz (1890) held justly that the rotation of the head is greater than that of the body and is primary, and that flattening of the uterus, when the back is directed initially more or less backwards, confirms the backward position. ZWEIFEL (1890) shows that, in one of his frozen sections, the head has begun to turn, while the back is still in the transverse position (i.e. antero-posterior). In 1893 ZWEIFEL admits that the uterus is flattened during a pain, but denies its effect in rotating the fetus, owing to the great mobility of the neck in presence of a resistance. In his head first section of 1893, the shoulders look obliquely forwards, while the breech is turned directly to the left. FROMMEL (1890) records a labour in which the original position was occipito-posterior, and in which the back was directed to the side and the rear, at a time when the occiput was under the pubic arch. MAYDELL (1891) found in a hundred cases that the back mostly turned later than the head, and/

OLSHAUSEN'S theory of the

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and when the back did turn first the head, though it followed the back during a pain, yet retreated in the following pause. HENRY (1891), in reporting a great number of observations, states that the head was found to rotate without there being a corresponding rotation of the body. Mme. HENRY further observes - and her conclusions are derived from experiment - that the head is able to rotate on the trunk through 180° of arc, of which about 90° are produced ~~at the~~ ~~the~~ atlanto-axial joint and the rest in the other vertebrae; so that it is clear there is no necessity for the back to rotate along with the head or vice versa. AHLFELD (1881 and 1903) raises the grave objections that rotation occurs in the first of ~~twins~~ when the uterus is not flattened during a contraction: and that the after-coming head rotates when, if the uterus were the cause of rotation, the head ought to emerge in the transverse position. In one of his able reviews of the evidence derived from frozen sections BARBOUR (1898) records that everything there points to the head rotating before the body, and he adds that the flexibility of the child's neck is an a priori argument against OLSHAUSEN'S theory. SCHICKELE (1901) objects to OLSHAUSEN'S theory on the ground that rotation is in/

in default in the split pelvis. PARAMORE (1909^u) argues at some length against OLSHAUSEN. His main thesis is taken up with the evidence derived from frozen sections that, as labour advances, the uterus is flattened in an antero-posterior direction. This is manifest whether the bodies are frozen in the dorsal or erect position and is due to the lumbar column pressing into the uterine body. PARAMORE asserts that the lumbar column cannot impress the uterus when it is contracting. It then becomes more cylindrical or pyriform. Hence PARAMORE is led to doubt if any flattening of the uterus or bending of the fetal trunk can occur during a uterine contraction. Both these conditions are postulates of OLSHAUSEN. Another is that the head cannot rotate the trunk owing to the trunk being enclosed within the uterine body. PARAMORE shows that there is no need for head and body to rotate together. Incidentally it may be noted that his estimate of only 90° as the limit of rotation without injury is very moderate. Then the shoulders may rotate before the head, if they come down early enough into contact with the brim of the pelvis. VALTORTA (1912) objects that it is not proved clinically that there is a sufficient bond/

bond between the head and the body to account for rotation of the head by the body, in the presence of the resistances of the pelvic canal. SELLHEIM (1913^a) argues that neither is the head turned by the body nor the body by the head, and that the rotation of each zone of the fetus is determined in one direction by the resistances with which it comes into contact.

I have now quoted some examples of the objections to OLSHAUSEN'S theory. It will be seen that, if not overwhelming, they strongly oppose the theory. Perhaps, those raised by AHLFELD are the most damaging. While it does not seem possible to admit OLSHAUSEN'S theory as the "primum movens", there is greater difficulty in deciding whether or not the rotation of the body is able to contribute to the production of internal rotation. The flattening of the uterus during a contraction is not definitely excluded, as long as the evidence against it is clinical only. But even if the uterus does become flattened antero-posteriorly it is a step forward of some magnitude then to assert that the flattening/

flattening of the uterus is able to rotate the fetal trunk, and still more the fetal head. BARNES (1885), SELLHEIM (1907), and others have shown that the shoulders and the chest of the fetus are rounded by the pressure of the pelvic canal. Now the concentric pressure within the uterus is much greater than the general concentric pressure or resistance exercised by the pelvic canal, and at times indeed is incredibly severe. It is, therefore, much more likely that, instead of being rotated, the trunk of the fetus is merely moulded in accordance with the pressure to which it is subjected. Adaptation of the fetus to the uterine cavity during pregnancy is quite a different function from what it is during labour. If during labour the fetus preserved its primitive general attitude of flexion, it would still be possible to talk about the adaptation of the dorsal convexity of the fetus to the anterior concavity of the uterus, or if in presentations of the face and the forehead the fetus developed a marked degree of convexity on the sternal aspect (which is at least open to doubt), there might still be an adaptation of this convexity to the anterior hollow of the uterus. It has/

has been known, however, ever since the day when AHLFELD'S researches were published, that the fetus is straightened in the course of the second stage, and that in consequence any difference that existed primitively between the dorsal and sternal surfaces is gradually obliterated. And as rotation is generally held to occur later rather than earlier in the second stage, the differences existing in the fetus are nearly at their minimum at the time when rotation usually occurs. In addition, as I have just noted, the uterine and also the abdominal pressures are patently and relatively so enormous, that it does not appear to be established on sure ground that the differences between the two aspects of the fetus are sufficiently effective to lead to a change of the position of the fetus. The mobility of the child's neck is perhaps not a valid objection to OLSHAUSEN'S theory. Given a pressure and a resistance, the coefficient of friction between the head and the body, plus any degree of resistance to torsion present in the cervical column, may be sufficient to permit the body to rotate the head, as the head rotates the body./ and the body of the fetus (vertex and face presentations)./

body. In the absence, so far as I know, of any experiments bearing on this matter, objective criticism, derived from the uterine functions, seems more appropriate.

§ 26. MEEH'S theory.

MEEH (1882) attributed internal rotation to reflex movements of the arms and under at least one condition to reflex movements of the feet. During each pause in the uterine activity the wall of the uterus is unequally hard, and most hard in the region of the lower lumbar vertebrae and the hinder ends of the ilia. Movements of the fetus in the sense of internal rotation occur in each pause and are the consequence of the reflex irritability of the arms, increased by the preceding condition of compression. The posterior arm has more effect than the anterior arm because it is able to push against the most unyielding part of the uterine wall. It propels the body and therewith the head into an antero-posterior position, the direction of rotation depending on whether the posterior arm lies before or behind the body of the fetus (vertex and face presentations)./

presentations). The body does not rotate beyond the transverse, for the anterior arm, coming round to a more posterior position, raises "an antagonistic working" on the posterior wall. The theory is extended very ingeniously to explain super-rotations, when one arm or foot is prolapsed. No attempt seems to have been made to account for the normal reversed rotation of the shoulders.

§ 27. The bend in the canal theory.

West (1857) stated, for the first time I believe, what may be regarded as the law underlying the present theory. 'A curved body in a curved tube adapts the large convexity of the body to the large concavity of the tube, whatever may be the position of the small fontanelle at the beginning' expresses nearly in his own words WEST'S dictum. Obviously the statement, though correct, is very far from an explanation of the occurrence, nor is any suggestion made as to the justice of its application to the phenomena of labour. WEST, however, finds the principal factor of internal rotation in the pelvic floor, and the mechanism which he describes is/

is the precursor of BERRY HART'S. YOUNG (1913) found in this adaptation of a cylindrical body to a curved canal a sufficient explanation of internal rotation, but the others who may be said to belong to this group were acute enough to realise that this is not enough; that other factors must be added to account for the heterogeneous manifestations which are united under the term of internal rotation.

SCHATZ (1890) denies his former theory and expresses the opinion that uterine-axis pressure is not usually inclined to the inlet. After pointing out that an ovoid body, when it is propelled through a curved canal by water pressure, does not rotate; that the lower pole moves forward only as much as does the axis of the canal: SCHATZ proceeds to show that if the ovoid body is held back either absolutely or relatively, and laterally or excentrically it rotates so that the portion held back moves into the concavity of the canal. SCHATZ claims to have found the cause of the holding back of the head, to which the neck is attached laterally or excentrically, in a negative form-restitution-power. This arises after the fetus is fully elongated and is made/

made manifest by the breech leaving the fundus, and the lower limbs being pushed up towards the fundus. SCHATZ claims to have proved the existence of this retentive power by the tokodynamometer. So far as one can judge, the negative power draws the limbs up and at the same time drives the breech away from the fundus. In a breech case the negative form-restitution-power turns the back of the fetus on to the bend of the canal. In a head case, the thorax is stemmed against the inlet and holds back the head through the neck on one side so that the occiput moves into the bend of the canal. Turning is the more certain, the more difficult is the entry of the thorax to the pelvis, as with a large child or in a face presentation.

OSTERMANN (1894) argues that, besides the expelling powers, two factors are applicable for all positions and presentations - the curve which the canal describes and the consequent movements of the fetal vertebral column which act according to the law of the "greater action possibility". The movement or function of extension tends to overcome the movement/

movement of flexion in head presentations: lateral movement to overcome antero-posterior movement in breech presentations. As I have already shown, OSTERMANN also relies in part on the influence of the flattened and rotated uterus on the trunk of the fetus. OSTERMANN made a number of simple experiments to demonstrate his theory. The canal was represented by a curved tube of circular lumen; the fetus by a bent rod with a ball on one end of it to represent the head. When the staff was pushed into the tube so that the two concavities were opposite one another, and was so held that no axial rotation could happen, the staff bent at the upper end of the canal and also lower down so that it became a sigmoid. At the same time, the staff twisted on itself so that a spot marked on the ball to represent the occiput in the occipito-transverse position, rotated in the course of the descent to the occipito-anterior position. To represent the mechanism of the occipito-posterior position, the staff was inserted into the tube so that the two concavities corresponded, and the spot was directed postero-laterally. OSTERMANN found that with descent the staff became more bent and also twisted in such a way that the spot moved forwards in/

in rotation. In the remainder of his paper, OSTERMANN is occupied in trying to reconcile the phenomena of labour in the lower animals with those of labour in the human female, and he there points out that the utero-vaginal canal shows a change of direction where the uterus meets the vagina, the curve having a concavity directed forwards.

If the number of his writings on internal rotation alone are considered, SELLHEIM (1904 et seq.) has probably established a record in the history of the mechanism. Apart from their number, however, the quality of his contributions entitles SELLHEIM to the greater measure of respect. It may be said that in this matter nothing is taken for granted. No hypothetical explanations are put forward; everything that has not already been submitted to confirmation is tested by means of elaborate and often costly series of experiments; and the story of internal rotation, as SELLHEIM conceives it, is built up stage by stage in a manner that commands the highest admiration.

The pelvic canal, according to SELLHEIM, consists briefly of an upper straight portion and a lower/

lower gently curved part which meets the former at a fairly sharp bend under the pubis - the knee of the canal. The bones with the exception of the pubis, and the muscles with the exception of the pubo-coccygeus have no effect on the mechanism in normal labour. . . . The pressure is hydrostatic mainly. The effect of gravity may be there, but is unimportant. There is also what SELLHEIM calls the concentrated pressure where the head meets with the resistance of the canal. The fetus is a partly soft and a partly firm body which adapts itself to the canal. It undergoes changes of position of its individual parts, and also changes of position in part, or as a whole relative to the pelvic canal. The latter occurs on the "knee of the canal." SELLHEIM believes that most of the factors described by others can produce rotation, but the chief factor is the forward movement under the pubic arch. The first experiments were designed to show that, when a cylindrical body able to bend equally well in all directions, is propelled through a curved canal, it will not rotate. By other experiments and by observations on the new born, SELLHEIM then came to the conclusion that rotation/

rotation depends on an unequal capacity to bend in various directions in the individual segments of the fetus. He determined by an ingenious attachment to a dynamometer that the head of the new born bends most easily backwards, with greatest difficulty forwards, and intermediately to the side; that the chest bends most easily towards the sides, and with greatest difficulty backwards and forwards; so also for the breech, that is the lumbar region. The differences are greatest in the neck, and least in the lumbar region. To put it in another way, the head in a face presentation has a strong tendency to flex, in a vertex presentation a strong tendency to extend. Further experiments with a cylinder which could bend most easily in one direction showed that, when it was pushed through a curved canal, if not already there, the bend of the cylinder adapted itself by a rotation to the bend of the canal. SELLHEIM further shows that in a vertex presentation the head first undergoes a forced flexion which reinforces the movement of extension, when the time arrives for the latter to take place. Finally SELLHEIM holds that this mechanism is true for all positions and presentations/

presentations, for living and for dead children, for men and for animals. SELLHEIM made plaster casts of the head after birth, and from these he showed that the pressure of the soft canal tends to reduce the primitive inequality of the long and the short diameters of the head. The tracings which he reproduces show rather the effect of the mechanism of extension and are inconclusive evidence as to the form of the head above the outlet.

Many X-ray observations were made on the spine, of the fetus. They showed that the cervical spine normally lies in a position between flexion and extension, with a slight convexity forwards. Then further tests were made on the new-born to determine the angular movements of the various segments of the fetus. Elaborate birth-machines were designed and built to illustrate the theory. After showing that a rigid bent object turns in the bend of a canal until its bend coincides with that of the canal, SELLHEIM proved that a body and a head articulated together and united by springs on one side rotated in a curved canal, even when made to descend by gravity alone. Long rotation was produced as well as/

as ordinary rotation, and the various positions and presentations were made the subjects of experiments.

In one of his papers (1906) SELLHEIM deals with certain exceptional mechanisms. Short rotations of the head in the occipito-posterior position is attributed to abnormal bendability of the region of the neck, due either to natural weakness of the ligaments and the muscles, or to their weakening by a too long duration of labour. The arrest of the head in the deep transverse position is due to the neck being able to bend equally well in all directions. In twins the extension of the canal by the first twin does not favour the rotation of the second. Operations applied to widen the pelvis not uncommonly are associated with a failure of internal rotation. These operations act, not as SCHIKELE (1901) suggested, but by a lessening of the bend of the canal. Split pelvis has a similar effect. Relative narrowing of the pelvis may also impede or prevent internal rotation. With strong pains, rotation is more certain to occur than with weak pains. In the former case the resistance is greater and leads to greater bending of the fetus which favours/

favours rotation. Super-rotation is caused by an excessive difference existing between the resistance to bending on one side and the diminution of resistance to bending on another, or by excessive bending of the fetus in a rigid canal, and with strong pains. Non-rotation of the shoulders may be produced by weakness of the fetus, or by the pelvis being too wide; that is, the differences of bendability in the fetus are slight, or the bend in the canal is less than normal. The mechanism is valid for the fetus dead intra-partum, but maceration of the fetus is a sufficient reason for the absence of rotation. With this paper woodcuts are given which show rotation in progress, when a good part of the head and the shoulders respectively are born.

HERZFELD (1905) gives as the chief factor of internal rotation the pelvic floor, and the mechanism which he describes corresponds closely to that of HART. The next most important factor is that which forms the main thesis of SELLHEIM, but HERZFELD will not go so far as SELLHEIM in ignoring the influence of the pelvic bones, and admits the general form of the bony canal and the shape of the rotated part. Otherwise HERZFELD accepts SELLHEIM'S theory/

theory without reserve.

According to KEHRER (1906) the fetus presents a concavity on the abdominal side of the paturient, and this concavity adapts itself during descent to the concavity on the abdominal side of the utero-vaginal wall. In the occipito-posterior position, this adaptation fails when the pelvis is wide, the pubic arch is much hollowed, the genitals are roomy, the pelvis is narrowed, the lumbar spine is projecting (here the lumbar spine hinders the rotation of the shoulders and therewith the rotation of the head) the head is unusually round small or soft, a hand is prolapsed, or a tumour enters the pelvis with the head. KEHRER expounded this theory as early as 1859. The earlier papers I have not seen. PARVIN, as I have already observed, regarded it as a body-first theory, and it has been so classed, but it appears to come equally well into the present group.

MUELLER (1907) agrees with HERZFELD in opposition to SELLHEIM about the influence of the bones of the pelvic girdle on the mechanism of birth. In other respects, he completely accepts SELLHEIM'S views/

views. Hence OSTERMANN'S theory has not a general

application to the mechanism of rotation. SCHATZ

§28. Objections to the bend in the canal theory.

LAHS (1877) criticises the two birth-machines with which SCHATZ was demonstrating his theory of rotation anterior to 1877 (SCHATZ 1875). According to LAHS, it is erroneous to accept, as SCHATZ does, a canal of circular lumen and a round head. He apparently doubts the existence of a bend in the fetal column during the period of rotation, and objects that SCHATZ'S phantom had no provision to represent the atlas and axis joint which LAHS believed to nullify the rotative effect of the bend of the fetus in a bent canal.

LAHS considers both the head and the canal are oval, the latter making a quarter spiral turn in its descent: these factors render a bending of the fetus unnecessary. In the same year, SCHATZ replied to these adversions without, however, making his own point of view any clearer. LAHS'S objections apply with equal force to OSTERMANN'S and SELLHEIM'S theories. PARVIN (1895), with special reference to OSTERMANN'S theory, holds that rotation takes place often before the head is on the floor of the pelvis, and/

and that hence OSTERMANN'S theory has not a general application to the mechanism of rotation. SCHATZ (1905) raised a similar objection to SELLHEIM'S theory. OSTERMANN (1905) does not recognise the value of SELLHEIM'S experiments as representing what takes place in the birth. He points out that the shoulders usually rotate at a higher level than that demanded by SELLHEIM'S theory, and that extension of the fetus begins much earlier than rotation and forms part of the mechanism of descent. OLSHAUSEN (1906) denies the correctness of SCHATZ'S (1890) theory and considers there is no evidence for a form-restitution-force, mainly on the ground that, according to OLSHAUSEN, fetal-axis-pressure exists during the expulsive period. OLSHAUSEN says that frozen sections prove it; which shows what can be done with frozen sections. OLSHAUSEN, with reference to SELLHEIM'S theory, holds it to be correct in itself, but inapplicable to the mechanism of labour. Among other objections, OLSHAUSEN states that SELLHEIM does not explain the rotation of the body when the head is turning, or the rotation of the head in the deep transverse position, or the long rotation of the chin/

chin in face presentations. In this last example, OLSHAUSEN is clearly wrong. If SELLHEIM'S theory is a valid theory, it is quite capable of explaining the long rotation of a mento-posterior position, as SELLHEIM himself showed by experiment. PARAMORE (1909^a) inveighs strongly against the spiral springs used by SELLHEIM to extend the model head in his experiments, considering them to be far stronger than a similarly situated physiological contrivance in the fetus. According to PARAMORE, the extension of the head and neck can only act, "if the fetal force towards extension is greater than the summation of all the other forces acting on the head". PARAMORE concludes that the fetal force is of little importance when the pressure and the resistances are great, and it can only act as long as the extensor muscles are not exhausted. "Thus the head will not rotate on account of any tendency to extend ; it will merely deviate in the direction of extension." But the mechanism of extension will probably act when the resistances are small. The failure of rotation, when the head is small, is also against SELLHEIM'S theory. According to PARAMORE, when the head is small, SELLHEIM'S theory ought to act best. As, however, FEHLING/

FEHLING (1903) states that a small head can rotate, it is not the smallness of the head which causes rotation to be in default. PARAMORE further objects that SELLHEIM does not explain the mechanism of the persistent occipito-posterior position. SELLHEIM does attempt to explain this position, though it must be admitted that it forms one of the few occasions on which SELLHEIM descends to pure theory. VALTORTA (1912), with reference to SELLHEIM'S views, points out that the head sometimes rotates on its own longitudinal axis without there being a contemporary movement of the neck; that the theory undervalues numerous factors which are generally considered to influence the head directly; that internal rotation can happen with the head directed posteriorly and the trunk anteriorly. This latest objection is a serious one for the "Biegungsfacillimum." VALTORTA quotes RIBEMONT-DESSAIGNES who showed that by twisting the head of the fetus the rotation is not confined to the cervical portion of the spine, but extends to all parts. Similarly, SCHROEDER'S and SUTUGIN'S researches on the torsion of the fetus do not simplify matters for SELLHEIM'S theory, even though they cannot be regarded as arguments against the/

the theory. It has not been proved that the canal is curved from inlet to outlet. As I pointed out (Section I.) all investigators who have made casts of the canal come to the conclusion that the upper portion is direct and only the lower portion curved. This is admitted by SELLHEIM who made casts of the canal. As JONES (1906) has shown, the two divisions of the superior portion of the pelvic canal are different mechanically. The upper has a quick pitch, and the lower a slow pitch. In the latter, the lower part of the superior portion of the canal, the greatest delay occurs in labour. No curved canal theory satisfactorily explains the delay. The clinically observed resistances to the head at the outlet, and the consequent moulding commonly reaching its extremity at the moment when internal rotation is about to begin, are not accounted for by the curve of the canal. It is not enough to say that these phenomena are independent of internal rotation. Curved canal exponents have not been at the trouble to show by analysis that the components of the observed shears destroy themselves. In SCHATZ'S theory/

theory, the stemming of the thorax on the brim of the canal has a great deal to do with the production of internal rotation, by retarding the occiput through the medium of the neck; and, as noted, SCHATZ finds rotation to be the more certain of occurrence, the more difficult is the entry of the shoulders. I have seen the shoulders impacted antero-posteriorly at the brim of a normal pelvis, but the circumstance did not favour internal rotation. The head received no impulse from the pains, during which it hung loosely by the neck, and could readily be moved about inside the pelvic canal.

According to SELLHEIM, the bending capacities of the fetal cylinder get less every day after birth, are greater in the head than in the body, greater in the head of the male than in the head of the female, greater in the breech of the female than in the breech of the male, less in death than in life. These facts suggest that the bending capacities of the fetus ought to be treated not from the standpoint of internal rotation, but from the point of view of evolution. They are adaptations to meet the change of direction from the superior to the inferior/

inferior portion of the canal, and like the movements of flexion are most developed where they are most required. PARAMORE'S view seems irrefutable that the more or less long continued constraint of the fetus in the canal nullifies all capacity for active movement, and leaves only a capacity for passive movement. Even if an active power of movement is considered to survive the constraint of the fetus, the activity or effectiveness of the movement diminishes from the moment when it begins, and long before the occiput, for example, has passed under the pubic arch to the extent demanded by SELLHEIM'S theory and exhibited in his schematic figures, the movement has become a passive protrusion. If the bending capacity is active enough to carry the occiput under the pubic arch, the mechanism of internal rotation and of extension ought to be independent of the pelvic floor, and where the pelvic floor is torn back to the rectum one ought to be able to witness the head, the shoulders, and the breech each describing a self-made curve round and under the pubic arch. In these cases it is well known the curvation forwards is materially lessened. Yet/

Yet SELLHEIM believes that strong pains make internal rotation more certain of occurrence, because the resistance of the pelvic floor is then greater, and forces the head forwards under the arch. On the other hand, many have recorded their opinion that strong pains, or rather too strong pains, are a cause of short rotation in the occipito-posterior positions. In the same way, according to SELLHEIM, the failure of the shoulders to rotate is due to a two wide pelvis, and therewith a defective action of the pelvic floor in not forcing, or constraining the shoulders sufficiently forwards. All these points are really arguments for the truth of evolution and not for the causation of internal rotation. The objection of the short rotation of a well flexed head in the occipito-posterior position is a serious one, and SELLHEIM has been able to meet it only by a hypothetical abnormality in the bending capacities of the head on the body. PARAMORE says that a small head would always rotate, if SELLHEIM'S theory was valid. It does so in the model with springs to operate it. But, where the model differs from the living is in the excessive capacity towards extension. If/

If the capacity for active extension was limited to that possible in labour, rotation would fail as often as in life. SELLHEIM inclines towards a fetal head in which the sagittal diameter is little, if at all, greater than the transverse, and he bases his belief on plaster casts made after birth. Then the equality of the diameters is often, if not always, true, but it may be erroneous to suppose that the same is always, or even most frequently, correct when the head reaches the bottom of the cavity. In BARBOUR'S late second stage section internal rotation is nearly completed before the head has begun, or has even been able to bend under the pubic arch. Rotation by SELLHEIM'S factors takes place at too low a level to be a correct representation of the most frequent event. Recently, however, (1913^a and ^b) SELLHEIM has been forced to meet the differences of inlet and cavity rotation which previously he disregarded. To do so, SELLHEIM has gone back to LAHS, for he says the cross section of the contents always turns with its preponderating diameter, or with that inclining to preponderance into the corresponding long diameter of the canal. SELLHEIM applies this latest view to the/

the head, the shoulder girdle, and the pelvic girdle of the fetus, as effective from the inlet to the outlet of the canal. This is nothing more than the oval head and the oval canal of LAHS. Lastly, SELLHEIM has not excluded from the working of his theory, the influence of the intervening pubic arch, against which the head is pressed excentrically by the reflected force of the pelvic floor. These two factors (those of KIWISCH and BERTHAUT) are, in my opinion, the sole cause of the rotation described by SELLHEIM.

PART II/

the convergence of PART II. lateral and the postero-

lateral walls, and the normal inclination of the

anterior segment of the pelvis from the plane of the
 §29. Before describing the factors of internal
 rotation, I will here recall the points which have
 been gained so far.

The pelvic canal consists of two portions,
 an upper or straight portion ending at the outlet,
 and a lower or curved portion whose centre line is a
 variable. The upper portion is divided into two
 parts by an imaginary plane passing through the
 ischial spines. The upper part belongs properly to
 the end of pregnancy or the first stage: the lower
 is usually concerned in the principal event of the
 second stage. The upper portion is enclosed by a
 bony framework whose components are able to influence
 the mechanism of normal labour, and which is under
 maternal reflex control to a limited, and as yet un-
 defined, degree. The upper portion is commonly re-
 garded as approximately cylindrical. The word
 "approximately" yields to intensive analysis, and a
 canal is disclosed whose variations from cylindricity
 are appreciable, and have every appearance of bear-
 ing on the mechanism. The most important points are
 the/
 normally/

the convergence of the antero-lateral and the postero-lateral walls, and the normal inclination of the anterior segment of the pelvis from the plane of the brim at more than a right angle. The measurements of the diameters of the bony and ligamentous outlet are transverse = 111.3 mm., oblique = 116.5 mm.; those of the outlet of the superior portion of the pelvic canal are transverse = 77.5 mm., oblique = 87.5 mm. (ZWEIFEL).

The head and the body of the child cannot be regarded as plastic fluids or as plastic solids. When they are deformed, there is a limit to the capacity for deformation. When the head, and in a lesser degree the body, are deformed they behave as elastic solids, and in virtue of the property of resilience they are capable of yielding active work when the deforming force is removed. The average diameters of the head before rotation are O.F. 12 cm., S-O.B. 9.5 cm., Bi-P. 9.25 cm., Bi-T. 7.5 cm.; and the diameters of the smallest average head O.F. 10.5 cm., S-O B. 8.5 cm., Bi-P. 8.7 cm., Bi-T. 7.5 cm.

The uterus acts as a constrictor and retractor and not as a contractor and detrusor. The abdominal powers are mainly constrictive. Both act normally/

normally together in the second stage of labour and they act by developing a general-contents pressure, there being no fetal-axis pressure in the sense of pressure transmitted through the spinal column alone. The uterus is fastened near its lower pole to the pelvis, and is able to move angularly on its attachments. As the pressure of the uterus and of the abdominal system is developed at the lower pole of the oval or cylindrical uterus, the pressure has a direction which is primarily variable and ultimately determinate. The generally accepted opinion that uterine and a abdominal pressure is directed at right angles to the plane of the brim rests on the dubious premise that the canal is nearly cylindrical and that its axis runs at right angles to the plane of the brim. Evidence has been led to show that this arrangement of the parts is unusual, and that, even when it happens, the direction in which the canal tends to dilate does not necessarily follow suit, but is more probably inclined forwards. No method has yet been evolved to determine accurately the direction of uterine pressure during a uterine and/

history of obstetrics are associated with the transverse mode of entry which indeed, though not acceptable/

and an abdominal contraction. That being so, it is necessary to consider the mechanism of internal rotation under various inclinations of uterine pressure. This is the more necessary, because the centre of pressure lies excentric within the head, after flexion or extension has been produced; and further, because the evidence of the form of the child's head derived from measurements made after birth is unsatisfactory in the sense of a criterion of the form of the child's head anterior to the occurrence of internal rotation, and which being due to a different mechanism, is probably different. Hardly any evidence exists regarding this matter. What there is points to an inequality of the mesial and transverse diameters before internal rotation occurs, and this is what one naturally would expect.

§30. Though the majority favours Solayrean obliquity above the brim, there is a strong body of opinion upholding the transverse mode of entry, the head normally becoming oblique in position when engagement is complete. Some of the greatest names in the history of obstetrics are associated with the transverse mode of entry which indeed, though not acceptable/

acceptable to the majority, has overwhelming evidence in its support. For transverse entry I have noted the following authors, all except four being verified from the original sources:- OULD (1741), SMELLIE (1752), LACHAPELLE (1795), NAEGELE (1819), HOHL (1834), DUBOIS (1834), KIWISCH (1846), LEISHMAN (1864), MACDONALD (1872), COHNSTEIN (1871), FRITSCH (1875), LAHS (1877), TARNIER and CHANTREUIL (1882), MEEH (1882), FARABEUF (1886 and 1894), PINARD (1887), PINARD and VARNIER (1892), AUVARD (1894), FABRE (1896), WILSON (1897), SCHAEFFER (1899), OLSHAUSEN (1899), VARNIER (1900), GARRIGUES (1902), AHLFELD (1903), HERZFELD (1905), and MUELLER (1907). LEVRET (1761), SPIEGELBERG (1867), and PLAYFAIR (1880) say the transverse mode of entry occurs often. CASEAUX (1840) admits its partial occurrence, while PARISOT (1893) says it is less common than the oblique position. That being so, I shall accept the transverse mode of entry as existent. But the mechanism of the conversion of the transverse to the oblique position will be considered in relation to the second stage only. (The manner in which the one is changed to the other in pregnancy or in the first stage is, I think, wholly/

wholly different and it falls outside the scope of the present paper.)

Surprisingly few writers have distinctly insisted upon the possibility of the occurrence of internal rotation at different heights within the pelvic canal. Among them are LACHAPELLE (1795), GUILLEMOT (1837), JACQUEMIER (1846), RITCHIE (1865), CASEAUX (1868), FABBRI (1857-78), TARNIER and CHANTREUIL (1882), PLAYFAIR (1886), VEIT (1887), CHARLES (1887), PARISOT (1893), PARVIN (1895), OLSHAUSEN (1899), GILLESPIE (1897), STARK (1903), WEBSTER (1903) MUELLER (1907), GALABIN and BLACKER (1910), FABRE (1910), VALTORTA (1912), and now SELLHEIM (1913^a & b) has admitted the fact. Though there is one region of the pelvis within which internal rotation usually happens, the movement may occur and sometimes does occur at a higher or a lower level.

§31. The movement of internal rotation is essentially the consequence of the interaction of a force and a resistance which are not directly opposed to one another. Or, more generally as STEPHENSON (1881) has it, the forces concerned in labour produce a resultant and a couple. The former leads to descent, the latter to internal rotation. But clinical evidence does not entirely support Prof. STEPHENSON in regarding the movement of internal rotation as a combination of rotations about a vertical and a horizontal axis, that is to say, as a rolling movement. Such occurs only when rotation is greatly delayed. The force consists of the uterine and abdominal pressures, or of the uterine pressure alone. The force has to be studied especially in relation to its direction. The resistance may be developed wholly within that portion of the canal which is contained within the bony and ligamentous pelvis, it may arise entirely from the resistance of the pelvic floor; these two factors may operate together; it may be developed by the interaction of the pelvic floor and the pubic arch; and lastly there may be no suitable resistance, when, as also in the absence of a force, no rotation occurs. That is to say, movement/

movement downwards, upwards, forwards, or backwards is necessary to the production of rotation. Resistance must either be overcome, or it must be able to cause retreat. Given then a force, and given a resistance which is not directly opposed to the force, and which is either actively repelling the mobile object lying between the two, or is so far a resistance that it is not being too readily overcome, then rotation will certainly occur somewhere within the canal, because in these provisions the disturbing factor of excessive frictional resistance is automatically excluded. There are, however, other factors which, though not essential to the occurrence of internal rotation, are yet able to determine the level at which it will occur and the direction which it will take. Under the factors of level, come the relative proportions of the head and the pelvic canal, and the position of the centre of pressure relative to the head and to the canal: under the latter are primarily the direction of pressure and secondarily the inclined planes of the pelvic canal and floor.

The relative proportions of the head and the pelvic canal are not simply a problem of comparing/

comparing the diameters of the pelvis, or the pelvic canal, and the fetal head. The factor also includes the position and presentation of the head in the movements preceding the occurrence of internal rotation, and the position and presentation are indissolubly interwoven with other factors such as the direction of uterine pressure, the position and extent of the resistances including the girdle of resistance, and the capacity which the head shows to become moulded, both as regards the degree and as regards the speed of the movement. The position of the centre of pressure is also inseparably connected with the presence or absence of the just mentioned factors. When the centre coincides with the true centre of the head at a time and level approaching those of internal rotation, the circumstances are abnormal and will be considered separately. Most frequently as I have shown, the centre of pressure has already taken up a position which is mesially excentric within the head, and at the same time it has moved as near as possible to the mesial plane of the canal, this circumstance being dependent on the tendency of the axis of pressure to seek the centre of the area of least resistance. The result of these arrangements/

arrangements is that the head, whether it is flexed or extended, occupies an excentric position within the canal. That portion of the head which is concentric with the centre of pressure lies approximately around the centre of the area of least resistance and probably also around the axis of descent, while that portion of the head which is excentric to the centre of pressure is also markedly excentric within the canal. Hence it becomes possible for a head of a certain size to be practically influenced by lateral and infero-lateral resistances, more particularly by those of the bony and ligamentous pelvis without being actually large enough to occupy the bony and ligamentous pelvis with the true centre of the head coinciding with that of the bony and ligamentous pelvis, and under these conditions to be influenced by the pelvis in the sense of internal rotation. The tendency of the axis of pressure to seek the mesial plane of the pelvis and the ultimate excentricity of the centre of pressure within the head also indicate a possible source of error in the later standard views of the mechanism. It has been, and still is, argued that, as the sub-occipitobregmatic diameter of the average head is less than any/

any of the diameters of the bony and ligamentous outlet, the bony and ligamentous pelvis even with a thin covering of soft parts cannot be a cause of internal rotation. The sub-occipito-bregmatic diameter is the observed diameter of engagement at the vulvar outlet, and it has been at once accepted as the diameter of engagement within the superior portion of the pelvic canal. Now, the sub-occipito-bregmatic diameter is sometimes the diameter of engagement even from the brim downwards, but it is not so in a much greater number of labours. BRAUNE'S second section and BARBOUR'S late second stage section are not evidence for the usually accepted view that the sub-occipito-bregmatic diameter is the diameter of engagement after flexion occurs. Clinical examination, by the greater abundance of its opportunities, furnishes much stronger evidence for the view which is illustrated by these two sections, that the diameter of engagement before internal rotation has occurred is in a preponderating number of labours the sub-occipito frontal. But that is not all. Neither in relation to the pelvis nor to the pelvic floor is the diameter of engagement necessarily also the diameter of the head concerned with the production of internal rotation. The diameter/
meter/

diameter of engagement plays its part in rotation only when the head is relatively large for the canal, and then it may or may not be subsidiary in action to that diameter which in all cases except one is immediately associated with the production of internal rotation. The plane of rotation, at whatever level of the canal it is situated, is usually, if not indeed always, obliquely inclined away from the plane of engagement and in consequence, while the sub-occipito frontal diameter lies within the plane of engagement, the occipito-frontal diameter lies within the plane of rotation. And as the occipito-frontal diameter is larger than the sub-occipito frontal and the latter exceeds the sub-occipito bregmatic, the head needs to be fairly small before it is able to escape the influence of the superior portion of the pelvic canal, or even of the bony and ligamentous pelvis. Hence, there is every reason to believe that it is only when the sub-occipito bregmatic diameter is truly engaged within the superior portion of the pelvic canal that the head escapes the influence of that portion of the canal, the reason being that the obliquity of the occipito-frontal/

frontal diameter to the plane of engagement is much greater than that of the plane of rotation to the plane of engagement. Thus the sub-occipito bregmatic diameter measured after birth compared with the diameters of the average pelvic outlet is not a certain guide to the dispositions ruling before internal rotation occurs. The only safe method is to observe clinically before and during internal rotation the exact position of the head and its relations to the parts. And we then find that, in primiparae in whom the soft parts are resistant and the area of the girdle of resistance small, the diameter of the head engaged is the sub-occipito-frontal the diameter of rotation is the occipito-frontal, and the rotation is mainly pelvic. In multiparae similar arrangements hold good, but for a different reason. In them the girdle of resistance can hardly be said to exist and the head appears to descend evenly to the bottom of the cavity. In pluriparae the resistances are of medium severity and the girdle of moderate to large size. In consequence, the diameter engaged is the sub-occipito bregmatic and the rotation is other than pelvic. Small heads when they/

they must be rigid in a high degree. This rotation may be distinguished as rigid vertical rotation.

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they are soft and macerated heads react as do those of the fetuses of pluriparae, so also do very large and relatively disproportionate heads, for then the ultimate resistances of the bony pelvis compel the engagement of the sub-occipito-bregmatic diameter. But, whereas in the small head group the pelvis is unable usually to produce rotation, the large head group in spite of the engagement of the sub-occipito-bregmatic diameter is usually rotated within the superior portion of the pelvic canal, though here as in other cases the pelvis may not be the only factor giving rise to the couple which determines the occurrence of rotation.

When the head escapes pelvic rotation, it descends onto and presses upon the pelvic floor where rotation may be produced. Pelvic floor or perineal rotation may take one of two forms. The resistance acting in opposition to the driving force may operate in a single part of the head, excentric but generally near to the centre of pressure. In order that this may happen the head must be unable to distend the pelvic floor anterior to the occurrence of internal rotation. That is to say, the pelvic floor must be rigid in a high degree. This form may be distinguished as rigid perineal rotation.

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In the other form, the head distends the pelvic floor before internal rotation occurs, and the resistance acts over a wide area in both lateral halves of the head. Here the pelvic floor, if not actually relaxed, must be capable of ready distension. This form may be called relaxed perineal rotation. In thinking of the relative degrees of resistance, it is important to observe that a floor with a given capacity for resistance may be able to move the head forwards and yet be unable to rotate the head, for there is every reason to believe that the effort which is required to produce internal rotation is much greater than that needed simply to forward the head. Thus, a floor may press the head forwards quite well, yet without rotation being observed to occur. In this case, rotation may still be produced by the "passive intervention" of a pubic arch acting on a head which is placed excentrically to the canal, and pressed forwards by the pelvic floor.

So far we have been viewing the factors of resistance required to produce internal rotation, but nothing has been written about the direction of rotation. When the head alone is considered, the direction of rotation is nearly as important as the occurrence/

occurrence of rotation itself. The direction of internal rotation is ultimately determined by the direction of uterine and abdominal pressure, the sole accessory stipulation being the mesially excentric position of the centre of pressure within the head of the fetus, the excentricity being manifest whenever flexion or extension occurs. When the axis of pressure is inclined downwards and forwards to the plane of the brim, rotation invariably takes place forwards and inwards: when the axis of pressure is inclined downwards and backwards to the plane of the brim, rotation invariably takes place backwards and inwards. When, however, the axis of pressure is directed at right angles to the brim, one of several things may happen. If the head is capable of pelvic rotation and is in the oblique anterior position, rotation forwards and inwards may occur, the head may impact, or by an increase of the second and third movements of flexion or extension it may escape the pelvis. If the head is in the occipito-posterior position the same may occur, except that rotation, if it happens, will be directed backwards and inwards. Should rotation devolve in the pelvic floor, the direction will be forwards and inwards in both positions provided the pelvic floor/

floor is adequately resistant, and the same direction of rotation will follow if the pelvic floor operates against the pubic arch. When, however, the direction of pressure is inclined downwards and backwards, the pelvic floor, I believe, is incapable in the occipito-posterior positions of producing long rotation and it is unable to advance the head towards the pubic arch until short rotation, as determined by the direction of uterine pressure, has taken place and has caused the head to rest symmetrically on the pelvic floor. Both when the direction of pressure is inclined downwards and backwards and at right angles to the plane of the brim, the strain on the pelvic floor is very serious and the mechanism can be greatly delayed. This is comprehensible when it is remembered that one of the forces going towards the making of the couple is either defective or contrary. As I have already indicated (Sect. II), the reference of the direction of uterine and abdominal pressure to the plane of the brim has nothing to recommend it except convenience and a relative ignorance of the precise inclination of the planes of rotation. Experimentally an inclination forwards or backwards of 10° - 15° gives/

gives the best results. But as the planes of the rotation, whether pelvic or perineal, are also inclined to the brim, it follows that the total inclination is much greater. Frozen sections indicate an average inclination of the resting pelvic floor of some 15° to the brim. That makes a total inclination, when pressure is directed downwards and forwards to the brim, of 25° to 30° and reduces the inclination to nil when pressure is inclined downwards and backwards to the brim. The latter circumstance argues either for an observational error in determining the inclination, or for a continued pelvic mechanical effect even when the pelvic floor seems to be the sole resistance operating. Probably, the pelvic plane of rotation is less inclined than the floor. But the inclination directed at right angles to the brim is able to operate as if it were inclined downwards and forwards, and in all cases to produce rotation forwards and inwards. The inclination is just sufficient to do this. At first sight, it might appear as if the gradual distension of the pelvic floor by increasing its inclination would favour rotation forwards and inwards but it does not do so experimentally if the direction/

direction of pressure is primarily at fault, unless the inclination of the floor is altogether so excessive that it surpasses anything witnessed in labour. And long before this state of distension has arrived rotation has already occurred, it being apparently essential to the production of distension that rotation should occur first, that is, when the axis of pressure is inclined downwards and backwards to the brim.

A rather important argument raised against changes in the direction of pressure, or against its want of coincidence with what is known as the axis of the canal is the circumstance that the head often, if not always, fills the canal. When the head fills the canal, there is no need, it is said, of any special direction of pressure, except that one directed downwards through the canal. I take it that, however well the head fills the canal, it is able to rotate - unless the frictional resistance becomes excessive, and also that it is able to rotate either the one way or the other. Now, if the pressure acts excentrically on the head, the direction of rotation will certainly be determined by the direction of pressure in spite of the fact that the/
the/

the head fills the canal, and provided that the couple which is developed is powerful enough to move the head. That the pressure is applied excentrically to a flexed or an extended head is rendered certain by the fact that the circumstance knowingly or unknowingly has been exploited for at least 160 years in the manual treatment of occipito-posterior positions, though it is true that many have overlooked this fundamental matter.

§32. Proceeding next to describe in more detail the several mechanical causes of internal rotation and their results, I will assume at first that engagement of the head is complete and refer later to the mechanisms of those labours in which the head traverses the whole canal during the second stage.

The mechanical causes of pelvic rotation are the form and size of lower part of the superior portion of the pelvic canal, the size and form of the fetal head, the excentric position of the head relative to the canal, the excentric position of the centre of pressure relative to the head, and the presence of, at least, uterine pressure. The direction of rotation within the pelvic canal is determined by the/

the direction of pressure.

From the primitive left occipito-transverse position the head normally moves to the right oblique diameter (L.O.A. position) during engagement. In the second stage the occiput descends into the lower part of the superior portion of the pelvic canal, in close contact with, but not injuriously pressing upon the anterior segment of the canal. At the same time, it moves to some extent towards the right so that it does not occupy the right oblique diameter of obstetricians, but so that its mesial plane coincides with a diameter of the pelvis which meets the true oblique diameter at a narrow angle. This circumstance is due to the tendency of the centre of pressure to seek the mesial plane of the canal, and at the same time to continue to occupy the mesial plane of the head. Probably, it compromises between the two in a position which is not far removed from the mesial plane of the canal. The consequence is that, when internal rotation does occur, the occiput experiences a very small lateral displacement and much more a true rotation or spinning about an axis which is almost stationary in a lateral sense. This view accords with my clinical/going/

clinical experience. A further consequence is that while much of the head is concentric with the centre of pressure, and therefore experiences nothing more than a spinning movement, a considerable part is excentric to the centre of pressure, and also excentric to the axis of descent and to the canal. This part comprises the greater part of the sinciput, which has a longer radius of action and a wider circle to describe than any of the concentric parts of the head. The head descends then towards the bottom of the cavity until the lateral margin of the occiput rests against the ischio-pubic ramus, and the sinciput overlaps the sacro-sciatic ligaments (OLSHAUSEN 1870) by as much, in the latter instance, as two cm. The head can then go no further until certain changes have taken place. In certain labours, however, it should be noted that before the head reaches this level it has met the resistance of the muscles and other soft parts, especially the obturator internus and the pubo-coccygeus muscles which make up so much of the thickness of the soft parts in the lower part of the cavity. These muscles are effaced by direct pressure in a greater or less degree according to the requirements of the head, which meanwhile is undergoing/

undergoing the changes that are about to be described. In the most frequently observed course of events, the head ceases to descend at a not very precise level below that of the ischial spines. It presses comparatively lightly against the margin of the left ischio-pubic ramus and comparatively heavily over the right sacro-sciatic ligaments. Rotation cannot yet occur because the co-efficient of friction is yet too high, due to the want of conformability of the apposed surfaces. The co-efficient is lowered during a greater or less lapse of time which comprises often the slowest part of the second stage, by a process of adaptive moulding, already described as the third movement of flexion. The diameter of the head which is now arrested is not strictly the occipito-frontal, as mentioned in the general outline of the mechanism, but more correctly an oblique diameter of the head extending from the left lower margin of the occiput to the right corner of the sinciput. No measurements of this diameter exist, and the same may be said of the most important diameter of the outlet which extends from the margin of the ischio-pubic ramus to the anterior third or the middle of the lower margin of/

of the great sacro-sciatic ligament. In neither instance does the deficiency matter greatly, because the differences between the occipito-frontal diameter and the oblique occipito-frontal diameter of the head on the one hand, and between the presently described oblique diameter and the transverse diameter of the pelvis on the other are probably not very great. The adaptation of the head at this period to reduce the co-efficient of resistance constitutes the supreme function of the third movement of flexion. The fact has been already recognised and correctly interpreted by LABAT (1881) and confirmed by BERTHAUT (1907-g). As a result of the diagonally opposing pressures, the anterior parietal is displaced backwards, while the posterior parietal retains very nearly its original position. At the same time the two parietals are displaced antero-posteriorly relatively to the head, the anterior being displaced towards the occipital, the posterior towards the frontal bone. These changes LABAT, by a process of exclusion, clearly recognised as being due to the necessity for internal rotation. They had already been described by DOHRN (1864) and others but the cause was misunderstood. Further the lateral/

lateral aspect of the occiput is flattened slightly while there is great compression and depression of the sinciput, together with what is even more important a skewed distortion of the sincipital region due to the fact that the resistance raised against the anterior frontal bone is greater than that raised against the posterior. These changes are compensated for by a certain amount of elongation of the head in the region of the centre of pressure and the area of least resistance, constituting in fact the main features of DOHRN'S shear. These changes result gradually in an adaptation of the apposed surfaces to one another which, together with the effacement of the soft parts clothing the pelvic walls, succeeds in reducing both the local and the general co-efficient of friction, so that in time a given pressure is enabled to initiate the movement of internal rotation. This movement, as is well known, increases in speed as it progresses - a circumstance which is due to at least three factors. First, the co-efficient of kinetic friction is always less than that of static friction (it is more difficult to start a body than to keep it moving): secondly, the resistances grow less as rotation/

rotation proceeds: and thirdly, the head behaving as an elastic solid performs useful work in the direction of internal rotation as the cause of the deformation is removed (one has only to depress a cranial bone of a newly born child to realise the force with which it springs back to its original position). Under the direction of pressure already stipulated, the major portion of the head revolves around the axis of pressure with, however, some displacement towards the right, while the sinuiput sweeps boldly round towards the left until it is clear of the sacro-sciatic ligament of the right side. At the same time, descent takes place and for the first time the head presses heavily on the pelvic floor. Before internal rotation occurs, it is always possible to pass one or two fingers between the head and the floor. This enables us to realise that the floor is then supporting no pressure and that the head is bearing upon unyielding bony and ligamentous resistances, and is only making progress with the pains in proportion to the thickness of the soft parts lining the walls of the lower cavity and lying between the head and the bones and ligaments.

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The main agent in the rotation just described is the considerable overlap of the sacro-sciatic ligaments by the sinciput, due partly to the size of the head and partly to its excentric position within the pelvis. The resistance arising from the ligaments of the one side acts in a direction inwards, upwards, and forwards. It is here necessary strongly to deprecate the view that these ligaments are not tense structures. They are not only tense ad naturam, but the tension is usually increased in labour by changes in the relative dispositions of the bones of the pelvic girdle under maternal control, to which I have already alluded (section I). Clinically, they are felt as broad tense bands with at least the lower edge sharply defined, and whenever the head overlaps one of these bands the obstruction can only be overcome by the production, through the ligament, of internal rotation, or - and this is much more difficult - of a further development of the second and third movements of flexion. On the other hand, when these ligaments are absent, it is doubtful if any pelvic structure remains capable of producing internal rotation. In the often quoted case of LIHOTSKY'S (1839)/

(1839) these ligaments were absent, yet internal rotation occurred in the normal direction.

§33. The resistance which the left lateral aspect* meets with from the pubic ramus is peculiar in the sense that, while it offers some degree of resistance before moulding has occurred to rotation inwards and forwards, it does not prevent in any way a backward movement of the occiput unless the head, as a whole, has descended to so deep a level that it is virtually impacted in a vertical sense, meaning that the head could not pass backwards through the transverse diameter of the lower cavity without, at any rate, some complex and therefore slow alteration of its mode of presentation. The resistance offered by the ischio-pubic ramus is indeed so slight, that, were not uterine-axis pressure directed downwards and forwards, or at all events at right angles to the brim, nothing would prevent the occiput passing backwards within the cavity. The sacro-sciatic ligaments of the opposite side would not then be able to do so; they would merely serve as a fulcrum or pivot on which the head would be carried backwards. On these clinical grounds and on experimental evidence/

* of the head.

evidence I believe that the appropriate couples from the opposing resistances can only be aroused in the normal case of the occipito-anterior position, and therewith the direction of rotation secured, by the direction of the uterine pressure. With it alone rests the direction of internal rotation. When pressure is inclined downwards and forwards to the brim rotation of the occiput readily occurs forwards and inwards.

SPIEGELBERG (1882) found that the head sometimes changed in the cavity from the left occipito-anterior to the direct occipito-posterior position. AUVARD (1894) says that the left occipito-anterior and the right occipito-posterior positions become direct occipito-posterior in 1% of cases. RIBEMONT DESSAIGNES (1899) records that in 8007 births there were 44 in the direct occipito-posterior position, of which 17 were originally in the left occipito-anterior position. Hitherto, no theory of rotation has accounted for these cases. In them I believe the direction of uterine pressure was inclined downwards and backwards to the brim and carried the occiput containing the centre of pressure backwards in long rotation, by a movement which is/

is similar to the long rotation of the head in the occipito-posterior position, but in the reverse direction.

That the long rotation of the head from the left occipito-anterior position should be rare is comprehensible. The area of least resistance lies in front, the head is in the most favourable position and under the most suitable presentation for the correct direction of uterine force. The turning movement will then have to be carried out against a progressive resistance. The moment most favourable to its occurrence is at the end of the first stage before the head has descended deeply into the lower part of the cavity, and when uterine pressure may be surprised into action in an erroneous direction. But even then the chances are all in favour of a readjustment of the axis of the uterus as the second stage proceeds. Labours in which this happens are by no means uncommon. The head which is in the right oblique at the end of the first stage rotates backwards nearly to the transverse diameter, even when well flexed, and then as it steps deeper recovers itself and rotates forwards. Such phenomena are readily explained by a primitive and vanishing/

backwards/

vanishing error in the direction of uterine pressure. On the effect of the direction of uterine pressure at right angles to the brim my evidence is purely experimental. The production of internal rotation by the pelvis is uncertain and difficult. There is no tendency, however, for the occiput to turn backwards. The absence of a sufficiently directive couple sometimes results in the resistances causing an increase in the movements of flexion so that the cephalic diameters are reduced and the head escapes from the pelvis without rotating. If the flexional movement fails the head may impact in the cavity. The head in the occipito-posterior positions acts in a similar way when the axis of uterine pressure is directed at right angles to the brim.

Otherwise, the mechanism of the occipito-posterior positions depends on whether flexion or extension is present. When the sinciput presents and contains the centre of pressure, the mechanism of rotation is identical with that of the left occipito-anterior position, the short rotation which occurs when the axis of pressure is inclined downwards and forwards being really a rotation forwards and inwards of the sinciput, as HART (1885) first pointed out. The long rotation of the sinciput backwards/

backwards, unrecorded so far as I am aware, will be even rarer than the long rotation backwards of the occiput for the same reasons, and also owing to the fact that the disposition of the head is less favourable to long rotation by the greater diameter that is engaged.

§34. When the occiput presents in the right occipito-posterior position it tends slowly but surely to move downwards and forwards across the space of the pelvic canal. At the same time the sinciput is pushed upwards over the antero-lateral wall of the pelvis, and is greatly compressed and depressed. The second movement of flexion progresses to an extent not witnessed in the left occipito-anterior position. The head becomes greatly elongated to compensate for the deformities which it is undergoing, and in consequence it rarely if ever happens that the rotation of a well flexed head in the occipito-posterior position is achieved through the pelvic cavity alone; the pelvic floor also comes into action and assists the other factors. As the occiput is moved forwards, the sinciput necessarily rolls on the antero-lateral wall of the canal, and experiences/

experiences a redistribution of the resistances, to which it is exposed, in such a way that the resistances become progressively greater on the anterior parts and progressively less on the posterior parts of the sinciput. Thus the sinciput becomes skewed in adaptation to the resistances to which it is exposed, and in preparation for the movement which it is about to make. The occiput likewise undergoes a skew distortion due partly to the lower part of the right lateral wall of the cavity, and partly to the resistance of the pelvic floor. For although the axis of pressure seeks to keep to the mesial plane of the pelvic canal, it is not able consistently to maintain this position in a movement such as long rotation, and so the occiput becomes exposed to lateral pressures. The occiput is carried forwards into the anterior part of the canal by degrees, short stabbing pains with equally sharp recoils being more effective than a succession of long sustained powerful pains. This feature of long rotation I found experimentally to be as equally necessary then, as it is believed to be essential in labour from the frequency of its occurrence, and the good results that follow from it.

so/

So far it is not strictly correct to speak of rotation. One ought to refer to the transit of the occiput across the pelvic cavity. Rotation theoretically sets in only when the occiput reaches the anterior segment of the canal, but in practice the transit of the occiput and the rotation of the head are more or less confluent. Hence it will always be more convenient to speak of long rotation. When the occiput reaches the end of its transit, the sinciput partly as a ne plus ultra and partly as the result of the reduction of the local co-efficient of friction by adaptive moulding, glides downwards and backwards in a long slant across the left lateral wall of the pelvic cavity, and is finally swept backwards and inwards towards the middle line of the cavity by the left sacro-sciatic ligaments. From the moment when the sinciput begins to move backwards the occiput spins around its axis - the axis of pressure, and the spinning movement does not cease until the sinciput reaches a position symmetrical to the pelvis. This spinning movement, as in the left occipito-anterior position, is associated with very little lateral displacement. In practice, as I once more repeat, the transit and the rotation are/

are not separated. The one merges in the other, but in most instances it is possible to point to the transit of the occiput being in progress before true rotation begins. The distinction is analytic and represents one view of the long rotation complex.

Long rotation, as it is clinically observed often takes place with lightning-like rapidity: as often it is slow and laborious. In either the one form or the other, I believe on experimental and clinical grounds that the explanation of long rotation is incomplete without reference to the direction of uterine pressure. Long rotation occurs by a pelvic mechanism only when the direction of pressure is inclined downwards and forwards to the plane of the brim; and by any mechanism only when pressure has that direction, or is directed at right angles to the brim. Many hold the view that a resistant pelvic floor is always able to forward the occiput in long rotation, provided there are no extrinsic disabilities. It must be remembered however, in order that delivery may occur, that the pressure must always be stronger than the resistance. Both the pressure and the resistance have a direction, and the direction of the stronger pressure will tend to/

to overweigh the direction of the weaker resistance. And so, if the pressure and the resistance are not operating towards the same end, the chances are that the pressure wins.

Short rotation of the head in the occipito-posterior position is a much commoner event than the long rotation of the head from the occipito-anterior position, and a large number of statistics are available to show its frequency. Some of these are given in the following tables.

TABLE.

FREQUENCY OF SHORT ROTATION IN LABOUR.

(ALL POSITIONS).

AUTHOR.	FREQUENCY.	NUMBER OF OBSERVATIONS.
HECKER (1881)	1 in 68.	17,400.
KEHRER (1859)	1 in 79	84,653.
NAGEL (1910)	1 in 97	30,914.
DESSAIGNES (1899)	1 in 132	8,007.
BIDDER (1884)	1 in 137	29,800.
v WEISS (1892)	1 in 192	19,000.
SINCLAIR & JOHNSTON (1858)	1 in 417	13,748.
HARRAR (1907)	1 in 29	41,800.

TABLE.

FREQUENCY OF SHORT ROTATION IN THE OCCIPITO-
POSTERIOR POSITIONS ONLY.

AUTHOR.	FREQUENCY	NUMBER OF OBSERVATIONS.
QUIEREL (1908)	1 in 2.5	40.
RICE (1912)	1 in 2.5	400.
SENTEX (1872)	1 in 4	
MILES (1887)	1 in 4.4	75.
COLES (1899)	1 in 5	30.
NAEGELE, quoted by MUELLER (1898)	1 in 8	
BATAILLARD (1889)	1 in 8.5	400.
DUBOIS, quoted by MUELLER (1898)	1 in 12	
PETERSON (1907)	1 in 12	5000.
LEISHMAN (1864)	1 in 25	
WEST (1857)	1 in 33	2585.
STOLTZ (1826)	1 in 50	
VALTORTA (1912)	1 in 50	674.
VARNIER (1900)	1 in 52	311.

While the tables indicate a comparatively high rate of frequency of malrotation, it will be observed that the discrepancies in the results of the authors are relatively enormous, even when the total/

total number of observations are great. The inference to be derived from these differences is that a fresh collection of data is required (if it has not already been done), such data to include only labours observed from the beginning and allowed to take a natural course.

I have already referred to the anterior rotation of the sinciput when it is presenting in the occipito-posterior position. If, however, the head is well flexed so that the vertex presents in the same position, short rotation may occur. Various reasons have been advanced to account for this circumstance. These I shall refer to later. In the mechanism, the occiput instead of travelling forwards, rotates by a spinning motion backwards and inwards, there being no immediate compression and depression of the sinciput. The main pelvic factors are the resistances of the antero-lateral and postero-lateral walls (sacro-sciatic ligaments) operating on the excentrically placed head. I believe both from observation and by experiment that in these cases the factor which primarily and sometimes ultimately determines short rotation is a misdirection of uterine pressure downwards and backwards/

backwards. No other factor that I am aware of explains the circumstance.

§35. It is clear from the history of the mechanism that two forms of perineal rotation are distinguished. It is convenient to adhere to the distinction, though the differences between the two forms are more those of degree than of kind. In the mechanism of perineal rotation described by HART, one half of the sacral segment meets the more dependent part of the head before the other half comes into touch with that portion of the head which still lies at a higher level. The resultant of the first half acts, according to Dr. HART, parallel to the anterior segment or to the pubic ramus. This I take to mean forwards and inwards. Rotation is completed before the higher pole of the head reaches the floor. That is a necessity. If the whole head was on the floor before rotation was finished, then assuredly the rotation would be reversed, and the head would take up a transverse position within the pelvic canal. This untoward circumstance, if it were to happen, would be due to the implied similar action of the two halves of the sacral segment, and/

and to the greater effect of a resistance acting on the sinciput than of that acting on the occiput. Without calling upon physical considerations as a proof, we know that leverage exerted on the sinciput is more effective than leverage exerted on the occiput, and we demonstrate the fact every time we rotate the head by hand. Hence it follows that the mechanism, described by Dr. HART, in order to be effective must depend on a perineum so rigid that it cannot be easily distended, until at any rate rotation is complete. That limitation implies that some other form of movement must be applied to the head if rotation is to occur, and that can only be forwards or backwards. Naturally the opportunities in the normal pelvic canal and with the normal head are limited for forward and backward movement. Another circumstance which militates against the universal applicability of HART'S mechanism is the relative nearness to the centre of pressure of the area of the head acted upon by the pelvic floor. That has to be taken into account along with the other existing possibilities, in consideration of the axiom that a turning force is effective in proportion to the radius of its action. I do not doubt/

doubt the existence of HART'S mechanism: I question HART'S theory of its action. The learned writer, while denying the influence on rotation of the bony pelvis as a whole, grants to the anterior pelvic wall an importance dependent more on its position than on its shape. As we shall see, the anterior pelvic wall is more important to the mechanism of the rigid pelvic floor than DR. HART admits.

If we imagine the lower surface of the head to be divided by a mesial and by a transverse line, we have then four areas or quadrants, a left anterior and a left posterior, a right anterior and a right posterior, assuming the head to be in the left occipito-anterior position. If the head is applied to a tense rubber sheet so that contact is made with the left posterior quadrant, and pressure is made downwards and forwards through the same quadrant, rotation takes place into a position corresponding to the antero-posterior. If now pressure and contact are transferred to the anterior quadrant, rotation takes place into a transverse position. It can be demonstrated, however, that when the centre of pressure and the area of contact lie in the same quadrant, more force is required to produce rotation than/

than would be the case if they were separated. Suppose then that the area of contact lies as before in the left posterior quadrant and the centre of pressure in the left anterior quadrant, the head being supported anteriorly by a vertical flat board. With pressure directed as before a new phenomenon appears - the head rotates into a transverse position. If however a curved board clasping the curved anterior (in a pelvic sense) aspect of the occiput be substituted for the flat board, rotation takes place into an antero-posterior position when the area of contact, the centre of pressure, and the direction of pressure are precisely as in the preceding test. The deduction which seems warranted from these experiments is then that the form of the anterior pelvic wall is as important as its position, and not as Dr. HART asserts the form less important than the position. Probably no form of perineal rotation ever occurs without some part of the bony pelvis coming into play. As we have seen, the presence and form of the anterior pelvic wall modifies and even alters that direction of rotation which would have been produced by the direction of pressure and the pelvic floor alone, and similar considerations from the bony/

bony pelvis apply to other perineal rotations, as PARAMORE (1909a) has been careful to observe. It may be objected to the foregoing that in rigid perineal rotation behind the anterior wall one of the descriptive features has been sacrificed in order to secure one form of movement (descent) essential to rotation. At first sight the objection seems valid. But there appears to be a substantial difference between the give of a rigid perineum under intra-pelvic conditions and the saggy trough-formed depression of a relaxed perineum. A rigid perineum is able to give to some extent without becoming a relaxed perineum and without allowing the higher portions of the head to come into contact with it. If it were not able to give to some extent, it would cease to be a perineum from the mechanical point of view and ought properly to be referred to the pelvis.

These considerations then tend to limit the functional value of the rigid perineum as a solitary rotator, but they do not deny to it mechanical importance altogether. The special value of a rigid perineum arises when long rotation is slowed or failing. Even though the direction of pressure is correct/

correct, the amount of pressure may be deficient, or the general resistances experienced by the head may be greater than usual. Then a rigid perineum acts in two ways which are concordant. First, it adds an extra resistance which from the direction of pressure is correctly reflected in the proper direction of rotation and secondly, by its rigidity it prevents or restrains the head from descending too deeply and thus becoming impeded by the narrowing pelvis before passing through the important transverse plane.

A rigid perineum is able to produce long rotation even though the direction of pressure lies at right angles to the brim. But the mechanism is slow and laborious; there is much greater strain on the pelvic floor; and the applications of pressure must have a distinct to and fro character, as indeed is the case in labour. Thus under experimental conditions a long rotation which cannot be produced by the pelvis owing to the pressure being directed at right angles to the brim, will still probably occur through the mediation of the perineum. In experiments, the rigid perineum is unable to produce long rotation if the pressure is inclined downwards/

downwards and backwards to the brim. The occiput travels backwards and inwards until the head has assumed an antero-posterior position. That is to say, the rigid perineum, or indeed any perineum, has no constant direction attached to its reflected force. The direction depends upon, and varies with, the direction of pressure. It is true that the pelvic floor may become so inclined from the superjacent pressure, that a force which is inclined downwards and backwards to the brim is eventually inclined downwards and forwards in relation to the floor. But the invariable occurrence of short rotation speaks for two factors, first, the ultimate influence of the pelvic walls on all rotations, and secondly the relative incapacity of the pelvic floor to deal, as one might say, properly with the oblique occipito-posterior position, when a maldirection of uterine pressure co-exists. The circumstance appears to be due to the relative instability of the oblique position. The mere act of depressing the floor under these circumstances invokes short rotation, and it is not until the head is placed symmetrically within the pelvis and becomes therefore/

therefore relatively stable that the pelvic floor is able to operate in the direction of forwarding the occiput. As in the case of pelvic rotation, so also here I believe a misdirection of uterine pressure downwards and backwards to the brim is the cause of the perineal short rotation of a well flexed head in the occipito-posterior position.

As regards a purely pelvic floor rotation it is important to record that under a suitable direction of pressure the experimental floor is able to produce the complete long rotation of the occiput forwards or backwards from the right occipito-posterior and from the left occipito-anterior position independent of all other factors such as the walls of the pelvis, and it is also interesting to note that more force is not required to carry out long rotation than short rotation. All that is necessary is that in the former the force must operate during a longer time than in the latter. More force is required experimentally in the pelvic canal than on the perineum, and more is required for both than in the pelvic canal alone.

§36. The second form of perineal rotation is that/

that associated especially with the names of RITCHIE (1865) and HILDEBRANDT (1866) and also entering, as I believe, into PARAMORE'S (1909a) theory of rotation. It is a relaxed perineum into which the head sinks as into a gutter whose long axis is directed antero-posteriorly and whose incline trends downwards and forwards towards the outlet of the canal. It has frequently been assumed that the head must adapt its long axis to the direction of the gutter, and not only that but it must, when in the oblique occipito-posterior position, perform long rotation in accordance with the resistances to which it is exposed. I believe there are no adequate grounds for these assumptions. PARAMORE'S contention that the pelvic floor is incapable in itself of producing rotation demands further proof than PARAMORE has given it, in the face of my experimental results. PARAMORE admits the floor to form a gutter. This gutter has its sole function in pressing the occiput of the well-flexed head forwards towards the outlet. The sacrum falls into line behind the occiput because the pelvic diameters decrease transversely and increase antero-posteriorly as descent takes place. So that in one sense PARAMORE may be said/ gutter-shaped floor cannot determine

ion of that rotation. When however the

rotation is otherwise determined a

rotation/

said to postulate pelvic rotation, and in another really not to have got any further forward than HODGE (1864). But PARAMORE states that rotation is taking place while the perineum is being distended, and as the perineum is a gutter whose lateral walls necessarily continue the slope of the lateral pelvic walls, it is impossible to see how they are not equally able to produce internal rotation as HODGE suggested. And indeed, I hazard the guess that the rotation which, for PARAMORE, is the most frequent is really more perineal than pelvic.

PARAMORE also postulates as a function of the pelvic floor the provision of a point d'appui or central fixation point on which the head rotates. This is unnecessary. In a model canal, designed to give effect to the changes in the pelvic diameters, rotation occurred in the absence of a pelvic floor, and therefore of any perineal fixation point, as completely as when the floor was present and with less effort. It is, however, a fact that a gutter-shaped floor will under experimental conditions cause internal rotation. And when the natural mechanism is ^{re}produced as closely as possible, the pelvic floor furnishes a central fixation point for the production of rotation. But a gutter-shaped floor cannot determine the direction of that rotation. When however the direction of rotation is otherwise determined, a gutter-shaped floor will produce /

produce long and short rotations perfectly well in the entire absence of a pelvis. PARAMORE has, however, done good service in redirecting attention to the form of head - a factor which has been well-nigh forgotten in recent yearnings after a plastic head and a featureless canal. PARAMORE showed that in a preponderating number of heads, even when the sub-occipito-bregmatic diameter is engaged, the distance of the sincipital pole from the axis of pressure is still approximately twice that of the occipital pole from the same axis, and rightly attributed the rotations he described to the influence of the resistances on the sinciput. As in the pelvic cavity so also on the relaxed perineum, the diameter of engagement is one and the diameter concerned in rotation is another. And owing to the greater obliquity of the relaxed perineal rotative planes, as compared with the pelvic rotative planes, a head which is engaged by the sub-occipito-bregmatic diameter may still present the occipito-frontal diameter to the plane of rotation. As it happens, however, in most of these cases which have escaped pelvic rotation moulding of the head has already proceeded to a considerable extent, and the second movement/

movement of flexion may have developed to more than the ordinary degree. In consequence, the sub-occipito frontal diameter presents little if any difference from the sub-occipito-bregmatic, and the most likely plane of rotation is either the occipito-bregmatic or the occipito-mid-bregmatic-frontal, the effectiveness of the one or the other depending on the degree of the precedent flexional movements. These diameters are smaller than the occipito-frontal and, unless the head is very large, or the pelvis very small, are probably inadequate for a pure pelvic rotation, or at any rate for more than a partial pelvic rotation. Even under these conditions the distance of the bregma from the axis of pressure is greater than that of the occipital pole from the same axis, and the two points are not equivalent in producing internal rotation.

The greater rotative power of the sinciput over the occiput on a relaxed perineum admits of ready illustration. In the left occipito-anterior position we saw that, when contact was made with the rigid perineum through the left anterior quadrant of the head and pressure was directed downwards and forwards through the same area, that rotation of the head/

head took place into a transverse position. If now exactly the same arrangements of pressure and resistance are effected on a relaxed perineum, the head rotates not into a transverse position, but into an antero-posterior position. This holds good with all possible combinations of pressure and resistance on a relaxed perineum. The head always rotates ultimately into an antero-posterior position - never into a transverse position. The mechanics which underlie these various movements are I believe as follows. On the rigid perineum, when rotation took place into a transverse position, the direction of the resistance acting on the left anterior quadrant was inclined outwards and to the left in the beginning. As rotation proceeded the inclination lessened and when rotation ended with the head in a stable transverse position, the direction of the resistance lay in the same sagittal plane as the direction of pressure. On the relaxed perineum the direction of the resistance on the left anterior quadrant was similarly inclined, but owing to the fact that the sinciput was also evoking a resistance from the perineum, the expected rotation did not take place. The direction of the resistance acting on the/

the sinciput was also inclined to the left, but being on the opposite side it was also inclined inwards and tended to drive the sinciput towards the mesial plane. Now if the occipital resistance had been the greater, the expected rotation into the transverse position would have proceeded; if the two resistances had been equal no rotation would have occurred; the only other explanation then that suggests itself is that the resistance acting on the sinciput was more powerful than that acting on the occiput and succeeded in placing the head in the antero-posterior position, and the reason why is explained in accordance with the known physical law depending on the relative lengths of the radii to which I have already referred. The explanation given here is no doubt open to the objection that the oval form of the head during perineal rotation is not proven. SELLHEIM certainly denies it. On this matter I have no more evidence to offer than is accessible to everyone, and once more I decline to accept the observed form of the head at the outlet of the vulva as necessarily corresponding to the form existing before and during internal rotation. But in any case I can afford to view the situation calmly/

calmly, because the rigid perineal rotation is independent of the form of the head. A perfect sphere will be rotated by the rigid perineum in the appropriate direction. But owing to the extreme nearness of the area of contact between the head and the floor to the centre of pressure, the rotative moment is relatively feeble and may fail altogether if the general co-efficient of friction is relatively high. Also a relaxed perineum may operate in the same manner as the rigid perineum on a rotund head, but here the resistance developed is likely to be inadequate.

Thus it is certainly true as is the general opinion that a relaxed perineum can rotate the head and will eventually place the head in the antero-posterior position. But nothing so far has been conveyed of the manner or the direction in which that end is reached.

This I believe depends on the direction of uterine pressure, and everything I have written in this connection regarding pelvic and rigid perineal rotation applies with equal force to relaxed perineal rotation. As with the latter, the relaxed perineum is capable eventually and laboriously under experimental/

experimental conditions of producing long rotation of the head from the right occipito-posterior position when pressure is directed at right angles to the plane of the brim, and is unable to do so when pressure is inclined downwards and backwards to the brim.

§37. Whenever all these factors fail, rotation may still be produced by the pubic arch. This is the rotation of KIWISCH and BERTHAUT, and is I think the explanation of rotation at the vulvar outlet, rotation in the perineal strait (LACHAPELLE 1821), and of SELLHEIM'S rotation. Pubic arch rotation depends, as BERTHAUT points out, in the interaction of the pelvic floor and a lateral pelvic arch. More closely considered the oval form of the head and its excentric position relative to the canal are factors of importance. The occiput is pressed forwards along the mesial plane of the canal and the pubic arch of the one side catches the excentrically placed sinciput and forces it towards the middle line of the canal. That is the case in the left occipito-anterior position. In the right occipito-posterior position the sinciput first meets the arch of/

of its own side and is restrained, while the occiput is pressed forwards through the pubic arch and the sinciput gradually falls in behind. In the majority of labours the pubic arch does not function as a rotator: rotation has already occurred. In others it is rendered inoperative by the changes which occur in the head through the movement of extension and which, as will be shown later, tend to destroy the oval form of the head.

In the pelvic and perineal rotations the head rotates before it changes its direction of advance. I admit that this view does not apply strictly to relaxed perineal rotation, but in this last mechanism the rolling forward movement has not proceeded to a great extent when rotation is occurring. In pubic rotation on the other hand the head has greatly changed its direction before rotation occurs, and the change has a great influence on the effects experimentally observed of the direction of pressure on the direction of rotation. By the great change of direction to which the head has submitted, and also by the fact that however one may change the direction of a body one cannot thereby alter the direction of the force which is applied to it/

it - a fact clearly recognised by DUNCAN (1868) and forming part of the mechanical basis of the axis-traction forceps - the pelvic floor is more advantageously situated to nullify the effect of a misdirection of uterine pressure, and it is not possible to show the same invariable consequences of a misdirection as is the case under pelvic and perineal rotation. Still the same effects such as short rotation are witnessed. The variable factor appears then to be the degree of resistance in the pelvic floor. But there is one result of constant occurrence and that is that under a misdirection of pressure there is always a much greater burden on the pelvic floor than there is when pressure is inclined downwards and forwards at the brim.

§38. The average of thirty average measurements of the transverse diameter of the bony outlet is 111.3 mm. (see Section I). The figure agrees very closely with ZWEIFEL'S estimate of 110.5 mm. and probably comes near to the truth. The average from seventeen average measurements of the oblique diameter is 116.5 mm. From this ZWEIFEL'S figure of 105 mm. diverges considerably. Fortunately the oblique/

oblique diameter of the outlet does not matter so much, for as I have shown the diameter of importance at the outlet is one lying very near the transverse. Accepting 6.5 mm. as the minimum value of the soft parts at the outlet we have approximately 105 mm. as the length of the transverse diameter of the outlet. For the occurrence of pelvic rotation with the head in the left occipito-anterior position, or in the right occipito-posterior (bregma presenting) it is necessary that the dimensions of the rotative plane of the head should not be less than 105 mm., and in order that rotation may be completed by the pelvis considerably more. The usual rotative plane in these positions is the occipito-frontal which according to FARABEUF and VARNIER, (1891) averages 120 mm. before rotation. These figures give an overlap, not in a horizontal but in a confluent direction, of 15 mm. which is amply sufficient to produce and complete internal rotation when the direct converging course of the sacro-sciatic ligaments is considered. An overlap of 15 mm. agrees well with my clinical findings. At the anterior angle of the sinciput, when the occipito-frontal is the rotative plane in the left occipito-anterior position/

position, I generally find by tactile estimate an overlap of 10 to 20 mm. More often it approaches the latter figure. That is to say, the sinciput extends by 10-20 mm. beyond the lower and internal margin of the great sacro-sciatic ligament which can be felt as a sharply defined edge. When however the sub-occipito bregmatic diameter is engaged the plane of rotation is the occipito-bregmatic. The average measurement of the former before rotation (FARABEUF and VARNIER) is 95mm. The occipito-bregmatic will be greater, but it is doubtful if it often appreciably exceeds the transverse diameter of the outlet of the canal. In the extended occipito-posterior positions the fronto-lambdoidal diameter here corresponds to the occipito-bregmatic and may be of similar length. So that we have so far as internal rotation is concerned two groups, an occipito-frontal group and an occipito-bregmatic. The former I think comprise the majority and are rotated by the superior portion of the pelvic canal: the latter which are in a minority and along with those heads in which the occipito-frontal diameter falls to or below 105 mm. escape pelvic rotation altogether. Finally there is a small section in which the occipito/

occipito-frontal diameter slightly exceeds 105 mm. but not more. The heads belonging to this section are rotated partly by the pelvis and partly by the pelvic floor. In the flexed occipito-posterior positions purely pelvic rotation can hardly occur though FRITSCH (1875) held that two fingers can be passed under the head during rotation. In this position the head becomes greatly lengthened and the protuberant occiput probably in most cases strikes and is affected by the pelvic floor. The plane of rotation here is the occipito-frontal notwithstanding the great exhibition of the second movement of flexion, because the plane of rotation is correspondingly oblique. It is also necessary to observe that though the occiput strikes the floor and is affected by it, rotation is able to proceed as well without the intervention of the floor, namely when the axis of pressure is inclined downwards and forwards to the brim. In ordinary examples of long rotation the influence of the pelvic bones is considerable. Hypothetically one can only absolve the bones when the head is so small that the centre of pressure is able to maintain itself in the mesial plane of the pelvic canal and the sinciput is uninfluenced/

uninfluenced through the soft parts by the bones. And even under these conditions it would be difficult to deny the possible existence of a couple derived from the soft parts fairly high within the superior portion of the canal, while long rotation was apparently being produced solely by the pelvic floor.

§39. The factors of internal rotation in presentations of the face, are similar to those valid for vertex presentations. When the movements of extension comparable to the movements of flexion in head presentations have occurred the chin contains the centre of pressure and rotates as a rule forwards and inwards. The chief interest from the present point of view lies in the asserted greater frequency of long rotation in face than in head presentations. Incidentally it appears that the mento-posterior positions are more common than the mento-anterior (HOHL 1834, SCANZONI 1853, SIEBOLD 1859, SPÖNDLY 1869, HOFFHEINZ 1885, REED 1905) and hence though all face presentations are rare it would be an advantage on that account alone for long rotation to be fairly certain of occurrence. Short rotation is of rare occurrence/

occurrence according to NAEGELE (1819), BRAUN (1857), TYLER SMITH (1858), HODGE (1864), HICKS (1865), NAGEL (q. by Sigwart 1908), REED (1905), and GALABIN (1910). VOLLAND (1897) observes that if the position once reaches the transverse diameter of the cavity long rotation usually follows spontaneously, while GALABIN (1910) notes that though short rotation may be produced partially (due to incomplete extension) the head rarely remains in the mento-posterior position. REED, however, records that in 75 cases no less than 17 remained persistently mento-posterior. In America the percentages of short rotation in the occipito-posterior positions are also higher than in Europe. But they are not higher than the 22.7% of short rotation in the face presentations recorded by REED. The circumstance removes the serious difficulty of having to account for the alleged greater frequency of long rotation in these face presentations - a difficulty which no mechanical factors present in these presentations are adequate to overcome. The fronto-mental diameter measures only 8 cm. (TARNIER and CHANTREUIL 1882), the sub-mento-bregmatic only 9.5 cm.. (FABRE 1910). In the occipito-posterior positions smallness of the diameters of the head are not usually held to favour long rotations. In face presentations the engagement of/

of the large sterno-occipital diameter, if it has any effect at all, ought to favour short rotation rather than otherwise. According to HIRST (1900) the chin has difficulty in descending as far as the pelvic floor, and long rotation may in this way be hindered. Further the chances of rotation being absent, imperfect, or anomalous are considerable, as I shall have occasion to show. HODGE (1864) CASEAUX (1876 and earlier) and AUVARD (1894) endeavoured to explain part of the difficulties in the mento-posterior positions by drawing attention to the apparent necessity of the simultaneous entry of the thorax and the occiput into the cavity of the pelvis, and which would necessarily operate by restraining the descent of the chin. Here also the position is not very clear, as REED points out that the average length of the neck from the chin to the sternum (in 50 children) is 8.75 cm. while the length of the lateral wall of the pelvis does not exceed 9 cm., and hence deep engagement may quite well take place without the necessity arising for the thorax and occiput to enter the brim together. The level at which rotation takes place in presentations of the face is generally held to be lower than that applying/

applying to head presentations. BRAUN (1857) SIEBOLD (1859), HICKS (1865), and SIGWART (1908) place the usual level of rotation on the floor. In one of HICKS'S cases the root of the nose was visible at the vulva when rotation was taking place. The contrary view is held by GONNET (1907) who found rotation to occur earlier, that is, in the inlet or the cavity of the pelvis. The dimensions of the lower diameters which I have just quoted indicate pelvic floor rotation as probable in presentations of the face. The head is however, much lengthened vertically and the greater bulk of the cranium lies at a high level so that it seems injudicious to attribute entirely to the pelvic floor a rotation which may really have its main factors within the pelvic cavity. And it may be that the deep descent of the head antecedent to rotation is connected with the engagement of the perhaps larger head diameters in the lower part of the pelvic cavity. The notorious delay in labour does not appear to arise from the cephalic diameters being too large nor from dystocia resulting from the engagement of the sterno-occipital diameter. A similar tardiness in descent is observed in anencephalic monsters and also in breech/

breech presentations. None of these appears to act well as a dilator of the canal and in the face presentations the difficulty of producing further extension (KALTENBACH 1891) does not quickly favour the excentric movement of the centre of pressure. As I believe that the direction of pressure influences or determines the direction of rotation in face presentations as much as in head presentations it is interesting to note that CASEAUX who held the direction of uterine pressure to be variable and indeterminate writes specially in connection with these presentations that, when pressure is directed at right angles through the chin to the floor, no rotation occurs; directed downwards and backwards, short rotation occurs; directed downwards and forwards long rotation follows. CASEAUX, however, gave no explanation of the variability of the direction of pressure, or rather of the frequency of its specific variability. In this respect, I can see no reason to separate presentations of the head and the face so far as the factors of long and short rotation are concerned, and they will be considered together.

§40. If the head in a forehead presentation is stable/

stable so that the presentation remains a forehead, the mechanism of rotation does not appear to differ in its course or in the factors of its occurrence from that of the other presentations. The first forehead position is stated to be the commoner of the two ordinary positions. In LANGERHANS'S five cases (1877) four were in the first position and one in the second. In BAYER'S (1885) five cases the same proportions were observed. According to v HELLY (1861) and HILDEBRANDT (1865) the entry is in the transverse diameter of the inlet, and the face comes forwards in internal rotation. The rotation forwards of the chin is the rule also for MANGIAGALLI (1884), BUDIN and POLOSSON (1892), and LEO (1906). HILDEBRANDT quotes BUSCH that rotation may take place posteriorly, as it happened in the case described by RASCH (1885) and that of LEO. HUETER, according to HILDEBRANDT, has found rotation not to occur, delivery taking place in the transverse diameter of the canal, which is also v.HELLY'S alternative mechanism. BELUZZI (1884) holds the unique position that rotation forwards of the chin is dangerous in forehead presentations. POLOSSON says the anterior fontanelle is the centre of the presentation, /

presentation, and quotes BUDIN to the same effect, and who added that descent of the forehead occurred. MANGIAGALLI expressed a similar view. But POLOSSON holds the occiput to descend. The occipito-mental diameter is not engaged in the pelvis, the mouth opening at an early period as was recognised by HENRICIUS (1885), POLOSSON and others. FABRE (1910) gives a good photograph of a child's head born in forehead presentation. The appearance of the face bears a remarkable resemblance to the tearful attitude but the child, it is stated, is not crying. The diameters engaged, according to POLOSSON, are the fronto-sub-occipital, the naso-occipital, and the mento-sub-occipital, with a maximum dimension of 12 cm. unmoulded. The main diameter engaged is therefore not greater than the fronto-occipital diameter of an average head presentation, but is considerably greater than the usual diameter engaged in that presentation, the fronto-sub-occipital. The descent, rotation, and delivery of a stable forehead presentation therefore becomes as AUVARD has it "un veritable tour de force de la Nature", and probably it does not occur unless the head is below the average size. The forehead contains the centre/

centre of pressure and is rotated forwards in the majority of cases. As I have quoted a recorded case to show, the forehead as the presenting part may rotate backwards in long rotation. Such a rotation like the long rotation of the head in the **left** occipito-anterior position, is explained only by a direction of uterine pressure downwards and backwards to the brim. The chances of observing forehead presentations to the end are remote. In SOLOWIEFF'S (1898) 18 examples only one ended a forehead presentation. According to this author a wide pelvis or a small head is essential to the stability of a forehead presentation.

§41. The entry of the head in the direct antero-posterior position is decidedly rare. It was, however, well known to some of the older writers such as BANDELOCQUE, NAEGELE, BOIVIN, and SCANZONI, and more recently to RAMSBOTHAM, HODGE, RADFORD, and STEPHENSON (1880) (fide MUELLER (1898²), MCKERRON (1899)). The position may be either anterior or posterior, and it has been observed in head, face, and breech presentations. In head presentations flexion to an extreme degree appears always to be present/

present. Of the direct occipito-anterior positions NAEGELE had two, MCKERRON two, LIEPMANN (1910) two, LIPSKY (1911) one, v WEISS (1912) seven, and NACKE (1913) two. Of the direct occipito-posterior positions CASEAUX had one, MUELLER (1898^a) three, NACKE (1909) two (1913) one, LIEPMANN five, TRAPL (1910) one, LIPSKY one, v. WEISS four, PANKOW (1913) had fourteen (out of 4000 deliveries) of which more were direct occipito-anterior than the converse. Of face presentations PANKOW had one and VOGELSANGER (1907) one (direct mento-posterior), while PANKOW had the one example in breech presentation. Spontaneous delivery occurred in nine of these cases, according to my notes, namely, LIEPMANN 3 O.A., v. WEISS 5, and VOGELSANGER'S face presentation. Spontaneous delivery also occurred among LIEPMANN'S five direct occipito-posterior cases, and according to the reference many of PANKOW'S examples were also spontaneous. Out of the nine cases rotation entirely failed to occur in three, including VOGELSANGER'S case. In the remaining seven internal rotation did take place. Rotation failed in NACKE'S case which was delivered with forceps, once only in v. WEISS'S series, and did not always occur in PANKOW'S/

PANKOW'S collection. PANKOW sums up the usual mechanism as flexion followed by rotation to the oblique or the transverse diameter of the pelvis and thereafter the mechanism appropriate to the oblique occipito-anterior or the oblique occipito-posterior, accordingly as the head is primitively direct occipito-anterior or direct occipito-posterior. The interest in the mechanism therefore centres in the production of rotation at the brim. HODGE attributes the cause of this rotation to the projection of the lumbar column. But even if the promontory and the form of the pelvic brim are added, there is still no adequate cause of rotation. If the head descends strictly in the antero-posterior position it is inconceivable that the column and the promontory can have any more effect than that of vertically grooving the sinciput or the occiput, as the case may be. And owing to the position of the head, the axis of pressure is already within the mesial plane of the pelvis, and hence no movement determining rotation can be sought for in this direction. Beyond the possibility of an obscure asymmetry of the pelvis in and near the mesial plane there seems no doubt that the prime factor in the rotation/

rotation at the brim exists in a want of perfect coincidence of the mesial plane of the head with the mesial plane of the pelvis in those cases of spontaneous delivery in which rotation at the brim occurs. The angular deviation need be very slight, less probably than can be detected per vaginam yet sufficient through adaptive moulding to determine a rotation of the head towards one side or the other.

§42. I have already mentioned the circumstance that a strong body of evidence supports the occurrence of the transverse position of the head above the brim as the normal primitive position. By the mechanism of engagement the position usually becomes oblique, and as the change as a rule occurs in pregnancy or in the first stage, the mechanism of the change falls outside the scope of this paper. In a lesser number of cases engagement does not occur until after the onset of the second stage, and with the mechanism of these engagements we are here directly concerned, more especially as regards the rotative movement which occurs about the longitudinal axis of the head.

In/

descending. In a proportion of labours the change from the transverse to the oblique diameter does not occur, and the head descends deeply into the cavity in the primitive transverse position. These we shall consider first. According to MURET (1894) who gives a good account of the subject the final result of the deep transverse position may be that internal rotation does not occur, or it takes place after great delay in the outlet or in the soft canal. In the former case the head is delivered transversely, or else it impacts. The transverse diameter of the outlet may be too small for the antero-posterior diameter of the head especially if the pubic arch is narrow and its angle acute (FRITSCH 1875). The head, may however, be forced past this obstacle. It is then greatly altered in shape and escapes between the tubera ischii. MURET quotes OLSHAUSEN that a head of average size may pass in this way through a bony outlet which is a little contracted. KILIAN, OLSHAUSEN, and KLEINWÄCHTER insist on the value of moulding and flexion at this moment; WERTH on the dilatibility of the soft parts. MURET himself stipulates a small head and a wide pelvis and adds that in a flat pelvis the two fontanelles are descending/

descending at the same level with each other, even in the soft canal. In a generally contracted pelvis, and also in a flat pelvis with extreme flexion, the transverse diameter of the head is not greater than the antero-posterior, and the head in consequence has a spherical form. Such heads fail to rotate, and MURET further believes that the absence of long rotation in small pelvises is due to the co-existent sphericity of the head. As however, a spherical object will rotate on the pelvic floor under an appropriate direction of pressure, MURET is in error in attributing the failure of rotation solely to the form of the head. It is the sphericity of the head together with the coincidence of the centre of pressure, the true centre of the head, and the area of contact that leads to an absence of internal rotation. WERTH, FRITSCH, and CASEAUX write of rotation occurring suddenly after a long delay. MURET adds that it may occur more slowly, and if the anterior fontanelle comes lower, it comes forward and the head assumes the direct occipito-posterior position. And further rotation may be delayed until after the head has escaped from the osseous canal. MURET quotes LACHAPELLE and CASEAUX as/

as witnesses of this rotation in the vulva. He attributes the rotation of the head from the transverse position to the oblique to the engagement of the shoulders in the pelvis. SMELLIE (1764) records several cases of the deep transverse position which were rotated artificially. TYLER SMITH (1858) says the position is rare (FRITSCH 2 in 1000), and depends on the head being small and the pelvis deformed. SPEIGELBERG (1882) gives as the causes a small head and a wide pelvis of the funnel shape: PINARD (1887) anteflexion of the uterus or flat pelvis: REED (1902) and GARRIGUES (1902) flat, generally contracted, or too wide pelvis, an arm anterior to the head, a long head, anteflexion of the uterus: AHLFELD (1903) flat or too wide pelvis, slight inclination of the brim, an arm anterior to the head and primiparity, because the head descends deeply in the transverse position in pregnancy. In WAEBER'S case (1912) the pelvis was generally contracted and the head small (premature). WEICHSEL (1913) records 59 cases in which 35 were primiparae, but narrow pelvis, large and small children appear to have been unimportant factors. CHAPPLE'S case (1912) was also a primipara. SIGWART (1908) had a face presentation in this position. Of other writers on the ultimate result of the deep transverse/

transverse position, DUHRRSEN (1896) held views similar to MURET'S. REED (1902) considers the occiput may rotate forwards or backwards, or the head may be born transversely (5 out of 34). In BROCKHAUSEN'S seventy-two cases (1910) fourteen were treated by posture. Of these internal rotation occurred in eleven, while the remaining three were born in the transverse position. The rest (Fifty-eight) were rotated artificially.

It would appear from the foregoing that cases of the deep transverse position may be divided broadly into two groups. The type of the one group is that in which the fontanelles are level with each other, and the type of the other that in which flexion, present from the beginning, gradually reaches an extreme degree. The former is liable to occur under normal relationships of head and pelvis, when the head is hard and small, when the resistance of the soft canal is considerable as in primiparae, or when the pelvis is flat. The latter makes its appearance when there is general disproportion between the head and the canal.

When the fontanelles are level or nearly so, there has been and is a want of the first movement of flexion, the centre of pressure is situated equidistant/

equidistant between the occipital and sincipital poles and the head is carried forwards and downwards or backwards according to the direction of uterine pressure, without any rotation occurring. As the head is truly in the transverse position, the causes which operate on the shoulders to produce rotation are here invalid, and rotation is unlikely to occur unless some factor steps in to produce either or both the first and second movements of flexion. Where engagement is delayed to the second stage and the expulsive pains begin to act on a head in the transverse position and with the two fontanelles level, there is for the foregoing reasons a great probability of a deep descent of the head in the transverse position, and it may indeed go through the pelvis in that manner. If however the first movement of flexion is complete at the beginning of the second stage, the centre of pressure is already excentric within the head, lying as it does nearer the occipital than the sincipital pole of the head, and it also lies as nearly as possible in the mesial plane of the canal. Experimentally the course of events then depends on the direction of uterine pressure. If it is inclined downwards and/

and/

and forwards, then the occiput is carried inevitably against the anterior wall, while the sinciput lags behind, and the oblique anterior positions result. If on the other hand pressure is inclined downwards and backwards, the occiput is carried backwards and the oblique posterior positions follow. When however pressure is directed at right angles to the brim, the head descends following the same axis, neither approaching the anterior nor the posterior wall, and the forward movement of the occiput devolves on the pelvic floor - a movement in itself a laborious proceeding when no pelvic walls are present, or when they form a canal of normal dimensions, but approaching the impossible when some degree of general pelvic contraction is present. This last combination of the direction of pressure and flexion holds, as I believe, the probable explanation of the deep transverse position with flexion. The general frictional resistances are too high to allow of the occurrence of internal rotation when the means to produce internal rotation are in any case deficient, though not in themselves inadequate.

§43. An interest in contracted pelves pertains to the presence or absence of internal rotation, and/

and specially in the occipito-posterior positions to the vexed question of long or short rotation. Pelves which are so deformed or contracted that natural delivery is impossible do not concern the study of the mechanism of internal rotation.

In generally contracted pelves internal rotation may fail altogether, and in the occipito-posterior positions short rotation is liable to occur (PARAMORE 1909a) in spite of the fact that flexion is good. According to LITZMANN (1872^b) rotation takes place early when the forehead is still above the brim. In these pelves the little fontanelle is in the centre of the presentation. MURET (1894) holds that when this is the case the head is probably as broad as it is long, and hence fails to rotate. I have already pointed out that rotation can occur even when the head is round, and that the cause of the failure must be looked for more deeply. There are two sources of failure which interact in a manner prejudicial to internal rotation. The most obvious is the excessive resistance of the hard and soft parts of the pelvic canal. These parts do not act directly by resisting rotation, for if the resistance is equally distributed all round the head/

head there is no bar to rotation, but they act by producing between themselves and the head an excessive co-efficient of friction which the factors tending to produce rotation are unable to overcome. The excessive co-efficient of friction acts also in the occipito-posterior positions, but there is also for a time a pure effect of the resistances, for the head has to pass through the transverse diameter of the pelvis. As the head approaches this diameter, its own diameters increase relative to the pelvis, though by the tendency of the axis of pressure to hold to the mesial plane of the pelvis means are taken by way of flexion to render the increase as little as possible. There is, however, always some increase and it may be sufficient to render impossible the passage of the head through the transverse diameter of the lower part of the contracted cavity.

The high co-efficient of friction in the generally contracted pelvis has its injurious property enhanced by the low rotative value of the head itself. The head is round: it is therefore incapable of evoking pelvic rotation, and rotation devolves upon the pelvic floor. Owing to the form of the head the rotative mechanism is similar to that/

that sketched for the rigid perineum. The area of contact is very near the centre of pressure and the rotative force correspondingly low. In the generally contracted pelvis the probability of a failure of rotation therefore depends upon a high co-efficient of friction plus a low rotative value in the occipito-anterior positions, and on these two factors plus the difficulty at the transverse diameter of the lower cavity in the occipito-posterior positions.

In flat pelves the mechanism is as a rule normal once the brim is passed (HART 1885), though there is a distinct tendency, as I have quoted evidence to show, for the primitive transverse position to persist, and LITZMANN (1872^b) holds there is a tendency to the persistence of occipito- and mento-posterior positions. In a generally contracted flat pelvis rotation occurs at a low level owing to the shallowness of the pelvis according to MICHAELIS (1851), but LITZMANN maintains the contrary.

Kyphotic pelves: CHAMPNEYS (1883) records the histories of eight cases which were delivered, or were otherwise of interest mechanically. In two, spontaneous evolution occurred from head to breech presentation/

presentation; one was a transverse deep position; two did not rotate at all; one rotated from the transverse to the oblique position and was so delivered; two rotated from the right anterior oblique diameter to the antero-posterior diameter (O.A.). One of these last was CHAMPNEYS'S own case in which rotation forwards occurred after the head left the pelvis. HERMAN (1886) gives the history of a labour in which anterior rotation occurred. CHAMPNEYS (1886) records a case of SCHAUTA'S, in which after external cephalic version had been performed the brow presented, went over into vertex, and rotated posteriorly. The author adds another case of his own in which the primitive left occipito-anterior position became transverse. Under traction the occiput rotated more backwards until clear of the bony pelvis when long rotation followed on the pelvic floor. In BREWIS'S case (1887) the head was at first direct occipito-anterior. It went back to the right occipito-anterior position and was born occipito-anterior by artificial rotation and traction.

KLIEN (1895) sums up the most of the history of the mechanism in Kyphotic pelves. He recounts 103 recorded examples. Of these 94 were head presentations and were mostly in the left and right occipito/

occipito-anterior positions. Of 18 oblique occipito-posterior positions long rotation occurred in only three, while in five left occipito-anterior positions long rotation occurred backwards. There were six examples of the deep transverse position. One reached the plane of greatest dimensions (BECKENWEITE), four the plane of least dimensions (BECKENENGE), and one the pelvic floor. Out of six oblique entries not one rotated. There was also a number of spontaneous changes of presentation within the pelvis.

According to CHAMPNEYS, MOOR (1865) definitely recognised the mobility of the pelvic joints in kyphotic pelves and described the movements as taking place at the pubic symphysis and at the sacro-iliac synchondroses, there being also in addition to the other movements a nutation of the sacrum. HOENING (1870) (fide CHAMPNEYS) considered transverse entry to be the commonest event and that sooner or later the head became antero-posterior, short rotation being the rule in the occipito-posterior positions. CHAMPNEYS says that deep transverse positions are common, posterior rotations not uncommon, and that the head may emerge transversely or/

or obliquely from the pelvis and rotate on the pelvic floor. KLIEN states that the head usually enters obliquely, sometimes transversely and very rarely in the antero-posterior diameter. He attributes posterior rotation to the great space between the kyphotic spine and the anterior abdominal wall, and which favours the back of the child turning backwards.

We thus have in kyphotic pelves a relatively great frequency of:-

- (1) No rotation.
- (2) Posterior rotation both in the oblique posterior and oblique anterior positions
- (3) Deep transverse positions and
- (4) According to CHAMPNEYS a subsequent anterior rotation on the pelvic floor.

The absence of rotation is probably dependent on circumstances similar to those valid for the generally contracted pelvis. From the descriptions of BREWIS, CHAMPNEYS, and KLIEN, it is apparent that there is great contraction of the transverse diameters towards the outlet, a diminution of pelvic inclination, in 30% of these pelves more or less general contraction (KLIEN), and great ante-flexion/

anteflexion of the uterus. In most of the labours the head descended far back in the pelvis - behind the ischial spines, or at any rate behind the tubera ischii. It is therefore apparent that below a parallel plane drawn through the ischial spines the area of least resistance did not present anteriorly but posteriorly, and that what may be called the true area of least resistance was not able to influence the mechanism until after the head escaped from the bony pelvis. The pelvic inclination was lessened and there was pendulous belly, while it may be assumed that the usual adaptive instinct of the mother was absent or greatly deficient, that is to say, the mechanism for regulating the degree of pelvic inclination to the axis of the uterus. We thus have three factors, the posterior area of least resistance, the pendulous belly, and the lessened inclination of the canal; and for the oblique occipito-posterior positions we may add in some cases a fourth the diminished transverse diameter of the bony outlet, as causes of an abnormal direction of uterine pressure. Even so, the direction may still have been at right angles to the plane of the brim, and most of the mechanisms would have occurred as they are recorded. But the long rotation posteriorly of the five

five originally left oblique anterior positions is tolerably good evidence for an inclination of uterine pressure downwards and backwards to the brim in these cases. No other factor or group of factors is so well adapted to account for the circumstances. And in the posterior rotations of the other examples this inclination of pressure is an easier explanation of the observed rotations than the direction of pressure at right angles to the brim, though the latter is able so far as one can see to account for them. CHAMPNEYS'S two records of anterior rotation on the pelvic floor after the head had escaped from the pelvis imply first, that the preceding posterior rotations within the pelvis were not complete, and secondly, a maintenance of, or a change in the direction of uterine pressure. If the direction was originally at right angles to the brim the direction is adequate to account for long rotation anteriorly on the pelvic floor, though as I have reason to believe, laboriously and at some risk to the perineum. If on the other hand the direction of pressure was inclined downwards and backwards to the brim, it is experimentally certain that the pelvic floor will not be able to rotate the occiput forwards, while from the clinical point of view further evidence is required/

required before the possibility can be accepted as a fact. There are three circumstances which will favour a change in the direction of pressure after the head has escaped from the bony pelvis. One is the situation of the true area of least resistance anteriorly with which the head directly and the uterus indirectly come into touch. A second is the smaller diameters of the head and the body engaged in the lower pelvis. These I suggest favour a movement forwards of the parts towards the anterior pelvic wall and straighten the intra-pelvic axis of the fetus, thus bringing it to bear directly on the outlet. The third circumstance is the probability that the deeper the presenting part steps into the pelvis the more the axis of the uterus is inclined backwards at the fundus. This circumstance is readily observed in many labours. Under either of these two alternatives long rotation anteriorly is the probable event on the pelvic floor, while within the pelvis itself under the three factors and possibly the fourth factor which I have mentioned posterior rotation is likely to happen. This posterior pelvic rotation can however be superseded by anterior perineal/

perineal rotation, only when the former is incomplete. The oblique pelvis does not differ in its mechanism from the generally contracted pelvis (JOLLY 1913), except that as SCHÜLEIN (1913) points out in the latter the head occupies the whole of the pelvis while in the former only the wide part is occupied. A similar mode of entry and descent occurs in some forms of more or less flat pelvis (BREISKY 1869, KOHN 1888), and indicates that the axis of pressure is sometimes compelled to deviate laterally from the mesial plane.

Accessible reports on the mechanism of labour in Split Pelvis have been made by FREUND (1872) LITZMANN (1872^u), GUSSEROW (1878), SCHICKELE (1901), and v. FRANQUÉ (1913). From these reports I have notes of ten cases, and the following observations. The pelvis is not materially affected by the deficiency of the pubic bones. There is no projection of the promontory, and the outlet is normal. (In LITZMANN'S and GUNZBURG'S (1872-3) examples the pelvis were apparently flat rachitic.) There is great mobility of the ileo-sacral joints leading to an increase during labour of the anterior gap by 2-6 cm. (V FRANQUÉ)/

(v FRANQUÉ). Owing to the want of fixation anteriorly there is defective abdominal action. In five out of the ten labours tears occurred or artificial cuts had to be made in the vagina and perineum, the soft passages being almost stenosed. Internal rotation is frequently absent. In SCHICKELE'S case the head is stated to have rotated from the right occipito-anterior to the left occipito-anterior position, and back to the right in which position the head was delivered. SCHICKELE and v FRANQUÉ unite in ascribing the failure of internal rotation to the defect in the anterior wall of the pelvis. According to the former the head is unable to fix itself in a definite position as the symphysis gives way. AHLFELD 1903 (after ZWEIFEL, HEGAR'S BEITRAGE, VI, 18. See also ZWEIFEL, 1893) says rotation fails after symphysectomy because the pelvis has not then the necessary funnel shape. SELLHEIM (1906) attributes the failure to the absence of a bend in the canal due to the gap in the anterior wall, and points out as AHLFELD does that after operations carried out to widen the pelvis rotation "not seldom" fails. Here the Author cuts the ground from under his own feet.

For/

For a simple rotation the bend in the canal is not essential. Rotation occurs in the bird's oviduct, as SELLHEIM points out, but he does not add that it still goes on after the egg has descended into the straight portion of the duct. At the same time, as SCHATZ and SELLHEIM hold, the mechanisms of rotation in the oviduct and in the pelvic canal are not strictly comparable, and for the rotations which are observed in labour the bend in the canal may be necessary as SELLHEIM maintains. But this is a different thing from saying that a gap in the anterior pelvic wall is the cause of a failure of internal rotation. That the gap should cause pelvic rotation to fail is not surprising if v FRANQUÉ'S figures are correct. But it does not explain why the pelvic floor fails to rotate the head. There, rotation will take place whether the head is moving forwards or downwards. Retention behind the anterior wall is not essential to the occurrence of perineal rotation. The cause of the failure is to be sought therefore not in the gap in the anterior wall, but somewhere else. A salient feature of these labours is the imperfect development of the soft parts. By the want of dilatibility which the

of the cause. In analogous rotation is thus also an abnormal rotation in the sense of the first clause/

the parts exhibit there is applied to the head an excessive concentric resistance which by a too high coefficient of friction hinders or prevents rotation. As the operations of pubiotomy and symphysectomy are applied to pelves where there is a misrelation of the head and the pelvis, the occasional failure of rotation may well be due to a similar cause. In these operations it should be noted that anaesthesia adds to the effect on the expulsive powers of the gap in the anterior pelvic wall. Deficient pressure is associated with an excessive resistance of the soft parts. Before the gap in the anterior wall can be accepted as a sufficient cause it would need to be shown statistically that the failures of rotation are more numerous in split pelves than they are in contracted pelves.

§44. The use of the term anomalous for certain rotations is wise, for it expresses the idea of something unusual without conveying any information as to the cause. An abnormal rotation means a rotation which departs from the more frequent or more expected direction of movement, and the words imply some knowledge of the cause. An anomalous rotation is thus also an abnormal rotation in the sense of the first clause/

clause. For example, the short rotation of the extended head in the occipit-posterior position is abnormal, but not anomalous, for the cause is well known and generally accepted. Fundamentally the rotation is really normal: it is the original position that is abnormal, while the immediate cause - the presentation - being obscure in origin is anomalous. On the other hand the short rotation of a well flexed head in the occipito-posterior position is anomalous, because its causation is doubtful. Were the cause or causes known, the rotation would be apparently abnormal and fundamentally normal, but it would not be anomalous.

For the short occipito-posterior rotation I have notes of 35 distinct causes culled from the writings of 40 authors.* These causes I have grouped by/

*NAEGELE (1819), KIWISCH (1846), WEST (1857), SMITH (1858), HILDEBRANDT (1866), HOENING (1870), MACDONALD (1872), FRITSCH (1875), MILNE (1879), CROOM (1881), CHAMPNEYS (1883), HART (1885), WINCKEL (1887), MILES (1887), BATAILLARD (1889), KALTENBACH (1891), MARX (1892), EDGAR (1893), AUVARD (1894), KLIEN (1895), MURRAY (1896), COLES (1899), VEIT (1900), HIRST (1900), GARRIGUES (1902), DEMELIN (1903), STARK (1903), GILLESPIE (1903), SELLHEIM (1906), KEHRER (1906), LEO (1906), PETERSON (1907), OLSHAUSEN (1908), QUIEREL (1908), PARAMORE (1909^a), GALABIN (1910), RICE (1912), VALTORTA (1912), LEHLE (1913), BERKELEY and BONNEY (1913).

by similarity, arranged in some sort of order, and marked for each the number of opinions it gets from among the forty authors. Extension of the head is excluded. That it is the principal factor in the production of a so-called short rotation is generally admitted and the mechanism of the rotation is well understood.

(1) Small head (including twins and soft heads):

normal pelvis, 23.

(2) Large head: normal pelvis.....10.

(3) Normal head: large pelvis (including broad pubic arch and small spines)....9.

(4) Normal head: contracted pelvis (including asymmetry of the pelvis, a cause of L.O.P. short rotation)....21.

(5) Laxity of the soft parts (including rupture of the perineum, pendulous belly, and multiparity).....20.

(6) Strong pains: rapid labour.....5.

(7) Weak pains: slow labour.....4.

(8) Prolapse of hand, foot, or anterior to head.....6.

(9) Projection of ischial spines.....3.

(10). Vacant space on sacrum, narrow vulva,

face unable to pass brim, twisting

of/

of cord round neck of fetus, faulty posture of woman, error of bendability of neck (SELLHEIM), overdistension of uterus, posterior obliquity of uterus, clumsy interference.....each 1.

In how far these opinions are representative I am unable to judge, but so far as it goes the analysis brings out a preponderance of views in favour of three separate factors - relative underproportion, relative disproportion, and laxity of the soft parts (mechanically the third factor might with propriety be classed under the first). Of the other factors the most important are strong and weak pains, and the prolapse of a small body before the head. A small head it is generally said leads to short rotation, because it does not fill the pelvis well, and so does not furnish a suitable lever for the production of long rotation. It is nearly round and often soft, both of which characters operate in a similar way to that of the smallness. But long rotation occurs experimentally on a pelvic floor without the intervention of pelvic walls, and also when the head is perfectly round. Smallness and roundness/

roundness of the head are therefore not per se factors of short rotation. Long rotation then occurs on the pelvic floor in spite of smallness and roundness of the fetal head, but as I have already pointed out it is improbable under maternal conditions that long rotation can ever occur without the intervention of the pelvic walls. Smallness of the head may however lead to short rotation in the following way. If the abdominal walls are vigorously contracted and hold the uterus in good position, then the long rotation of a small round head will occur, provided the pelvic floor is sufficiently resistant. If on the other hand the abdominal walls are weak, then the small head by its mobility within the pelvis favours the propence of the uterus which under these circumstances is not able to pull truly against the pelvis through its attachments. When however the head fits the pelvis well, it gives the uterus a fixed point to pull upon, and by the tendency of the uterus and therewith the fetus to straighten themselves during a pain, enables the uterus to assume a proper direction independently of the abdominal walls, though in most cases these improve in action, owing to the fact that with the deep-stepping of the/

the well fitting head in the pelvis part of the burden is removed. In this case the direction of uterine pressure is correct, and long rotation will occur. In the former, where the head is small and the abdominal walls more or less weak, the uterus straightens itself during a pain in the line of the head which is then inclined backwards, with the result that uterine pressure is inclined downwards and backwards, and short rotation results. The position is further safeguarded, however, by the circumstance that the deeper the head descends in the pelvic canal, the more likely is pressure to be correctly inclined; and as the preparations for rotation usually take some time, the line of pressure may be corrected before short rotation is begun or ended. Examples are familiar of partial short rotations followed by long rotation in each instance. Excluding the production of flexion, which I think, should not enter into the present connection, there is nothing in the fetus or in the canal to account for the change of rotative direction. Secondly, it should be remembered that the mother possesses the power, even under considerable exposure to an anaesthetic, of adapting the pelvic inclination to the inclination of the uterus, so that in/

in order to cause short rotation the uterus must always be inclined during a pain more than the pelvic brim.

Under relative disproportion are included a large head in a normal pelvis and an ordinary head in any of the contracted pelves. In these cases rotation would appear to be mainly pelvic and only partially perineal. As the head has at first to expose increasing diameters to the transverse diameters of the lower cavity, it follows that if the transverse diameter of the extremely flexed head cannot pass through the transverse diameter of the pelvis long rotation will not occur. This does not amount, however, to an explanation of the occurrence in all cases of short rotation which is a reversed movement. In many of these cases there are reasons for believing that pressure is already directed downwards and backwards to the brim, and long rotation is never attempted. Though the head is large or relatively large, it does not become properly stepped in the cavity, and in many cases true NAEGELE obliquity or excessive true LITZMANN'S obliquity appears, indicating that the uterus is taking or has taken an erroneous direction. In other cases we assume/

assume that pressure is inclined downwards and for-
 wards to the brim, and long rotation has been checked.
 As long as the pressure remains in this direction,
 it is difficult to see how short rotation can arise.
 Descent or impaction may occur, but not rotation.
 I believe that the mechanism now becomes like that
 which I have suggested for the kyphotic pelvis.
 Temporarily there is a new area of least resistance
 posterior to the transverse diameter of the cavity.
 Into this area the axis of pressure moves and be-
 comes inclined downwards and backwards to the brim
 so that short rotation is produced. If on the other
 hand we assume pressure to be directed at right an-
 gles to the brim, then long rotation is being pro-
 duced solely by the pelvic floor acting against the
 resistances of the pelvic cavity. Short rotation
 will be produced by the pelvic walls, but only under
 great difficulty and with an extreme likelihood of
 impaction. Experimentally the greatest conser-
 vation of energy occurs by an alteration of the di-
 rection of pressure from a forward inclination or
 a rectilinear direction to an inclination backwards
 to the brim.

Under the heading of relative dispropor-
 tion/

disproportion ought also to come excessive resistance of the soft parts, which by setting up a too high co-efficient of friction, or even by their mere resistance prevent the occurrence of long rotation. Thus in primiparae, especially if elderly, short rotation is apt to occur in spite of good flexion. Laxity of the soft parts is said to cause short rotation by failing to provide a ~~too~~ sufficient resistance to the most dependent part of the head. As however, so long as there is any resistance at all, it will always act in the same direction, it is difficult to see how it can determine short rotation. That it may allow of the head being born in the primitive oblique position is readily understood. The pelvic floor is elastic, but in a sense different from that of a rubber membrane. If the latter is stretched there comes a time when it will stretch no more, and it then opposes a resistance similar to that of a sheet of linen. If the sheet is further stretched it tears. The pelvic floor can also be stretched and stretched until it tears, but there is no intermediate "linen" stage. Hence the pelvic floor gives way indefinitely unless it tears. The consequence is that however slack the rubber-sheet/

sheet may be, it can be depended upon to produce rotation through its intermediate linen stage, but the lax pelvic floor recedes readily and continuously, and is incapable then, as I believe, of causing either long or short rotation. It simply allows the head to pass in the oblique position. Now if the direction of pressure is inclined downwards and forwards to the brim, long rotation will occur independently of the pelvic floor by the head being driven against the antero-lateral wall of the pelvis, and if pressure is inclined downwards and backwards, short rotation will occur on the pelvic floor in spite of its weakness. But if pressure is directed at right angles to the brim, the production of long and of short rotation depends on the pelvic floor, and if this is weak neither the one nor the other is likely to occur.

Too strong uterine contractions or a relatively quick passage of the head form another plausible factor of short rotation. NAEGELE long ago recognised that to the successful production of long rotation a coming and a going of the head were essential. The short sharp pains associated with the occipito-posterior positions have been the subject/

subject of general comment, and have even been regarded as diagnostic of the positions. Experimentally I found that these conditions of pressure are essential to the development of long rotation. The head does not recover its original position in each successive retreat, so that there is a progressive movement forwards in each cycle of pain and pause. When on the other hand strong continuous pressure is made, the head is forced through the cavity in its primitive position flexion becoming exaggerated to allow the awkward movement to occur. That proved true for the pelvis. When a floor is added to the cavity similar conditions of pressure are necessary, whether pressure is inclined downwards and forwards or directed at right angles to the brim. As is well known, after manual rotation of the head to the occipito-anterior position, the pains lose their previous short and sharp character and become longer and more wave-like. These observations are further evidence for the intimate connection presumed to exist between the vagina, the uterus and the abdominal muscles. The nature of the contractions is determined by the intra-pelvic requirements in a reflex manner, to a marvellous degree of refinement.

The/

The effect of weak pains is misleading. That they should fail to bring about long rotation is evident: that they should lead to short rotation is not so clear. Probably in the latter event some other factor appears.

When an arm, a foot, or a pelvic tumour comes down anterior to the head, it is probable that the contents of the pelvic canal are to be regarded as a whole with a transference of the centre of pressure to a position determined by the whole, and not that the presence of the anterior prolapse hinders or prevents long rotation. If the contents are regarded as a whole and the direction of pressure is normal, the sinciput plus the prolapse rotates forwards and inwards, while the occiput rotates backwards and inwards, as does the sinciput in the normal left occipito-anterior position. An exception lies in the circumstance that the presence of a prolapse beside the head may produce relative disproportion, which by raising the general concentric resistance and the co-efficient of friction may lead to a failure of internal rotation.

Of the remaining factors which I have tabled the only one that calls for consideration is overdistension/

overdistension of the uterus to which should perhaps have been joined the case of twins. I am really unable to say any thing causal about the effect of overdistension. It is obvious that the condition is associated with other factors which may influence the mechanism, and analysis based on further observation is here required. The second twin may fail to rotate, and the correct explanation appears to be, as SELLHEIM points out, that the passage of the previous twin has so dilated the lower canal that the resistances are inadequate to produce rotation in the second twin which owing to its small head is uninfluenced by the pelvis. In the occipito-posterior positions the rapidity of the passage of the second twin and, probably, an error in the direction of pressure due to weakness of the abdominal walls are the factors. The latter may also be an important factor in determining short rotation when the uterus has been overdistended from other causes.

§45. Some anomalous rotations.

According to CASEAUX (1876), DUBOIS records a rotation from R.O.A. to L.O.A. to O.A.

TARNIER/

Though the perineum caused trouble, the vagina appears to have been simply dilated in SCHICKLE's case.

TARNIER (1882) vouches for rotation from L.O.A. to R.O.A. in which position the head may be delivered, or it may first go back to O.A. DESSAIGNES (1894) also believes in this rotation. WHEAT (1899) had an example of rotation from R.O.A. to L.O.A. from which position the head was rotated to O.A. with forceps. FLANDRIN'S (1890) rotation (L.O.P. to O.P. to R.O.P.) took place in the first stage: long rotation occurred normally in the second. SCHICKELE (1901) in a labour through a split pelvis found a rotation from R.O.A. to L.O.A. to R.O.A. in which position the head was born. These anomalous rotations form a well-defined group. DESSAIGNES says that usually they are associated with the prolapse of a hand beside the head, a coincidence referred to by CREDE, it appears, as early as 1851. AHLFELD (1903) gives wide pelvis, large child, short cord, and anomalous position of the shoulders as factors. WHEAT'S patient was a multipara: SCHICKELE'S as noted had a split pelvis. Probably a common but not universal feature is an absence of great concentric resistance around the head.* And in some respects the examples bear close resemblance to the rotations so frequently happening during the first stage, where the/

* Though the perineum caused trouble, the vagina appears to have been amply dilated in SCHICKELE'S case.

the liquor amnii gives the head a fluidity of movement. With a low concentric resistance an impulse towards rotation produces a movement which acquires considerable momentum, and the momentum may be sufficient to carry the head through the mesial plane of the pelvis, if during the rotation there is no marked descent. The latter movement would of course tend to fix the head whenever it's mesial plane approached that of the pelvis. If we imagine a head lying in the oblique position and in a comparatively wide space, the greater part of a given pain may be utilised in adapting the lower surface of the head to the apposed surfaces of the canal. Towards the end of the pain the apposed surfaces may be confluent and the pressure may just be sufficient to overcome the co-efficient of static friction and start the head in motion. As the co-efficient of kinetic is much lower than the co-efficient of static friction, the same dying impulse may be able to impart to the head a considerable angular velocity, and as no descent can then occur owing to the pressure becoming exhausted the impulse may be able to carry the head on it's way to the opposite oblique diameter. Such appears to be one explanation of these rotations/

rotations. In the example of split pelvis descent would not be a bar to the excessive rotation owing to the give and take movement of the lateral pelvic walls which is made possible by the congenital defect.

§46. A forehead presentation in the right occipito-anterior position was delivered O.A., the forehead still leading (AHLFELD 1903): a forehead presentation in the left occipito-anterior position rotated imperfectly towards O.A. (LEO 1906): in a frontal (bregmatic) presentation in an occipito-posterior position the occiput rotated forwards with forceps (ZIEGENSPECK 1909). LEO attributes the failure in his case to great weakness of the soft parts. If that were the cause, either no rotation should have occurred or else a partial rotation forwards of the forehead. So also in AHLFELD'S case. In both these examples the facts are best accounted for by a misdirection of uterine pressure, downwards and backwards to the plane of the brim. In ZIEGENSPECK'S case of labour the direction of traction downwards and forwards determined long rotation.

HIRST (1891) and HAMILTON (1891) each had to deal with a condition which may well be unique in the annals of obstetrics. The transverse diameter of/

of the shoulders was in line with the mesial plane of the head. HIRST'S patient died before the face had freed the cervix: in HAMILTON'S, craniotomy had to be performed. PETERS (1895) had a face presentation in the right mento-anterior position in a flat rachitic pelvis. The left arm rested on the back of the child. Here perforation was also required. In MURRAY'S case (1882) the head was primitively R.M.T. It rotated to R.M.P. and back to R.M.T. in which position it was delivered. The arms were aligned on the back of the child. The shoulders entered on the right oblique diameter of the pelvis. In this case the shoulders may be regarded as having influenced the rotation, but it is simpler to believe that the axis of pressure was at first inclined downwards and backwards to the brim and was partially or completely corrected as the head descended more deeply into the pelvis, when it was too late for long rotation as the greater frictional resistance at the assumed lower level prevented its occurrence. It is also to be noted that delivery was completed with forceps and these would aid in giving a correct direction. HENRY (1891) states that the head has been found to rotate without a corresponding/

corresponding rotation of the trunk. (According to LEISHMAN 1864 the fact had already been recognised by DUBOIS, while still earlier SMELLIE affirmed the rule). When this happens, the head is usually born oblique. In other labours after the forehead is freed, the face rotates rapidly in the vulva and the chin is born under the pubis where the occiput has just been delivered. Mme. Henry attributes the torsion to irregularities in uterine contraction. Such may explain much along with fetal axis-pressure, but they must fail with general-contents-pressure. Looking at the matter from the point of view of rotation which alone concerns us here it is possible to state an influence of the torsion of the neck on rotation, when the concentric resistances to which the head is exposed are low. In the latter cases the head in vertex presentation had already had its greatest circumference born. So long as this circumference was still within the canal, the head did not yield to the torsion and indeed as the earlier incidence of internal rotation showed was independent of it. Only when a small circumference of the cephalic pole was engaged in the vulva was the torsion able to take effect. This explanation so far/

far as I can see does not account for the circumstances in the late Dr. MURRAY'S case any more than it applies to the internal rotation which had already occurred in Mme. Henry's cases. And in Dr. MURRAY'S case there are no conditions corresponding to those in Mme. HENRY'S cases and for which the explanation seems valid.

§47. In so far as internal rotation is concerned I am not aware of any circumstances connected with the aftercoming head which do not also apply to the oncoming head. The former undergoes long or short rotation as does the latter and for the same reasons. But as the passages have been already more or less dilated by the transit of the fetal body, the process of internal rotation of the aftercoming head is as a rule easier than it is with the oncoming head, and may for that reason be sometimes defective in amount. According to TYLER SMITH (1858) when the aftercoming head is extended the vertex rotates towards the sacrum.

§48. According to most authors the shoulders enter the pelvic cavity in one of the oblique diameters/

diameters and in the course of descent through the cavity they approach the transverse diameter. As much is indicated by EDGAR'S experiments; they further show that when the position of the head is oblique occipito-posterior, the shoulders begin to rotate into the right oblique diameter when the head reaches the transverse diameter in long rotation. Both of these rotations proceed from a similar cause which for most observers is the rotation of the head. That the circumstance and not its converse is possible is due, I believe, to the lesser concentric resistance to which the body is exposed, compared with that applied to the head. This rotation is normally incomplete, that is to say, the shoulders as a rule do not completely enter the transverse diameter of the pelvis, a certain amount of obliquity remaining. The normal incompleteness of cephalic rotation (NAEGELE 1819) is not the cause of the imperfect rotation of the shoulders for the defective rotation of the shoulders at this level is greater than that of the head (SCHATZ 1890). It is due partly to the incapacity of the shoulders to pass through the transverse diameters of the lower pelvic cavity. The average reduced diameter/

only 90 mm. CALABRY and WACKER (1919) give measurements are too low and are certainly not in accordance with clinical experience.

diameter of the shoulders is 120 mm. (TARNIER 1332, FARABEUF and VARNIER 1391), * while the probable transverse diameter between the ischial tuberosities is 105 mm., so that the shoulders are arrested sometime before the inter-acromial diameter reaches the transverse of the cavity. The sterno-dorsal diameter is according to TARNIER 95 mm., and 90 mm according to FABRE (1910). Hence in the occipito-posterior positions no difficulty arises in the long rotation of the shoulders, however low the level at which it takes place may be. The other reason for the incompleteness of this shoulder rotation is the want of unity existing between the head and the trunk of the fetus. The co-efficient of friction between the head and the trunk is ample for the production of the greater part of the rotation, but is not sufficient for its completion under normal conditions. Under abnormal conditions the inadequacy of the co-efficient is well known, for instance in manual rotation of the head during a pain. In the first stage the naturally produced temporary rotations of the head are not accompanied by shoulder rotations/

* FABRE makes out that reduced diameter of the shoulders is only 90 mm. GALABIN and BLACKER (1910) give 103 mm. In both cases I believe the transverse measurements are too low and are certainly not in accordance with clinical experience.

rotations owing to the influence of the then abundant amniotic fluid on the co-efficient of resistance.

For this second reason the rotation of the shoulders is also incomplete in those labours in which the shoulders are too small to be influenced by the bony and ligamentous pelvis. And thus it happens that a truly transverse position of the shoulders at the end of descent is relatively rare.

So far we have been considering what may be called the cephalic rotation of the shoulders. The shoulders also undergo a rotation which is properly speaking the true rotation of the shoulders as it is invoked by the pelvic canal.

The act of restitution occurring immediately after the birth of the head and in the absence of a pain is the evidence of the incompletely transverse position of the shoulders: the act of external rotation occurring later and during a pain proves the existence of the internal rotation of the shoulders by the pelvic canal (CHAILLY HONORÉ 1853 fide BERTHAUT 1909). The former movement does not appear when the shoulders are truly transverse (HODGE 1864), while the latter is absent when the shoulders fail to rotate internally. When the shoulders have a transverse diameter ranging closely about 120 mm., they/

they descend downwards and forwards relative to the canal until they are arrested by the converging lateral walls of the superior portion of the pelvic canal. They cannot now go near the anterior wall of the canal, they cannot go backwards owing to the direction of uterine pressure and the gravitational or other traction of the head through the neck of the child, and they cannot descend further because of the relative disproportion which exists between the shoulders and the canal. Rotation of the shoulders usually takes place in a single pain. The first part of the pain is occupied in adapting the apposed surfaces by the third movement of flexion. Owing to the incompletely transverse position of the shoulders the moulding is skewed in a manner favourable to the incidence of rotation. The anterior shoulder is moulded in a direction curving forwards, outwards and then inwards: the posterior shoulder in a direction curving backwards, outwards and then inwards. As soon as the apposed surfaces are confluent and the co-efficient of friction is sufficiently reduced thereby, rotation with descent takes place in such a direction that the anterior shoulder is carried forwards behind the pubic arch. The couple is/

is developed by the pelvic slopes operating on both extremities of the shoulders, but unequally, as we will see, in the two extremities, and is sufficient under normal relations, to carry the shoulders into an approximately antero-posterior position. It will be observed that owing to the primitively incompletely transverse position of the shoulders and to the form of the moulding, the rotation is produced not in virtue of any special shape of the pelvic surfaces, but simply owing to their convergence. The same surfaces will produce rotation in the opposite direction equally well provided the shoulders descend in a position which is incompletely transverse in a sense opposite to that just described.

§49. The foregoing account represents by far the most frequent form of the internal rotation of the shoulders, that is to say, the rotation is pelvic in origin. The occurrence depends on the 120 mm. average of the interacromial diameter. If as FABRE makes out this diameter is reducible to 90 mm., then the average transverse diameter of the outlet of the pelvis which I have reached will have to be greatly reduced. Few are likely to concur in this device./

device. Whatever one may think about the causation of the internal rotation of the head (with forceps on the head there is really little difficulty in deciding) the obstructions which the shoulders have to overcome can be tested by the simple expedient of pulling on the head or on an armpit. Previous to rotation in most labours traction does not move the shoulders and the resistance as communicated to the tactile sense is ultimately bone. Rotation by traction is difficult, with the fingers it is still harder, yet the uterus does it often in a single pain. In other cases the minority in my opinion, the effect of traction on the head is some descent of the shoulders, and when traction is intermitted some recoil together with a general feeling of a soft and resilient resistance. In this minority, however, time sufficient for the observation seldom occurs; the events succeed each other so rapidly. A second point in favour of the present view is that the reduced transverse diameter of the shoulders must be larger on the whole than the oblique diameter of the head, if not the occipito-frontal then certainly the sub-occipito-bregmatic. The reason is that in spite/

spite of the less favourable conditions which the shoulders experience, that is to say, less favourable conditions from the point of view of the soft parts advocates, they rotate more often than the head rotates. A third point is that the reducibility of the shoulders under intrapelvic conditions has been exaggerated. One cannot determine the actual reduction merely by squeezing the shoulders together manually or in an elastic tube. The shoulders meet with resistances acting from below as well as laterally and the changes to which they submit are in effect a compromise between the two groups of resistances. It is probable therefore that in labour the shoulders are not reduced concentrically to the limits of their possibilities. A further point is that when the second movement of flexion is produced in the shoulders the inter-acromial diameter ceases to be the greatest transverse diameter of the shoulders. Its place is taken by a transverse diameter passing through the heads of the arm bones.

§50. When the shoulders have a reduced transverse diameter which is less than say 105 mm, pelvic rotation is impossible; and if the shoulders are

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a little larger than this, rotation will be partly pelvic and partly due to some other cause. In this connection I shall consider perineal and pubic arch rotation.

According to HART (1885) the anterior shoulder is lower in the canal than the posterior and strikes the pelvic floor first. In the left occipito-anterior position it strikes the right half of the floor and is rotated to the front. In the right occipito-anterior position it strikes the left half and is also rotated to the front. In the oblique posterior positions, however, either shoulder may strike first and be rotated forwards. As the shoulders are nearly transverse when they reach the floor Dr HART'S mechanism implies a lopsided descent. Secondly, the rotative value or otherwise of the anterior shoulder is capable of a simple demonstration. If in a multipara the vulva and the lower vaginal walls be spread open during the rotation of the shoulders, the anterior shoulder can be seen to perform the major portion of its movement (at least two-thirds) without visible support of any kind. The anterior shoulder is therefore not the rotative factor. With one exception the numerous followers of/

of Dr HART have attributed rotation to the anterior shoulder but judged by their writings they have not given much attention to the matter. HIRST realised the difficulty, but his solution is absurd. He says in effect that the posterior shoulder has no rotative power, though it is submitted to the same force as the anterior shoulder which strikes first and is rotated to the front. EDGAR (1903) also considered other possibilities and was led into the dubious statement that if both shoulders strike simultaneously no rotation follows. WILLIAMS (1903 and 1912) recognised the true position, but only in reference to the breech. The posterior hip strikes the pelvic floor and the anterior is rotated to the pubic arch.

I have already argued to show that the pelvic floor to carry out HART'S mechanism must be a rigid floor - it must give to that least extent compatible with the production of internal rotation. Applying the conclusion to the shoulders we find that, if the anterior shoulder does first strike the pelvic floor, the shoulders will certainly rotate into the antero-posterior position. But if the posterior shoulder strikes first, then the shoulders/

shoulders will rotate into the transverse position and will remain there. Now I believe, because I have found no evidence to the contrary, that both shoulders descend equally into the pelvic cavity; and as the floor before extension has an inclination of some ten to fifteen degrees, I am compelled to, and readily do, assume that the posterior shoulder strikes the pelvic floor first. Now experimentally under the so-called normal direction of uterine pressure at right angles to the plane of the brim the shoulders rotate under these conditions into the transverse diameter, and they do so also when pressure is inclined downwards and forwards to the brim. There remains an inclination of pressure downwards and backwards to the brim, and that admittedly results in the shoulders being placed antero-posteriorly on a rigid floor. But the last arrangement must be excessively rare in labour owing to the presence and position of the neck of the child and the favourable conditions under which uterine and abdominal pressure are working at this late stage. The conclusion must therefore be that by this mechanism the shoulders ought normally to rotate into the transverse position. Fortunately for the mother another circumstance/

circumstance intervenes in all cases without exception. The shoulders never meet a pelvic floor which has not already been distended by some other part of the fetus - either the head or the breech. In consequence it is a relaxed perineum which operates. Both shoulders reach the floor simultaneously, and at first are both rotated by the floor. But owing to the circumstance to which I have already referred the rotative effect on the anterior shoulder does not last long, and most of the rotative movement is effected through the medium of the posterior shoulder. Otherwise the mechanism is identical with that of the head. Lastly, the shoulders may escape rotation by the pelvic floor and rotate during extension by the intervention of one pubic arch. This as I have already indicated appears to be the simple explanation of the low level rotations described by OSTERMANN (1894) and by SELLHEIM (1904 et seq).

§51. Rotation of the shoulders may fail altogether or may be partial. DOHRN (1872) records an absence of rotation in 205 out of 2258 head births and attributes the failure to the configuration/

configuration of the uterus. DOHRN found the absence of rotation independent of the wideness or narrowness of the pelvis, the size and weight of the fetus, the prolapse of an extremity beside the head, and the winding of the cord round the child. On the other hand and perhaps more reasonably STRASSMANN (1897) attributes the failure of rotation to insufficient lateral resistance, strong pains and small shoulders, factors which are similar to those preventing, or at least not concurring in the rotations of the head. DOHRN observes that rotation failed more often in the occipito-posterior than the occipito-anterior positions, in primiparae more than in multiparae, in instrumental more than in natural deliveries. EDGAR (1893) traced a weakening of the rotative moment in his successive experiments. In the eighth experiment no rotation occurred, and it did not appear in subsequent experiments. In his clinical evidence EDGAR records that in one primipara the head failed to rotate, but the shoulders turned normally. In 67 primiparae rotation was partial or wanting in 24%: in 70 multiparae rotation was partial or wanting in 20%. Here EDGAR supports DOHRN. In EDGAR'S experiments the course of events with the shoulders does not necessarily prove the valency/

valency of pelvic floor rotation. The weakening of the resistances below is favourable to a further reduction of the transverse diameter of the shoulders: the successive deliveries tend to widen the transverse diameter of the outlet: the trunk like the head becomes after a time more conformable to the canal through which it has to pass - an observation which is even more true in death than in life. The comparatively more frequent failure of rotation in instrumental than in natural deliveries is due I believe to the circumstance that traction with the forceps applied when the relations of the parts are normal results usually in a marked separation of the ischial tuberosities. Owing to the oblique position which the head occupies, the impulse is generally sufficient to cause pelvic rotation in spite of the separation. The impulse is however not so effective in its action on the shoulders owing to their nearly transverse position; and as the mobility consequent on the previous action of the forceps persists for some time, the shoulders may escape rotation. The difference between primiparae and multiparae I have already endeavoured to explain. Of course it is open to anyone to suggest that as the perineum/

perineum is torn for the first time in more primiparae than multiparae, the failure is due to that cause. The percentage of failures given by DOHRN (24%) also agrees closely with the 25 per cent of tears in primiparae as given by LOUBIER (1897) and seems to bear out the objection. The rotation of the posterior shoulder takes place however behind the anus, and only a minority of tears penetrate even the anterior margin of the sphincter. The greater number of failures of the shoulders to rotate in the occipito-posterior positions as compared with the occipito-anterior is probably due to the same factors as interfere with the rotation of the head in those positions. The most important in the present connection is the small size of the child.

The mechanism of rotation of the after-coming shoulders is similar to that of the oncoming shoulders, and both proceed from similar causes. LABHARDT (1908) points out that in delivery by MUELLER'S method the extended position of the arms diminishes the breadth of the shoulders, and this factor may possibly affect the mechanism.

§52. The occurrence of super-rotation is well known/

known and has been attributed to various factors. DOHRN (1872) says it occurs in 9% of head presentations.

According to STRASSMANN (1897) it is due to the posterior shoulder coming deeper and rotating forwards. This view however does not explain why the hind shoulder should descend more than the anterior. FEHLING (1903) considers super-rotation to occur more often in multiparae, and if in say the left occipito-anterior position the right shoulder is behind the transverse diameter of the pelvis instead of before it super-rotation will occur. FEHLING produced this condition experimentally by altering the lie of the uterus to the pelvis. With the shoulders so disposed the right shoulder must rotate backwards either by pelvic or perineal rotation, but the amount of rotation is not greater than in the normal event. SCHATZ (1903) blames the extension of the arms for super-rotation and states they tend to move into the sacral hollow. But in MURRAY'S case (1882) the arms which were extended on the back of the child took up a lateral position within the pelvis on the completion of rotation. This example is similar in one respect to BERTHAUT'S (1909)/

(1909) in which the shoulders remained in the right dorso-posterior position until after the birth of the head, and afterwards rotated to the antero-posterior position. Though the rotation here was normal in amount and that in MURRAY'S case extended through the transverse diameter of the pelvis, both agree in the absence of what I have called the cephalic rotation of the shoulders at the proper time. In BERTHAUT'S case it never occurred: in MURRAY'S it did. Whether or not the extension of the arms modified the rotation, there is no evidence to show, and if it did the mechanism is not clear. I expect that here some necessary factor has escaped observation. HEWITSON (1885) describes a labour in which the shoulders were delivered in the transverse position (in effect - born as nearly as possible in the transverse). In this instance the arms were applied to the back of the child, and HEWITSON attributes the position of the shoulders to this circumstance and also to the laxity of the soft parts. The child was apparently small and the pelvis was wide so that the lateral bony walls did not intervene to produce dystocia. Here the mechanism is just what one expects with the dorsal displacement of the arms. The antero-posterior/

posterior diameter of the shoulders is increased by the position of the arms, while probably the centre of pressure is displaced forwards to correspond. The rotation is therefore a true rotation of the body mass into an antero-posterior position when the dimensions of the two rectilinear diameters of the shoulder mass are considered relative to one another. This suggested mechanism is also in agreement with that postulated for the head where the anterior prolapse of an extremity leads to rotation of at any rate a small head into the transverse position.

In SMITH'S example (1913) the shoulders failed to rotate because a hand was applied to one of them. Rotation subsequently occurred normally when the hand was displaced. As the thickness of the hand is not very great, the case forms an argument against perineal rotation in this instance.

In the direct occipito-anterior and occipito-posterior positions the shoulders rotate (according to HODGE 1864), but there is no certainty as to which comes forward. In EDGAR'S seventh experiment the head was passed through the canal in the direct occipito-posterior position. The shoulders

shoulders moved to the antero-posterior position, and then into the right oblique diameter in which position they were delivered. Here it is doubtful if the shoulders were truly transverse at the brim: otherwise it is difficult to see how they could rotate. Their passage into the right oblique may have been due to the momentum of the rotative impulse operating in a canal which in the next experiment failed to cause any rotation.

§ 53. BAYER (1911) divides pelvic presentations into breech and footling presentations and the division seems justified by the respective mechanisms. The various authors whom I have consulted give the same mechanism of rotation for the breech and for the shoulders, according to their respective beliefs. In the mode of descent I can see no essential difference between the breech and the shoulders. The breech descends in an oblique diameter of the pelvis, normally well pressed forwards against the anterior wall of the canal, with both hips level and with apparent Naegele obliquity, due to protrusion of the soft parts in a circle which includes the/

the excentrically placed anus in the sacro-anterior, and the anterior aspect of the breech in the sacro-posterior. Owing to the small size of the breech pelvic rotation is normally unknown. TARNIER (1882) gives 90 mm. as the dimension of the bitrochanteric diameter, and 80 mm. as that of the antero-posterior. GALABIN (1910) makes the former 82 mm. These diameters are lessened when the feet present.

The direction and completeness of rotation are variable, and the variability seems dependent to some extent on the size of the breech, as when the legs are extended rotation is more uncertain (GRIFFITH and LEA 1897). The most frequent event is however for the breech to rotate more or less into the antero-posterior diameter of the pelvis. TARNIER (1882) quotes Mme. LACHAPELLE that the breech is never directly antero-posterior or transverse after rotation, that the left sacro anterior may rotate to the right sacro-anterior. According to LEFOUR and TARNIER (as quoted by GRIFFITH and LEA) super-rotation is commoner in presentations with the legs extended, the anterior hip becoming posterior. SPIEGELBERG (1882) states that the breech may enter the pelvis in the transverse position in which position/

position it presumably remains. I have generally found that in footling presentations the breech rotated into the transverse position, and the mechanical cause in these cases appeared to be that which PARAMORE (1909a) ascribes to the vulvar outlet - the posterior margin exercising more pressure on the obliquely placed thighs than the lateral margins. Rotation into the transverse position is also frequent in very small breeches. These small breeches raise a very small co-efficient of friction, and they do not depress the floor very well, or at any rate rotation is over before the floor is much depressed. The mechanism is therefore that of the rigid pelvic floor. Experimentally rotation takes place into the transverse position on a rigid floor when pressure is directed at right angles, or inclined downwards and forwards to the brim. With pressure inclined downwards and backwards, however, rotation takes place into an antero-posterior position. The latter inclination is a priori probable in small breech labours for reasons which I have already set forth. Further the opposition of a rigid floor to the breech is likely to be present as the breech is here the first object to meet/

meet the floor. Large breeches tend uniformly to rotate towards or into the antero-posterior position. Here considerable distension of the floor has to take place before the movement of rotation can be initiated, and the mechanism is therefore that of a relaxed floor. When the breech escapes rotation by the pelvic floor, it may still receive an impulse towards rotation by the intervention of one pubic arch. This event is possible if the breech is large enough and the occurrence is favoured by the slightly excentric position of the non-rotated breech. SIMPSON (1871) states that the breech in the right sacro-posterior position usually undergoes long rotation. HART (1885) holds that the breech always exhibits short rotation, and with this opinion I am inclined to agree. The breech may however present the appearance of long rotation after its own proper rotation is over. This is due probably to the descent of the upper part of the trunk, especially the shoulders, into the pelvic canal. WEST (1857) indicates very clearly how the movement may take place.

§54. In the breech and the shoulders the centre
of/

of pressure probably lies close to the mesial plane of each part, and also approximately in the mesial plane of the canal. Normally it is inclined towards the anterior (pelvic) surface of the presentation. The position is therefore very slightly excentric within the pelvic canal during the descent in the oblique or nearly transverse position. In consequence the one lateral half of the part has little advantage over the other in the matter of rotative power. As long however as the part is not truly transverse or antero-posterior the advantage is there, and it shows itself in another way. If rotation is greatly delayed, the chances of the posterior lateral half coming into contact with one pubic arch are greater than those of the anterior lateral half with the other arch. The two lateral halves of either the breech or the shoulders are symmetrical. The practical outcome of the fact is that so long as the parts rotate into the antero-posterior position, it does not matter which hip or shoulder comes forward. Hence I am inclined to regard the shoulders and the breech as the analogues of the occipital segment of the head. They descend similarly and they are subject to the same process resulting/

resulting in rotation. The obvious objection that the occipital segment does not rotate into the antero-posterior position in labour is readily turned by the statement that it is not allowed to do so by the mechanically more powerful sinciput. The head as a whole behaves in an analogous manner to that of the breech or the shoulders only in the deep transverse position with the fontanelles level with each other. The head then rotates, if it does rotate, forwards or backwards as do the shoulders. But so far as is known, there are no factors controlling the primary transverse position of the head, as there are that of the shoulders. While it is possible to forecast with tolerable accuracy the rotation of the shoulders before they have entered the canal, an attempt to prewise the rotation of the head before it enters the pelvis, and supposing it is going to be in the deep transverse position will fail as often as it will succeed.

When however the head is flexed or extended, the centre of pressure is confined to one segment of the head, and the latter previous to the occurrence of internal rotation occupies a highly excentric position within the canal. Further the long/

long oval form of the head makes the direction of rotation a matter of considerable importance. It does not do merely to place the head in an antero-posterior position: the rotation must be so performed that the large end of the oval corresponds to the large end of the oval outlet. Otherwise the further progress of the labour will be more difficult than it might have been. The highly excentric position of the centre of pressure in the flexed or extended head enables that part of the head which is the further away from the centre to have the greater influence in producing internal rotation, and given flexion the greater distance of the sin-ciput from the centre of pressure is favourable to long rotation in the proper direction, when it is necessary.

Thus when we compare the breech, the shoulders and the head, we see that the process of evolution has been at work in providing for internal rotation just as much as it has been in providing for the mechanism of flexion which indeed is part of the provision for the succeeding event. Where the general resistances, as determined by the size of the canal and the size and form of the parts, /

parts, are small the rotation produced is approximately of the concentric type: where the general resistances are high and especially where the rotated parts are not symmetrical, the rotation is markedly of the excentric type. To the former group belong the breech and the shoulders: to the latter the flexed or extended head. It is therefore obvious that in the instance of the head the optimal conditions for internal rotation are best preserved by the excentric position of the head and of the centre of pressure relative to the head, and by the maintenance of its long-oval form. When these provisions deteriorate, internal rotation is most likely to fail.

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§1. From the time of SOLAYESS onwards the movement of extension has been attributed to the change in the direction of the canal which begins at the pelvic outlet. The fetus is compelled to follow the new direction owing, it is believed, to the resistance of the pelvic floor and the passive intervention of the pubic bones, it being known that the movement of extension is more or less in default when the symphysis pubis is broken, or the pelvic floor is torn. It is apparent that the three factors—pressure, perineal and pubic resistances, are able to act on the fetus in more than one way, and the principal object of investigators has been to determine which mode of action most nicely reproduces the movements observed at the bedside.

SECTION VI.

EXTENSION.

FABRI (HEGAR 1870) believed the head descends with the occipito-frontal diameter engaged, until the anterior fontanelle presses on the coccyx. Then the occiput goes more deeply and at the same time moves forwards under the pubic arch. The floor now acts in a direction forwards and continues the new movement of the head. The nape rests on the symphysis and the head rotates on the nape.

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FABBRI (HEGAR 1870) believed the head descends with the occipito-frontal diameter engaged, until the anterior fontanelle presses on the coccyx. Then the occiput goes more deeply and at the same time moves forwards under the pubic arch. The floor now acts in a direction forwards and continues the new movement of the head. The nape stems on the symphysis and the head rotates on the nape.

Another, DUNCAN (1868) considered that extension begins/

begins during rotation and is really a continuation of lateral obliquity which merges into extension.

KUNECKE (1869) found three movements in extension - two which are rotary and one which is progressive. The first or enclitic movement is an increase of flexion, produced by the mechanism of FABBRI and designed to conform the head to the pelvic outlet: the second or proclitic movement is the true movement of extension and is produced by the pelvic floor: the third is the movement of descent. KUNECKE quotes ROEDERER that the base of the occiput stems against the pubes, but he himself followed FABBRI and RITCHIE (1865) in considering the nape of the neck to act.

LAHS (1870) states that, when the patient lies in the semi-recumbent position, the occiput first meets with the resistance of the hinder pelvic wall. A "levelling movement results whereby the forehead comes more deeply.* As the occiput is pressed forwards it has progressively a smaller column of water-pressure to bear than the forehead. Hence a rotation takes/

*

Another levelling movement but at an earlier period of the descent has been described by RITCHIE and others.

takes place on a transverse axis under the pubes. The elasticity of the walls prevents any retreat so that the occiput is always pushed forwards. In the dorsal decubitus the occiput does not come so deeply, and the forehead first meets with the resistance of the hinder pelvic wall. The head is then directly moved forwards into extension.

According to STEPHAN (1877) the head rolls on the pubic bones and is not merely pushed through the vulva.

OLSHAUSEN (1882) observed that the changes in the direction of pressure towards the end of the labour are not given the position they deserve. For OLSHAUSEN the uterus becomes more anteverted as labour proceeds. Anteversion of the uterus and rotation of the child's back forwards change the direction of uterine-axis pressure and therewith fetal-axis pressure so that these instead of being, as they are at first, perpendicular to the inlet incline more towards the horizontal. In consequence pressure gradually becomes directed more towards the chin of the fetus, and the chin "is pressed against the pelvic floor, whereby the occiput without the co-operation of the latter comes into extension."

A contrary view as to the direction of pressure was advanced in the same year by MEEH as part of his theory of the effect of the upper limbs of the child on the mechanism. The head stems itself on the symphysis, while the pelvic floor hinders progress. The shoulders are already nearly transverse in position so that the extension-movements of both arms are equally effective against the resistant posterior and inferior uterine wall. The resultant forces the body forwards and causes pressure to be applied more anteriorly to the head with as a result the movement of extension.

BARNES (1885) considered the head to rotate around a transverse axis in extension. A similar view is expressed by ZWEIFEL (1890-3) who says the head and the shoulders roll out, the anterior parietal bone and the diaphysis of the arm being retarded in turn on the symphysis. (cf. PARVIN 1895). For KALTENBACH (1891) it is a pivotal movement on the pubic arch. GARRIGUES (1902) and PAJOT (vide PARVIN 1895) found it a leverage of the head on the pubic arch by the resistance of the pelvic floor. In all these examples the movement is generally a rotation on/

on a transverse axis. MURRAY (1891) dissented from this view, holding that the occiput and the face are born at the same time and rate, and observing that if the occiput were fixed the occipito-mental diameter would soon be engaged. Hence according to this author a levering of the head on the occiput must not occur as it would be harmful.

FRY (1888) followed FABBRI very closely in considering flexion not complete till the direction of the head is changed and the nape lies under the symphysis. The cause, as for FABBRI, is the coccyx while the perineum does not begin to extend until the head is fixed under the pubic arch - a matter which BERTHAUT (1908) emphasises, namely the value of the pubic arch in fixing the position of the head and so favouring the mechanism of extension. In the views of these authors there is implied either a belief in the pivotal action of the head or in an instability of the head after rotation.

KALTENBACH (1891) made one of the earliest references to the influence of the mobility of the fetal spine on the movement of extension. He shows that flexion of the spine is not equally easy in all the positions. The cervical column acts for the head and the lumbar region for the breech. The former extends/

extends most easily, the latter bends laterally most readily. If either the one or the other is immobile, impaction or difficulty may arise. In head presentations extension occurs in the occipito-anterior position, flexion in the occipito-posterior and mento-anterior positions and in presentations of the forehead. Extension should occur in the mento-posterior position, but it is impossible spontaneously as extension is already complete. KALTENBACH considered the circumference of the head engaged as of even greater importance than the mobility of the spine for the extensional movement. From his measurements it appears that the circumferences likely to be engaged are in the occipito-anterior position 32.3 cm., in the occipito-posterior position 34.4 cm., in face presentation 34.7 cm., and in forehead presentation 35.3 cm. KALTENBACH also points out that in extension the moulding of the head is increased. The floor flattens the forehead while the occipito-mental diameter is lengthened.

For OSTERMANN (1894 and 1905) and for SELLHEIM (1907) KALTENBACH'S discoveries have an important place in the mechanism of extension. And for/

for these authors together with the other exponents of the "bend in the canal" theory the mechanism of extension is intimately bound up with the mechanism of rotation to which I have already referred. SELLHEIM (1905) and MUELLER (1907) have laid especial stress on the width of the pubic arch and showed that with a narrow arch the head has to come more deeply in order to pass the plane of the arch, with a consequent greater danger to the perineum. The observation is of course much older, but SELLHEIM'S investigations placed it on a scientific basis.

JONES (1906) considerably extended KALTENBACH'S views and confirmed them by numerous experiments. He shows that a failure of extension near the outlet may be a cause of delay, and that for the production of extension it is necessary for the occiput to come below the pubis. Rigor mortis is mentioned as a cause of want of extension of the cervical spine.

GALABIN (1910) states that extension begins when the head meets the pelvic floor; the forehead moves faster than the occiput, but no point on the head is arrested at any time. As an account of what one/

one usually observes GALABIN'S statement is satisfactory, but it does not cover the whole mechanism.

After all the important problem in the movement of extension is the ultimate effect of the movement on the pelvic floor. In this connection PARAMORE (1909) has brought forward new observations and conclusions that in spite of the disfavour with which most of them have been received appear to be a most valuable contribution to the history of the mechanism of extension. The pelvic floor contains a muscle - the pubo-rectalis muscle whose commissure is at least five inches from the fourchette when the perineum is extended. The stretching and lengthening of the perineum pushes the head forwards. During the protrusion of the head the vulvar aperture becomes very oblique and approaches the coronal plane. The plane of the pubo-rectalis muscle is not nearly so oblique and remains nearly horizontal. The anterior ends of these two planes are close together, the posterior ends are far apart. In consequence, an ovoid body passing through these planes must have its long axis oblique to one of the planes when it is perpendicular to the other. In extension the head changes/

changes its course so that its long axis eventually becomes obliquely inclined to the plane of the pubo-rectalis muscle, which as a result is applied to an elliptic section instead of a circular segment of the head. Hence there is increased stretching in this plane and the stretching may result in a tear of the perineum. PARAMORE considers it better for the perineum at this point to tear than to stretch, but that is a matter which still lies sub judice. PARAMORE, however, advocates a method whereby the excessive stretching may be avoided, and to that I shall return.

§2. For the present purpose the main result of the foregoing account is that most if not all of the authors cited believed explicitly or by implication in a rotation of the head on the pubic arch. For some the occiput is totally arrested during rotation; according to others it moves, but more slowly than the forehead moves. And this kind of rotation is, I believe, the late Dr MURRAY'S views notwithstanding, the most frequent mechanism when the parturient woman is in the dorsal or lateral decubitus. But it does not follow therefrom that it is the normal mechanism/

mechanism for the human species : it is normal only to the extent that the dorsal or lateral posture is normal. And it is unlikely that the mechanism is the same for all postures. LAHS (1870-2-7) has made that clear, whatever value attaches to the causes which he postulates.

As the movement of extension proceeds, say in the occipito-anterior position, the head is changing its direction of motion, but the force which is applied to it cannot follow. (SCHULZE 1858, DUNCAN 1868). The force then comes progressively to be applied to more and more posterior (pelvic) parts of the head and would, if unopposed, tend to drive out the sinciput at a relatively greater rate than the occiput. This untoward event is resisted, but not entirely, by the pelvic floor which reflects partly the force forwards towards the outlet (SOLAYRÈS 1771), and partly absorbs or wastes the force. The amount of the latter component depends mainly on the direction of uterine pressure. When the axis of pressure is inclined downwards and forwards to the plane of the conjugate the amount lost is least. It is greater when pressure is directed at right angles to the brim, and greatest of all when it is inclined downwards/

downwards and backwards. This wasted force is the measure, as it is the cause, of the bursting pressure which the pelvic floor has to sustain, the subsidiary factors being the size, position and presentation of the head, the fit which it makes into the hollow of the pubic arch, and the amount of pivotal movement based on the pubic symphysis. The last factor is in part compounded of the preceding factors and in part dependent on the length of the child's neck, the ultimate control being established by the complete descent of the shoulders prior to external rotation. When the child's neck is long the occiput is able to be protruded at the same or nearly the same rate as the sinciput: when it is short the advance of the occiput is arrested by the shortness of the neck limiting the extension of the head, and the subsequent development of extension is effected by the pivotal movement of the sinciput. Between the two extremes there are innumerable grades of extension which can be estimated by observing the relative rate of advance of the occiput and the sinciput. Even when the neck is long it is doubtful if the limited descent of the shoulders will permit of the head being born beyond the forehead purely by the movement/

movement of extension. If at this moment the labour is left entirely to the natural means the perineum is observed to retract backwards from the face of the child without the latter making any contemporary movement. As soon, however, as the perineum retracts off the chin, the head falls down and the chin leaves the breast. This marks the earliest moment at which true extension occurs in natural labour. As however the chin cannot remain in contact with the anterior surface of the fetus above the manubrium sterni, true extension may appear earlier than at the time just postulated when the neck is very long and the movement of extension very great as it is produced by a long and rigid pelvic floor.

Many authors even as late as a year ago have asserted the separation of the chin from the breast at the beginning of the movement of extension, and most have attributed the circumstance to the uterine pressure acting further back on the head in the movement of extension. This mechanism is a necessary corollary of the theory of fetal-axis pressure. Under the pressure of the general contents it is impossible except for the anatomical reason just mentioned, and then it occurs only in extremest extension.

CASEAUX (1876) was one of the earliest authors to show that the chin does not leave the sternum until delivery of the head is effected. HART (1887 et seq.) constantly maintained the same view. EDGAR (1893) held a similar and equally definite opinion. DESSAIGNES (1894) believed separation to occur as the anterior fontanelle is born, but not before. FOTHERGILL (1898) says frozen sections do not show true extension till the sub-occipito-bregmatic diameter is born, while MATHEW (1898) was able to confirm these views by the application of a simple method at the bedside.

It is to be observed that the mere stemming of the nape on the symphysis does not evict the pivotal movement. All it does is to reduce the diameters engaged and so to lessen the distension of the perineum. The main objection to the pivotal movement is that by leverage about the symphysis it exposes the perineum to a bursting pressure out of all proportion to the forces and diameters engaged. A fault which is almost as great is that the inciput in its arcuate movement around the symphysis drags, or appears to drag, the pelvic floor along with it, and this causes excessive/

excessive stretching, lengthening, and thinning of the floor, together with an interference with the local blood supply. All these circumstances are favourable to the occurrence of tears.

§3. I have divided the mechanism of flexion into three movements (Section III). Extension also contains three separate movements. The first is the separation of the chin from the breast - a movement which does not occur in normal labour before the final act of expulsion of the head, but is present before or at the beginning of labour in face and forehead presentations and very often in the occipito-posterior positions. The second is a rotation of the head about a transverse axis within the body of the fetus. The third movement is the moulding of the head.

In describing the movements of extension it is more difficult to say when the first movement ends and the second begins than it is in describing the movements of flexion. In this event the contact of the chin with the sternum of the child forms a valuable distinction. No similar index is available for the movements of extension. But it may be held arbitrarily/

arbitrarily that the first movement of extension ends and the second begins at that point reached by the chin when the fetus is hung up by the feet (for face presentations, etc.), or that the second movement of extension begins when the quantity of the second movement of flexion begins to diminish (for head presentations, flexed). It is this second movement which is the main phenomenon of extension.

In the previous section I have advocated the view that rotation is complete in most cases before the parts (excepting perhaps the breech) descend onto and their direction is changed by the pelvic floor; and I have expressed the belief, as TARNIER and MACDONALD have done, that moulding reaches its greatest pitch at the moment when rotation is about to begin. During the act of internal rotation the moulding characteristic of the pre-rotation moments partially disappears. If at this moment an examination is made in a patient in whom the resistances are not more severe than usual, the frontal region of the child's head is found to have expanded in many cases to an extent sufficient to open up the anterior fontanelle. At this time in many labours I have passed a finger between the floor and the head and felt/

felt the patency of the fontanelle, though the fontanelle had been closed before rotation occurred. In other labours the resistances (or the more sudden descent onto the floor) do not permit of a palpable opening of the fontanelle, but it very rarely happens that the forehead does not expand more or less.

Rotation then normally marks the end of the third movement of flexion. The reasons for this circumstance are partly pelvic and partly perineal. With rare exceptions the head does not press heavily on the floor after rotation has occurred until several pains have occurred. Secondly, the head before rotating descends in a constrained position between the antero-lateral and postero-lateral walls of the superior portion of the pelvic canal. With rotation the head escapes into the comparative freedom of the antero-posterior diameters of the cavity, a circumstance which is due in part to the hollowing-out of the sacrum. This mechanism forms an argument to show that the arch of the sacrum is a postulate of the erect attitude and has nothing to do with the mechanism of labour in its main development. It is true that after rotation the head does transgress the air-line of the sacrum. But, it does not do so because it must, but because it can. And the manner is by the loss/

loss of the third movement of flexion. That is to say, the incompressible base of the cranium does not cross the air-line, but only the natural and conformable contour of the frontal region of the skull, which is able to expand when a source of constraint is removed. Even after rotation is complete there is no evidence to show that the head fully occupies the hollow of the sacrum, and it may be said to rotate towards the sacrum only to leave it. The anterior surface of the sacrum is ill adapted for a longitudinal gliding movement of the head which it seems more correct to say is rotated into a nearly antero-posterior position at or about one horizontal level, so that the frontal region of the head approaches the hollow of the sacrum. Whenever this happens the head is projected in a new direction away from the sacrum and downwards and forwards on a curved course to the vulvar outlet. As the head presses more firmly on the pelvic floor the second movement of extension appears, and the third movement develops pari-passu*.

The/

*BARBOUR'S late second stage section (1891) shows a protrusion of the lower and posterior part of the occiput forwards under the pubic arch at a time when rotation is not completed. The protrusion is an early development of the third movement of extension and it necessarily co-exists with the third movement of flexion. There is, however, no sign of the second movement of extension and the small protrusion can scarcely be regarded as having any mechanical effect on the movement of rotation. A tendency towards a similar protrusion is manifest in BRAUNE'S section from an earlier period of the same stage.

The delay here is due in part to changes which occur by nutation of the sacrum and by a corresponding depression of the coccyx and the associated musculature and in part to the production of the third movement which is necessary to the mechanism of extension. The forehead is again compressed and depressed in accordance with the degree of resistance of the pelvic floor. But the changes are seldom equal in extent to what they were before internal rotation occurred. As a rule compression is much less, depression is less considerable, and there is an entire absence of new-formed skew-distortion. In consequence the closure of the anterior fontanelle is not usually so great as it was prior to the event of internal rotation and the fontanelle may even remain partially open. The parietal and occipital regions are constricted and lengthened towards the occipital pole so that the occipito-mental diameter attains a length which it never possessed in the pelvic cavity. Further the elongation of the occiput takes place in a new direction towards the outlet, and relative to the long axis of the fetus it is more obliquely inclined than it was in the pelvic cavity. These changes are dependent in degree on the resistances to which the head is exposed and/

and the ultimate form of the head is mainly an expression of the mechanism of extension though the form still retains unmistakable evidence of the stresses of internal rotation in DOHRN'S vertical shear and LABAT'S antero-posterior displacement of the parietal bones.

§4. The foregoing account is, I believe, true for the commonest event - the left occipito-anterior position with vertex presentation, pelvic rotation, a resistant pelvic floor, and a change of direction downwards and forwards as the head emerges from the pelvic outlet. In those labours in which internal rotation is greatly delayed extension begins before rotation occurs, and with the exception of the first, the movements of flexion pass insensibly into those of extension. The phenomena of labour are then mainly those of extension and rotation. Owing to the oblique position of the head, and as long as it lasts, lateral obliquity is present relative to the brim. It takes the forms of true LITZMANN'S obliquity and apparent NAEGELE'S obliquity which are necessarily exaggerated.

In the persistent occipito-posterior positions the head is born by an increase of the second and/

and third movements of flexion. The mechanism of extension is there, but the movements are those of flexion. As the commonest cause in all probability of the persistent occipito-posterior position is a primary or secondary misdirection of uterine pressure, the strain on the pelvic floor in the act of forwarding the head to the outlet is relatively enormous. At an early stage the ultimate prolongation of the axis of pressure lies posteriorly outside the boundary of the head. The pelvic floor has unaided by a proper direction of pressure to push up, compress, and depress the sinicput behind the pubic bones before it can bring the occiput to delivery. The evidence of the strains exerted lies in the aspect of the posterior occipital region which may remain depressed for a long period after birth, if not indeed permanently (VEEDER 1898). It is known, however, that, without becoming a forehead presentation, the head in the occipito-posterior position can be born by a mechanism which is not flexional. KIDD (1863) pointed out that the head in this position can be born with either the occiput or the forehead leading - the latter, however, only when the head is small and soft. RITCHIE (1865) attributed the latter mechanism to the pressure of/

of the pelvic floor on a small head.* Here, as it seems, we have an arrangement in which the resistance is relatively more severe against the occiput than against the forehead, and owing to the softness of the head the occipital region readily becomes flattened and compressed against the pelvic floor, while the forehead quickly bulges into the area of least resistance. The alteration of the cephalic curves which results from these changes may simply cause the forehead to be born first, without the occurrence of any other changes. The change in the shape of the head may however lead to a transference of the centre of pressure to the area of the forehead and even to a delayed correction of the line of uterine-axis pressure. In these rare cases it would be of interest to learn the inclination of the base of the skull relative to anyone of the parallel planes of the pelvis.

According to TARNIER and BUDIN (1898), CHARRIER records an analogous case under anatomically though not mechanically different circumstances. The occiput of a well-flexed head in the persistent occipito-posterior position created a central tear of the/

*ZANGEMEISTER (1908) had an example similar to RITCHIE'S, but it was delivered with forceps.

the perineum. Extension then occurred and the head was born with the face leading through the vulva. Here a change in the inclination of the base of the skull is evident and therewith certainly a transference forwards of the centre of pressure. The pressure was not sufficient to force the occiput and the head through the central tear which necessarily also stopped the occiput from gliding forwards over the pelvic floor. The mechanism at the occipital end of the head was then arrested. The evidence derived from experiments strongly suggests that in such a case the axis of pressure leaves the impacted area and either swings forward in the direction of the area of least resistance, or else moves towards a temporary and relatively diminished area of resistance. In CHARRIER'S example the true area of least resistance was readily available, and the mechanism suggests that the axis of pressure did swing forwards, and that the centre of pressure entered the area of the forehead which was compelled to descend into the area of least resistance.

KEHRER (1906) gives two ends for the persistent occipito-posterior position. In the one the head is flexed, and the forehead and the face are born/

born last. In the other the head is extended and the forehead is born first, then the parietal region and the occiput, with the face coming last. In the former the movements in the mechanism of extension are wholly those of flexion: in the latter the head descends by the second and third movements of extension, and is born by the second and third movements of flexion.

KALTENBACH (1891) following KIDD and RITCHIE divides into two groups the well-flexed heads in the occipito-posterior positions - one in which the head is small, and the other in which it is large. In the former the anterior fontanelle appears first and then the sub-occipito-frontal plane: in the latter resistance becomes more severe, the glabella appears at the symphysis and then the occipito-frontal plane. The further adverse circumstance in the occipito-posterior positions, as KALTENBACH and others announce, is the greater diameter of the head engaged. This may be the occipito-frontal, while in the occipito-anterior positions the sub-occipito-bregmatic diameter is always applied during the movement of extension with the head flexed. Moreover, in the former group, unless the head is reduced by the/

the resistances to a rotund form, the broad end of the oval is the further away from the pubic arch. These circumstances are all adverse to the perineum.

At one time the persistent occipito-posterior position was held to be incapable of spontaneous delivery : later, this view was modified to one of difficulty. A very great deal has been written on the subject, especially in former times, with regard to the conditions which were supposed to forbid spontaneous delivery. The history has been ably reviewed by MUELLER (1898^a) and by VARNIER (1900). As the matter is no longer in doubt, it seems unnecessary to repeat it here. VILLENEUVE (1839), it appears, first showed that spontaneous delivery ought to be the expected event by having thirteen out of sixteen births in that position. It would appear, however, that as in the mechanism of extension the length of the neck is a matter of importance. GUILLEMOT (1837) quotes LACHAPELLE that flexion must be great to prevent the entry of the thorax into the pelvis along with the head. Similarly, by extension a long neck is favourable to easy delivery.

§5. In the mechanism of face presentations there/

there are no movements of flexion in the cavity. The first movement of extension is present early, the second is manifest when the chin dips towards the centre of the cavity, the third develops most greatly up to the moment of internal rotation. Birth takes place in the mento-posterior position by a further development of the second movement of extension (KALTENBACH and others notwithstanding) and probably by an increase of the third movement as well. In the mento-anterior positions the movements of extension in the cavity are replaced by the second and third movements of flexion in the outlet, that is when the mechanism of extension occurs. According to BRAUN (q.by KUNECHE 1864), either the chin or the forehead may be born first, which seems to indicate that the position is unstable.

Many authors have held, and some still hold, that delivery in the mento-posterior position is spontaneously impossible. SMELLIE (1752-1764) clearly describes a labour which so ended (No.136), and gives particulars of one delivered by Dr COOKE with slight manual assistance (Case 141). TORRGLER (1887) quotes SCHULZE (cf. KALTENBACH) that the circumference of the head is the greatest danger to the/

the perineum and proceeds to show that the sub-mento-occipital diameter exceeds the small oblique by 1.90 cm., and is therefore as dangerous as, if not more so than the occipito-frontal of the occipito-posterior position. It is doubtful, however, that the sub-mento-occipital diameter is that engaged in the outlet. BERTHAUT (1908) holds, probably with justice, that the head in the mento-anterior is less dangerous to the perineum than is the head in the occipito-posterior position.

§6. Presentations of the forehead are peculiar in several ways and it is unfortunate that opportunities of observing the mechanism are rare. The head in most cases appears to be small relative to the pelvic canal. When that is so the possibility exists of the greatest diameter of the head passing through any parallel plane of the pelvis so that the inclination of the base of the skull may be radically altered. That is to say, during the descent of the head either flexion or further extension of the head may result. Otherwise, circumstances may be favourable to the persistence of a forehead presentation as such until delivery is completed.

v.HELLY/

v. HELLY (1861) states that the head enters the brim in the transverse position and may traverse the whole length of the canal in the same position, while the presentation may be converted to a face or a vertex, as HILDEBRANDT (1865) afterwards confirmed. MANGIAGALLI (1884) and BELUZZI (1884) hold that during the descent through the cavity the chin comes a little lower than the occiput. MASCHIONESCHI, BLANC (1886), and POLOSSON (1892) maintain the opposite view. AUVARD (1894) suggests that both mechanisms may occur, and further that both ends of the head may descend equally, or that there may be an oscillation of the head.

According to POLOSSON a head presentation cannot develop in the cavity unless the head is very small. The diameter engaged (from the chin to a point on the sagittal suture midway between the anterior fontanelle and the occiput) is so large that, if the opposite movement occurs, the head impacts in the cavity. AUVARD says the inlet of the canal is sufficiently large to admit a diameter of 13cm. At the same time he quotes BUDIN that the average occipito-mental diameter is 13.5 cm. SOLOWIEFF (1898) thinks forehead presentations can end spontaneously only/

only when the pelvis is wide or the head is small. It is interesting to note that SMELLIE had two forehead presentations born spontaneously and a third which he converted to a vertex presentation.

POLOSSON states that the mechanism of the outlet is by flexion on the superior maxilla, while the chin is born last by a movement of extension. According to the same author the deformity (third movement) is always greater at the outlet than in the cavity, and in transition it assumes a new form. HILDEBRANDT (1865) had already observed that the forehead is born first and then the face. In LEO'S case (L.O.A., extended) which was not a frank forehead presentation the vertex was born first, then the forehead and the face, the chin coming last. Here the three movements were those of extension from first to last as in face presentations. AHLFELD (1903^b) records a labour in the right occipito-anterior position, the forehead presenting. The head rotated on the occiput so that the forehead was delivered first by a continuous movement of extension. A peculiarity of the third movement of extension in presentations of the forehead is the opening/

opening of the mouth during labour. According to POLOSSON (1892), FOCHIER describes the birth of the head with the mouth open. The former thinks the mouth is open all the time. The opening reduces the occipito-mental diameter of the head and arises on engagement by a movement of extension. POLOSSON also states that the open mouth in forehead presentations is figured by HENRICIUS, presumably in 1885.

§7. Numerous observations relate to the stability, or want of it, of face and forehead presentations. As the matter is of some importance for the present view of the mechanism I shall refer to those of which I have notes.

SPÖNDLY (1869) had a face presentation which became a vertex presentation after the waters broke, and a forehead which changed to a face presentation at the brim on rupture of the membranes.

KÜNECKE (1864) quotes BRAUN that a face presentation may become a vertex and HECKER that a face presentation may change to an anterior parietal presentation.

In BEUMER and PEIPER'S series of ten examples of forehead presentation (1884) the presentation became vertex four times (thrice instrumentally), four times it remained forehead (two perforations), once/

once it became a face (partly manual), and once version was performed.

RASCH (1885) records a spontaneous labour in which the forehead changed to the face in the cavity of the pelvis.

FRÖMEL (1888) and v.FELLENBERG (1908) had each a case in which an arm prolapsed. In the one a face presentation changed spontaneously into a head presentation ; in the other a head presentation became a face. FRÖMEL states that HECKER and SPIEGELBERG had two cases similar to his one case.

SOLOWIEFF (1898) in eighteen forehead presentations found one only to end as a forehead. Five became or were converted into face presentations, the rest were delivered artificially.

HENRICIUS (1885) in 221 forehead presentations had 122 remaining as forehead, 24 changing spontaneously to face, 29 to vertex presentations, the rest being treated artificially.

AUVARD (1894) quotes CASEAUX for the arrest of the chin on the sciatic spine and conversion from a face to a head presentation; DUBOIS for the arrest of the chin on the sacro-sciatic ligaments; and CHAILLY for the arrest of the chin on the coccyx. These/

These examples AUVARD thinks were forehead presentations in the mento-posterior positions.

GALABIN (1910) records a brow presentation which changed partly to face. The chin, then performed long rotation. The occiput came down and the labour ended in the persistent occipito-posterior position.

It is evident from these examples that no presentation is stable even in the second stage. Face and forehead presentations are, however, less stable than vertex presentations, though in the degree of instability of forehead presentations the records of SOLOWIEFF and HENRICIUS are an effective contrast. Where particulars are noted, the regions of instability are as one might expect at the brim, in the cavity (HODGE 1864) and at the pelvic outlet. Once the head is within the pelvic canal, it may be assumed on general grounds that any conversion which occurs is one towards which the head has an original bias, that is to say the head moves in the direction of its primitive obliquity, unless the head is so small or the pelvis so wide that the occipito-frontal diameter can pass through a parallel plane without impaction. These considerations do not, however, apply/

apply to the pelvic outlet when the head is in the direct position. Then the head is able to swing through the plane of the outlet in either direction. Where the cause of the conversion has been noted, it is an obstruction applied to the presenting part which it is unable to overcome, or a passive interference with the portion of the head which is furthest away from the presenting part. In the latter instance the explanation of the movement appears to be simply relative acceleration and retardation: in the former the mechanism appears to be similar to that of a kyphotic pelvis and to be open to a like explanation. When the centre of pressure meets an insuperable obstruction, it moves into the temporary and relative area of least resistance. So far as can be seen the flatness of the facial curve and the equality of the two portions of the forehead curve favour the movement of the centre of pressure when an obstruction occurs. In GALABIN'S case the complete change from face to vertex did not occur until the pelvic outlet was reached. Here the movements were first those of extension and secondly in the soft canal those of flexion.

In forehead presentations, as the evidence shows, there is a greater tendency for the presentation to give way to the face than to the vertex. The/

The nature and distribution of the resistances and the mobility of the head on a horizontal axis are not alone the cause. The primary reason is that in a forehead presentation the centre of pressure is primitively excentric on the surface of that portion of the head lying below its greatest circumference, and the axis of pressure (the sum of all the pressures) cuts the occipito-mental plane of the head nearer the chin than the occipital pole. As a result, the tendency is for the forehead, and it may be the face, to descend by a second movement of extension.

When the presentation of the forehead remains in stable equilibrium it is possible the third movement of extension (moulding) has a good deal of effect on the ultimate stability of the presentations as in other positions and presentations. For, by the protrusion and elongation of the frontal region and by the compression and depression of the other parts of the head the requisite curvature of the lower surface of the head is secondarily produced so as to fix the centre of pressure on one small area of the head.

As in the occipito-posterior positions, the normally persistent effort of the forehead to reach the anterior moiety of the canal when the chin is/
is/

is behind is limited by the ultimate degree to which the third movement can be developed; and a time comes when the placing the forehead behind the anterior wall of the canal can be effected or completed only by the substitution of one part of the head for another, that is, by the process of internal rotation.

§8. Shoulders 14 cm. broad have been dragged through a normal pelvis, and the child lived (AHLFELD 1881). Much discussion has taken place as to the precise manner in which the shoulders make their entry into the world. It is possible that a good deal of the obscurity which has arisen is due to a confusion of the words "appear" and "born". Any that remains may be covered by AUVARD'S deductions from his experiments. In the majority of labours the shoulders are born by a pivotal movement on the pubic arch for the same reasons and with the same disadvantage as those to which I have referred in describing the mechanism of head presentations. The diaphysis of the anterior arm stems itself on the pubis and the posterior shoulder rolls out over the pelvic floor. (ZWEIFEL 1893). Thus the anterior shoulder/

shoulder appears first and the posterior shoulder is born first. To some extent the order of the phenomena is due to obliquity of the plane of the dilated vulva. It is not due in most cases at any rate to a greater descent of the anterior shoulder. The rule of the time of appearance and of birth just quoted is that of most observers. But it is apparent from AUVARD'S observations (1838) that the order is dependent on the artificial support given to the head. According to AUVARD, when the birth is entirely unassisted, the posterior shoulder appears and is born before the anterior shoulder comes into view. LEFOUR (1838) and LEONET (1839) arrived at the same conclusion. Hence in the natural mechanism the cervico-acromial diameter engages for a time until the posterior shoulder is born. The natural order, however, is not strictly followed by nature, for AUVARD says that in unassisted labours the proportion of posterior shoulders first is as nine to six of anterior shoulders first. Yet AUVARD states that the primary appearance of the anterior shoulder is abnormal. EDGAR (1893) also made careful observations on this matter in spontaneous labours. He divides the data under/

under two headings - the shoulder appearing first at the vulva and the shoulder first born. Under the former the posterior and anterior shoulders appeared first in equal proportions in 69 primiparae, in three of whom both came together: while in 68 multiparae the posterior shoulder appeared first nearly twice as often as the anterior. Then, under the latter heading the posterior shoulder was born first 9 times, last 3 times, both were born together twice, and once the shoulders were delivered in the transverse position. All these were in primiparae.(15). In 28 multiparae the posterior shoulder was born first 19 times, the anterior 8 times and both came together once. In 1903 EDGAR sums up his results in saying that the posterior shoulder is born first three times as often as the anterior in primiparae and twice as often as the anterior in multiparae. On the strength of these and AUVARD'S observations TARNIER and BUDIN (1898), EDGAR (1893) and HART (1912) have all advocated as the correct manner of delivering the shoulders the pressing up of the anterior shoulder out of sight behind the symphysis until the posterior is born. It is open to question, however, whether or not the cervico-acromial diameter/

diameter which is apparently engaged is really so, and in any case the method makes a pivotal movement of the shoulders an undesirable certainty. Equally assertive to the contrary RITGEN (1855), COUDER (1891) and CAIE (1905) have advocated the premier delivery of the anterior shoulder, and whenever necessary the dangerous process of bringing down and freeing the anterior arm. Here also the pivotal movement is not evaded, and excepting when the arm is reduced the advantage gained in the reduction of the diameter engaged is not very great. SCHULTZE (1858), OLSHAUSEN (1870), PAJOT (q. by PARVIN 1895), CASEAUX (1876), TARNIER (1882), BARNES (1885), FARABEUF and VARNIER (1891), NORRIS and DICKINSON (1896), STRASSMANN (1897), AHLFELD (1903^a), and I think PARVIN (1895), to cite only a few, express views which are comparable to those of ZWEIFEL though they are expressed in various ways. HODGE (1864) states both shoulders appear together: BARNES adds that they may be born nearly at the same time. EDGAR'S statistics indicate the possibility of all three modes so that the problem is more one of frequency. This may have been settled by EDGAR'S and AUVARD'S work, but further evidence preferably photographic/

photographic seems desirable. In consideration of the two principal modes of delivery which I will call RITGEN'S and EDGAR'S, the behaviour of the posterior shoulder has an important bearing on the pivotal mechanism. The shoulders in their descent through the cavity experience the second and third movements of flexion which effect a reduction in the bisacromial diameter, and otherwise conform the shoulders to the pelvis. During the mechanism of extension in which the spinal column of the trunk usually inclines towards the outlet, the anterior shoulder maintains its condition of flexion under both modes of delivery. But the posterior shoulder shows a variation. So far as my experience goes it always remains flexed by EDGAR'S mechanism. By the other it is sometimes flexed and sometimes extended. The latter position is shown in ZWEIFEL'S second stage section with the head born (1893). In the pivotal movement with the posterior shoulder extended the longer radius of movement about the symphysis is fraught with greater danger to the pelvic floor. This possibility is therefore an argument against RITGEN'S method. There is, however, a method which appears better than either RITGEN'S or EDGAR'S. It will be referred to later.

In/

In some respects the shoulders do not form quite the same factor in the cavity and in the soft canal. In the former they behave like the occipital segment of the head: in the latter they do so also as long as flexion is complete. But, when the posterior shoulder is extended the parts present an analogy to the head in extension, the correspondence being wonderfully complete as to details. In the one case the shoulders re-act as shoulders, in the other as the head. The former is normal and conservative: the latter is abnormal and dangerous to the pelvic floor.

§ 9. The mechanism of extension in breech presentations demands no special remarks. Excepting that it possesses only the third movement of flexion or extension, the breech does not differ in its mode of delivery from the shoulders.

§ 10. When the head comes last it may be born either by flexion or extension (AUVARD 1894). So far as the details of the process are concerned most is to be learnt from the artificial modes of delivery, which is true also for the aftercoming shoulders

DEVENTER (q. by SMELLIE 1752) pulled
backwards/

backwards on the head so as to deliver the occiput first when the position is the occipito-anterior. SMELLIE on the other hand pulled forwards, using the fingers of one hand to draw the upper jaw downwards and the fingers of the other hand to push the occiput upwards, so as to deliver the face first.* The same mechanism is aimed at in the PRAGUE (KIWISCH 1846) and WIGAND-MARTIN methods (Martin 1886), namely to deliver the face first or rather that portion of the head facing the posterior wall of the canal, for in the occipito-posterior position the occiput is delivered first. There are, therefore, two possible methods of delivering the aftercoming head - by flexion or by extension. McCLINTOCK (1876) holds that DEVENTER'S method is possible only in conditions of relative underproportion. The method by flexion is more perfect, and it has the advantage that the direction of traction is favourable to the maintenance of flexion as I have shown. In order, however, to/

*LITZMANN writing in 1886 and 1887 attempts to show on historical grounds that Smellie's method often known as the Veit-Smellie ought to be called the Mauriceau-Levret, and he gives his approval to this method as it is modified by D'Outrepoint. It appears however, that, while Smellie applied traction to the upper jaw of the fetus, Mauriceau placed one or two fingers into the mouth of the child for the same purpose.

to make sure that flexion is maintained not only in the head but also in the arms, it is better to retain the hand which has been employed to produce internal version, in the uterus, or in an arrested breech presentation to introduce a hand as far as the child's face, to insert the index finger in the child's mouth, and to clasp the one arm with the thumb and the other arm with the remaining fingers. The other hand grasps the limbs of the child, each segment of which is brought, by gentle traction exercised by both hands, appropriately through the transverse diameter of the brim, the oblique diameter of the cavity, and the antero-posterior diameter of the outlet, in a state of complete flexion. Either the right or the left hand may be used as is convenient, and any canal which will allow the head to pass through will also admit the hand and forearm along with the body of the child. The method of extraction, just described, is partly shown in a diagram reproduced by WILLIAMS (1912 P. 817) after BUMM. But in the figure most of the hand is external to the canal and the arms are not guarded. And it is mainly in the height of the operation and the securing of the arms that the method differs from the/

the MAURICEAU-LEVRET.

The fact that the arms have become extended does not, however, invalidate delivery with the arms still in that position. MUELLER (1898^b) who described a method of delivery with extended arms (according to LABHARDT (1908) it had already been described by DEVENTER 1701) insists on the anterior shoulder being made to enter the oblique diameter of the pelvis first. If the manoeuvre is accomplished successfully, the rest is easy.

LOVRICH (1905) and CUKOR (1908) argued in favour of this method. LABHARDT states success in 90% of his cases. In 1909, LOVRICH was able to record a total of 743 cases all successfully delivered by MUELLER'S method. ZIEGLER'S results (1913) are not quite so good. They show, however, success in 80% of 493 examples. According to LABHARDT the secret of the success of this method apart from the manual manoeuvre is the reduction of the transverse diameter of the shoulders as a consequence of the extension of the arms. As the arms must lie alongside of the head during delivery, the circumstance argues against the views of DUNCAN and others that the head during its descent occupies the whole sectional/

sectional area of the pelvic canal and it is a practical proof of the soundness of SWAYNE'S contention that space always exists at the sides of the head within the pelvis. It does away at once with DUNCAN'S objection to SCHULZE and leaves the head capable of being influenced effectively by changes in the direction of uterine pressure.

The mechanism at the outlet when the shoulders are aftercoming is also pivotal and similar to that of the oncoming shoulders. LEFOUR (1888) advises that the anterior shoulder should be delivered first so that, with the neck applied to the pubis, the posterior shoulder may be allowed to sweep over the perineum in safety. This mechanism has the approval of TARNIER and BUDIN (1898) and is repeated by ROSSIER (1909), but it has a doubtful value. Before the anterior shoulder can be entirely born it is probable that the pelvic floor has already been exposed to more stretching than it will ever get from the posterior shoulder.

§ 11. The methods of safeguarding the perineum are so numerous that BOVIS (1911) disbelieves in any of them. It is generally admitted, however, that/

that if some precautions are not taken tears of the perineum will be more plentiful and more severe than they are. That being granted, it ought further to be insisted that secundiparae need as much attention in this respect as women in first labour.

The various methods which have been recommended from time to time resolve themselves under the headings of :-

I. Posture.

II. Predilatation.

III. Applications to the Perineum.

IV. Manual pressure designed to favour what is regarded as the normal mechanism.

V. Manual pressure intended to interfere with what appears to be the normal mechanism, and to replace it with a mechanism which is considered to be better.

I. As a general rule the lateral posture is favoured in Britain, the dorsal on the Continent of Europe and in America. Some authors, however, have made special recommendations as to the position of the mother during the passage of the head over the perineum. SCHULZE (1867 and 1903) advocated the extension of the lumbar spine by placing a pillow under the loins in the dorsal position.

NACKE/

NACKE (1908) advised a similar arrangement. RITGEN (1855) and FEHLING (1908) used the lateral posture on one or other side according to the position of the head. The left lateral position was favoured by GOODELL (1871), FASBENDER (1878), and HABERLIN (1901) while BONNINGHAUSEN (1903) preferred the right side. APFELSTEDT (1906), SAMUEL (1908), GRUBE (1910), and GREER-BAUGHAM (1913) wrote in favour of the lithotomy position, though in 1912 SAMUEL allowed the lateral position in the intervals of the pains, as also OLSHAUSEN (1872) from the dorsal.* The contrary attitude to the lithotomy, namely with the thighs extended on the trunk was approved of by HURT and MACDONALD (1882).

II. Predilation was practised by SMELLIE who employed the fingers of one hand closed together in the form of a cone. According to AUVARD (1894), BYFORD used an artificial bag of waters for a similar purpose, while DUMAS used three fingers. HURT (1871) pulled back the posterior commissure of the /

* GREER-BAUGHAM changed from the lithotomy position as soon as the head appeared to one in which the knees were extended and the closed legs were rotated externally.

the vulva to bring the vulva into the direction of the expulsive power. RUDOLPH (1913) followed SMELLIE and DUMAS, and he quotes HOHL (1862) to show that NAGEL (1851) made a similar practice.

III. Applications to the perineum do not call for any remarks.

IV. Of manual methods designed to forward the normal mechanism that described by RITGEN (1855) is one of the best known as it is also one of the oldest. An arm is placed between the thighs and the hand is hollowed over the head. The other hand is applied behind the anus to press inwards and forwards in the intervals of the pains. It is clear that RITGEN did not advise a finger to be placed in the rectum as has sometimes been said. FEHLING (1908) argues in favour of this method and adds that pressure should be made lateral to the median raphe of the perineum when the head is incompletely rotated. RITGEN, however, if I am not mistaken, counselled the procedure in all cases. GIFFARD (1734), it is said, made pressure downwards and forwards near the anus, while according to AHLFELD (1903^o) RITGEN'S method was already practised by /

by HAGEN-HOFFMANN (1790). SIEBOLD and PLAYFAIR (PARVIN 1895) employed a similar method. HART (1887) applies the thumb in front of the anus and makes pressure downwards and forwards. At the same time the fingers of the same hand are applied to the occiput as far up as the nape so as to bring down the nape to the symphysis - a valuable addition to what is virtually RITGEN'S method. STEVENS (1895), CALE (1905), and GRUBE (1910) describe methods which do not differ from HART'S except in detail. APFELSTEDT (1906) and NACKE (1908) write in favour of a system which may be regarded as a combination of HART'S and TARNIER'S methods.

The introduction of a finger into the rectum to make pressure downwards and forwards was practised by OULD (1741), SMELLIE (1752) and van BAMBECKE (1863). PARVIN states that BERNATTI (1778) used this method. GOODELL (1871) introduced two fingers into the rectum in order to press the anterior wall forwards. FASBENDER (1878) put a thumb in the rectum and the other fingers of the same hand over the head so as to clasp and control it. Here there is a close approximation to HART'S method with an obvious disadvantage. ROEDERER and HAMILTON, (LEISHMAN)/

(LEISHMAN 1864) pressed the perineum backwards towards the sacrum so as to peel it off the head. The method is safe only when the forehead is born and then it is hardly necessary.

TARNIER (1882) placed one hand over the head so as to control it and the other was laid flatly and transversely on the perineum through which the head was pressed forwards. BONNAIRE (1891), AUVARD (1894), DESSAIGNES (1894), and BONNINGHAUSEN (1903) closely followed this method, placing the hand which controls the head between the thighs of the mother.

CHARPENTIER and PINARD (BOVIS 1911) applied pressure from the sides of the anus - PINARD emphasises the importance of disengaging the parietal tuberosities in turn - a difficult thing to do, but already accomplished by GUILLEMOT (1837). LOHLEIN, BALANDIN (1883), and MERKETSCHIANTZ (WEBSTER 1903) spread a finger and thumb on the perineum, the last author specially for the purpose of drawing the perineum together and so preserving it from rupture.

HABERLIN (1901) used the left hand to hold the head back in the pains and to press upwards the anterior-lying soft parts in the intervals. The right /

right hand hinders too great extension of the floor by seizing the posterior portion of the vulva and during a pain pressing the head forwards from above its greatest circumference.

These are, I think, a fair account of the methods most readily accessible in print and probably most generally in use. In opposition to these methods CLAY (1844) claimed to have shown experimentally that pressure on the perineum increases the liability to rupture. (SCHROEDER asserted in 1867 that pressure diminishes the tendency.) SCANZONI (1853) and HOHL (1862) apparently controlled the head alone for some such reason. TYLER SMITH (1858) argued that interference with the perineum reflexly increases uterine and abdominal action, and is therefore to be avoided. GRAILY HEWITT on the other hand favoured support. (LEISHMAN 1864). TYLER SMITH'S view is, however, a weighty objection to the application of pressure to the perineum, excepting that of the head which is unavoidable.

V. In the second manual method which aims at changing the course of the head no manipulation of the perineum is required: it does not need to /

be touched by the hand of the accoucheur. TEMPLE (1886) prevented the occurrence of extension, and with forceps caused the head to be born in a state of forced flexion so that the sub-occipito-bregmatic diameter comes through the vulva. TEMPLE states that GAUSSEN had already done this with the fingers, but holds the practice more easy with instruments. In a paper published in 1889 GAUSSEN counsels bending the head backwards either with the fingers or with the forceps until the occiput has passed under the pubic arch. Thereafter extension is allowed to occur in the ordinary way. So far as the evidence goes, the method does not differ materially from that described by HART in 1887, and goes little beyond the procedure described by MATHEW (1898) for the use of the ordinary forceps. TOFF (1907) also wrote in favour of a method which has been lauded by PARAMORE (1909) as invaluable in preserving the perineum and as being a production of forced flexion. I have seen only the account of TOFF'S method given in the Epitome of the British Medical Journal, but as it is there set forth the method is entirely similar to that described by HART. TOFF, as HART, allows extension to occur when the nape rests against/

against the symphysis. This is the conclusion attained by ROUTH in the discussion on PARAMORE'S paper. PARAMORE appears, however, to have considered that TOFF advocated continued forced flexion. TOFF apparently did not do this, but PARAMORE does. The method is therefore TEMPLE'S and PARAMORE'S. PARAMORE, by his examination of the planes of the pubo-rectalis muscle and of the vulva, produced anatomical reasons for the birth by forced flexion, and he also shows that the method is not accompanied by a great lengthening and stretching of the perineum. The mere production of forced flexion, however, is not sufficient - it may in fact be dangerous. It is also necessary to insure that the third movement of extension is pronounced. It is not easy to manipulate the occiput as long as it lies wholly behind the pubic segment. Fortunately so far as can be seen, it is not necessary to interfere before a manageable portion of the occiput has appeared below the arch, because until then the distension of the perineum has not proceeded very far. As soon, however, as it is possible to exercise pressure on the occiput without pushing the fingers upwards behind the pubis the occiput should be pressed boldly backwards. The further the head descends, the more practicable/

practicable is the operation of forced flexion. When the head is well down and the sub-occipito bregmatic diameter is approaching engagement at the vulva, firm pressure should be applied for a few seconds to the sinciput in a direction forwards. The pressure should not last longer. PHENOMENOW and BROCK, according to BOVIS (1911) show that pressure tends to fix a portion of the perineum and this leads to rupture more readily than mere distension. Further if the pressure with the fingers is applied kinetically, the effect on the head is lasting owing to the tendency of the bones of the head to continue to move in the same direction for a little while after the pressure is removed and to remain in their new position for some time. The head is maintained in an attitude of forced flexion until the forehead is born. As a rule, when this happens, further descent of the head in the same direction becomes impossible owing to the shoulders reaching the end of their descent within the cavity prior to rotation. It is possible to continue the attitude of forced flexion until rotation of the shoulders has occurred, and the whole head has been born. There is no advantage in the proceeding, however, as when the forehead is/

is born the perineum will not again be so severely dilated by the head. As soon then as the limit of descent and the birth of the forehead has occurred, it is better to allow extension to take place. The head extends gently and indeed passively by the remnant of resistance exercised by the perineum, and is born. The shoulders ought to be delivered in the same way, making traction on the head in the same direction as that which the head took in forced flexion. It is necessary to be particular in this regard as traction applied to the shoulders in a direction too much backwards may lead to a deadlock, possibly by reason of the posterior shoulder coming into contact with the sacro-coccygeal junction.

At the first trial, the pressing of the head and the shoulders backwards onto the perineum demands courage of the attendant. The method looks so like perineal murder. But the results are good both in saving the perineum and in shortening the period of expulsion. It is hardly necessary to add that PARAMORE'S method is not a guarantee against rupture. Tears will still occur, but I believe they are less numerous and less severe in the use of this method than of any other which I have tried.

AS/

As nearly as it is possible to judge by external comparisons, the line of descent in forced flexion makes an angle of 40° to 45° with the axis of the brim. Sometimes it is a little less, sometimes a little more. These angles compare favourably with the 90° or more which the axis of the lower part of the canal makes with the upper in the ordinary mechanism of extension. The change of direction which, as it will be seen, still occurs takes place on the pelvic floor, but not at the level of the distended pelvic floor. The change of direction for each segment of the head is momentary and not continuous. These are important matters. Pivotal action in the ordinary sense is abolished entirely and with it disappears the very injurious bursting pressure to which the pelvic floor is ordinarily submitted. At the same time the perineum is not dragged along with the head: it does not lengthen, or become dry or friable. The perineum remains short and pliant. It does not become fixed to the head and thus a potent cause of rupture is removed. It is quite possible, and indeed ordinarily happens, that delivery is secured over a perineum which is never longer than two and a half inches in a primi-para/

primipara and two inches in a multipara, from the commissure to the anterior margin of the anus. The discrepancy between the planes of the vulvar outlet and the pubo-rectalis muscle is reduced to the least possible limit, and it is impossible at the same moment for the one to accommodate the sub-occipito-bregmatic diameter and the other the occipito-frontal. As a rule the perineum remains wrinkled during the period of greatest distension. If not, wrinkles can readily be produced in most cases. If the fingers are able to make a fold in the perineum it will not tear (BOVIS 1911). The head is compelled to enter the world in a state of forced flexion. That is to say, the second and third movements of flexion are exaggerated. I have already pointed out that in many cases after internal rotation has occurred the frontal region fills up and the anterior fontanelle becomes patent. It often happens that in the third movement of extension this region is never properly compressed and depressed. This circumstance increases the danger to the perineum. In the ordinary mechanism of extension it is rarely possible to reproduce the compression and depression manually, because there is no fixed point to work against. This difficulty/

difficulty is obviated by PARAMORE'S method, for the head is compressed in the appropriate diameter by the one hand acting directly against the other. The sub-occipito bregmatic diameter is the greatest diameter engaged. The head becomes greatly elongated not quite so much in the oblique direction to which SELLHEIM has drawn attention, but in a more vertical direction. The great elongation which at the labours I have conducted has generally been the subject of remark is readily produced, perhaps because the forces directly concerned are operating at the best mechanical advantage. In the usual mechanism of extension one notices at a time, when the perineum seems scarcely able to bear any further dilation, how much of the head, especially in the sincipital region, has still to pass the vulvar outlet. All this region has to make its exit by a process of further distension of the perineum. In an attitude of forced flexion the head at an early stage provides the perineum with a nearly vertical slope from which the perineum is able to retract rapidly and without experiencing any further dilation, while the total dilation is much less than it is in the ordinary mechanism, as the sub-occipito bregmatic diameter is truly/

truly engaged.

The advantages in delivering the shoulders by this method are similar. The greatest are the absence of the pivotal movement and the certainty that the posterior shoulder will not extend. An extended posterior shoulder rotating around the symphysis is liable to cause perineal rupture. The shoulders are born in a state of forced flexion. The one does not travel more rapidly than the other. Both are born simultaneously, though the anterior shoulder necessarily appears first at the vulva.

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SECTION VI.

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Trading of ... late ... stage section to
 show the ... appearance of the third ...
 of extension of point ... after ...

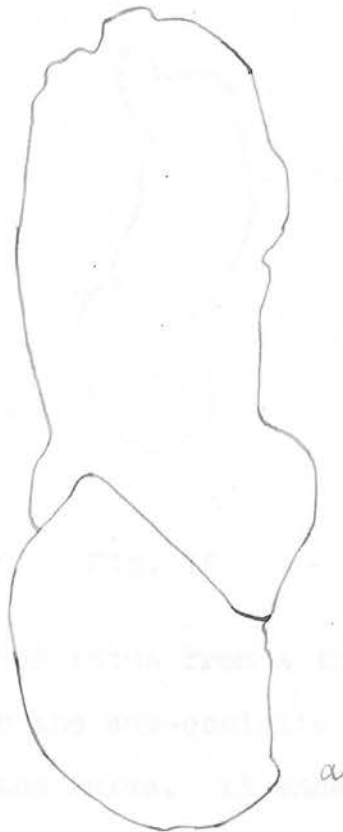


Fig. 9.

Tracing of fetus from late second stage section to show the earliest appearance of the third movement of extension (at point marked a). After BARBOUR.



Fig. 10.

Tracing of cast of fetus from a frozen section made at the time when the sub-occipito frontal diameter was engaged in the vulva. It shows the first movement of flexion complete, the third and second movements of extension fully developed (DE RIBES and VARNIER)



Fig. 11.

Diagram (after WILLIAMS) showing the third, second, and first movements of extension fully developed. Sub-occipito bregmatic diameter born. (Note:- the first movement of extension is exaggerated.)