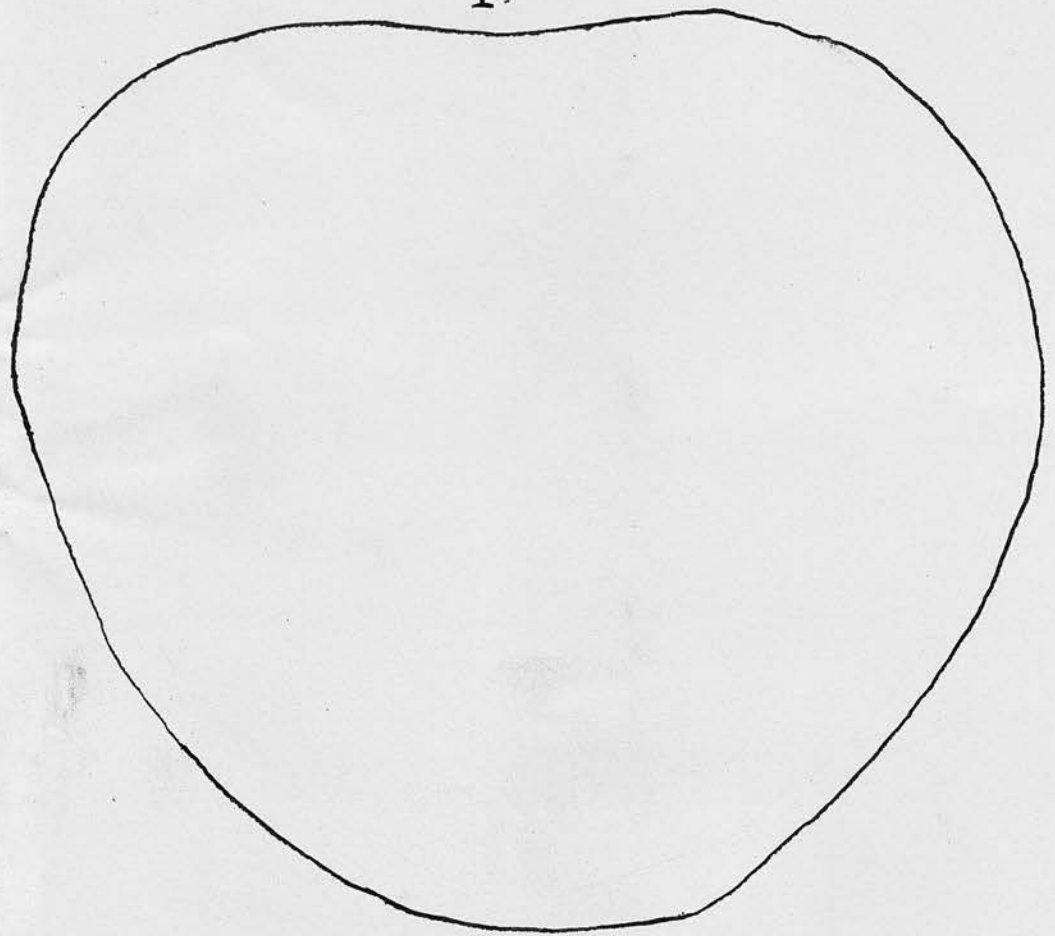
With graduation thesis.

F. Jurlach.

I.



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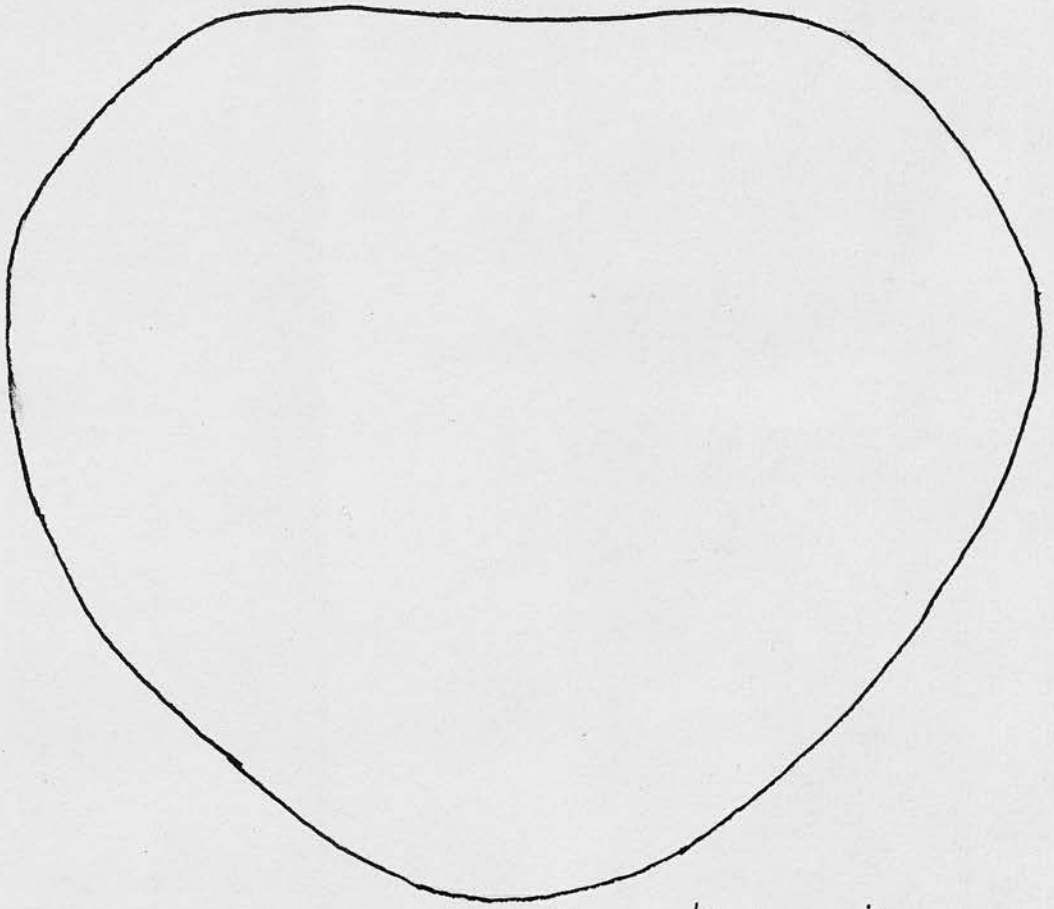

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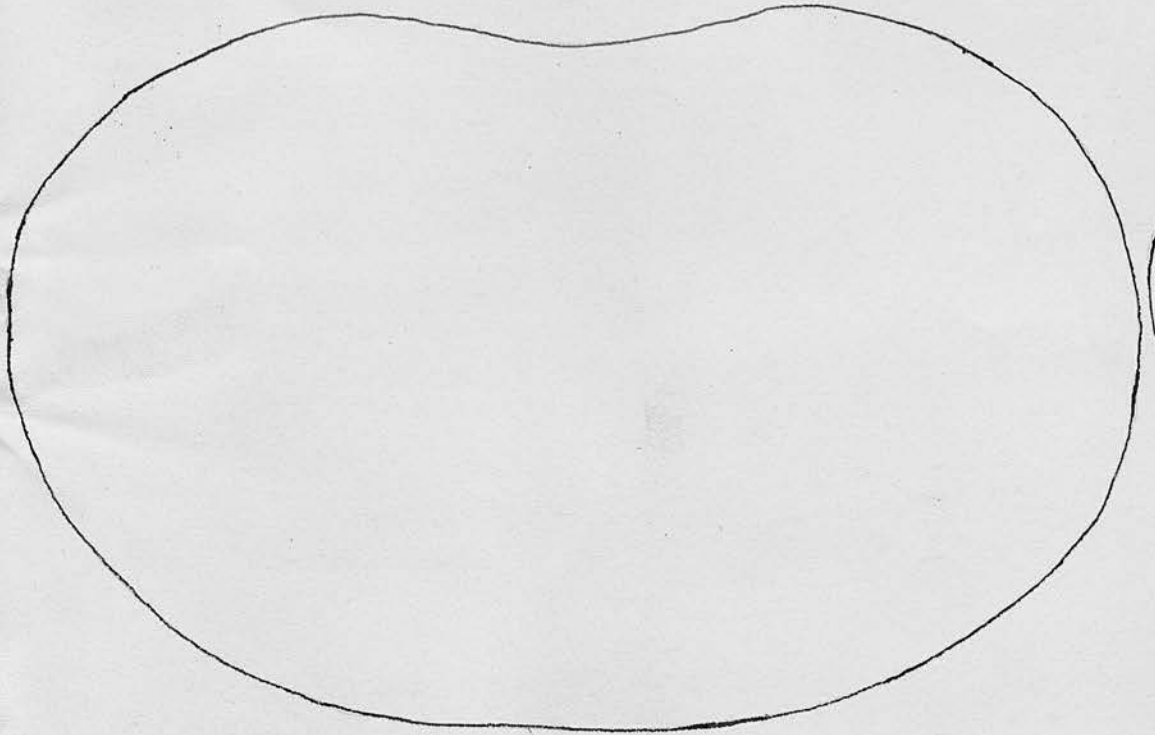

Obst: Mus:, Edin: University.

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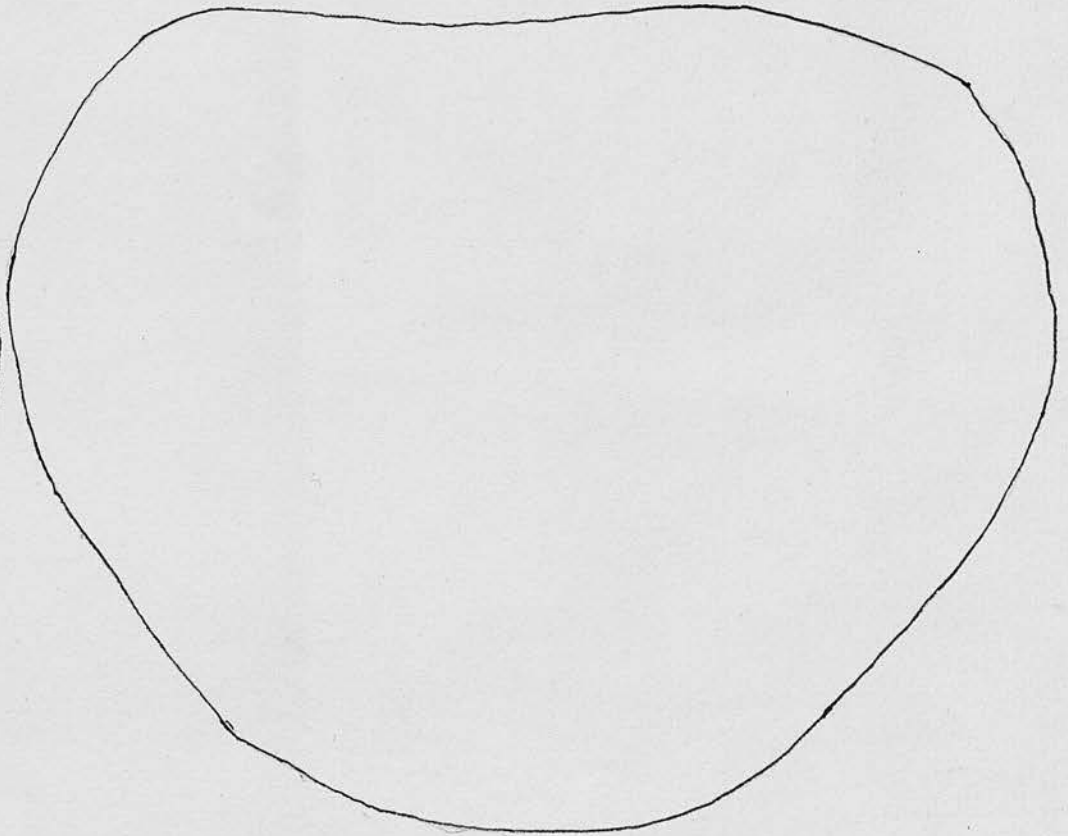
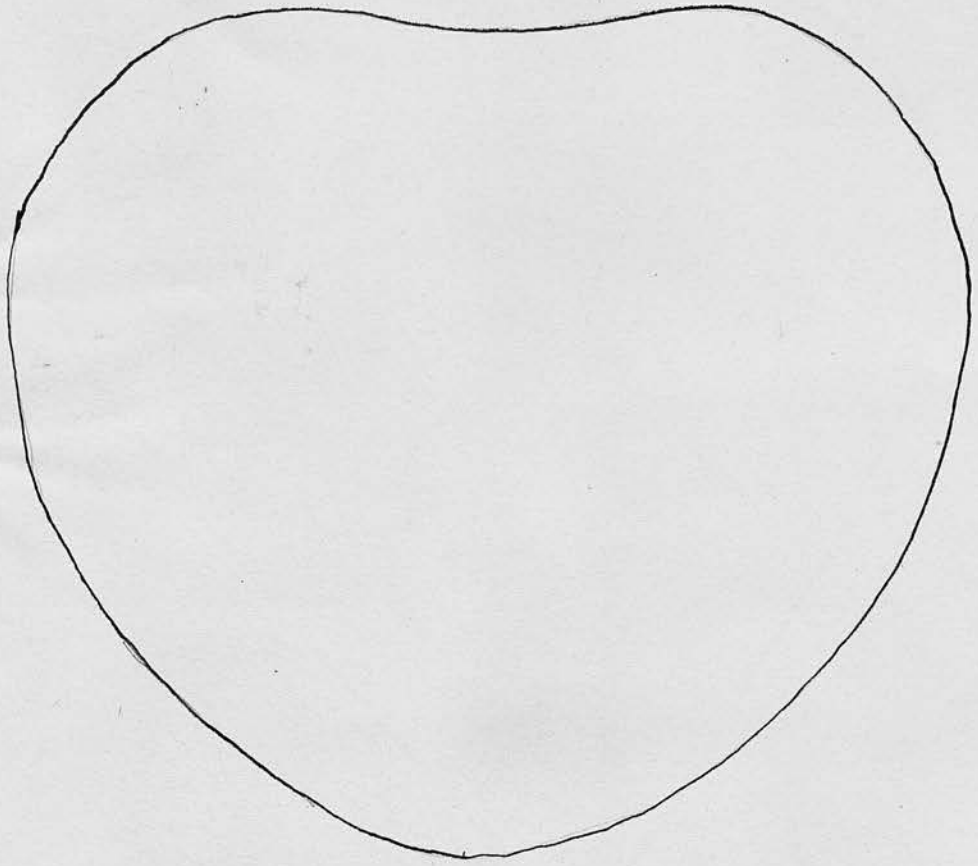


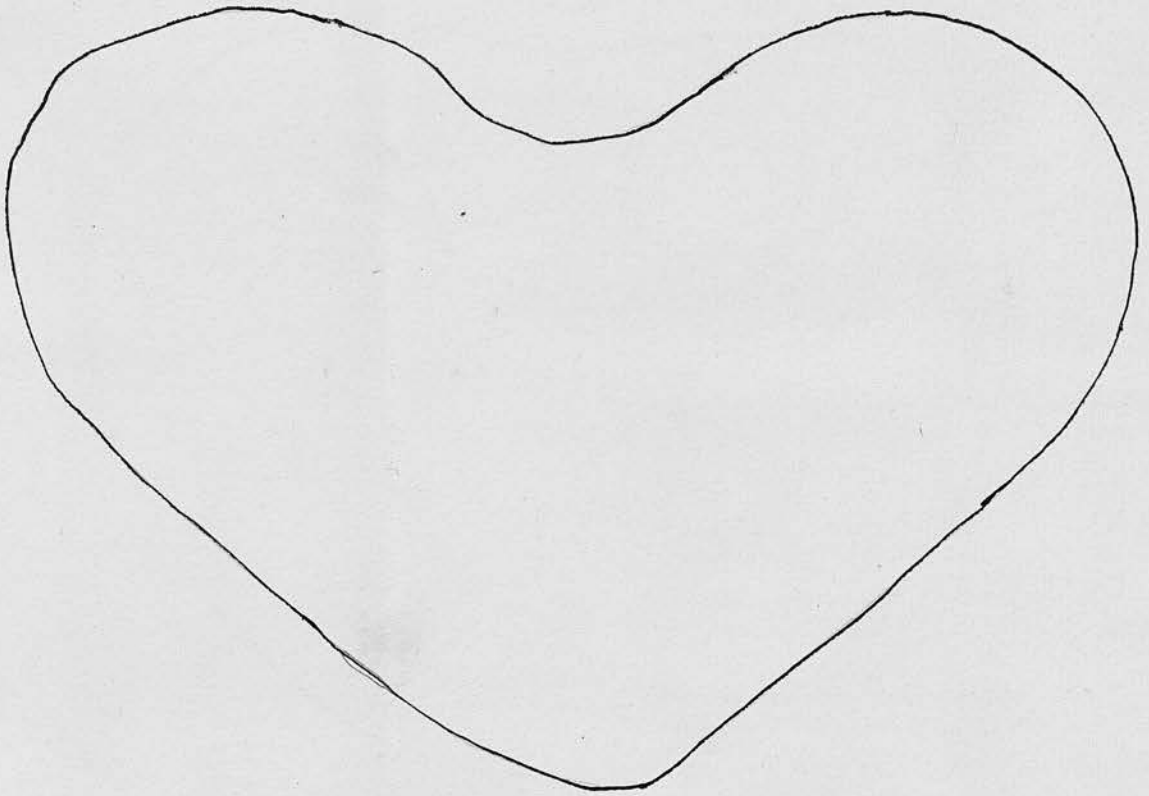
Royal Med: Soc:, Edinburgh.

V.



Obst: Mus:, Edin: University.
(The late Sir James Y. Simpson's Standard Pelvis)

VI.



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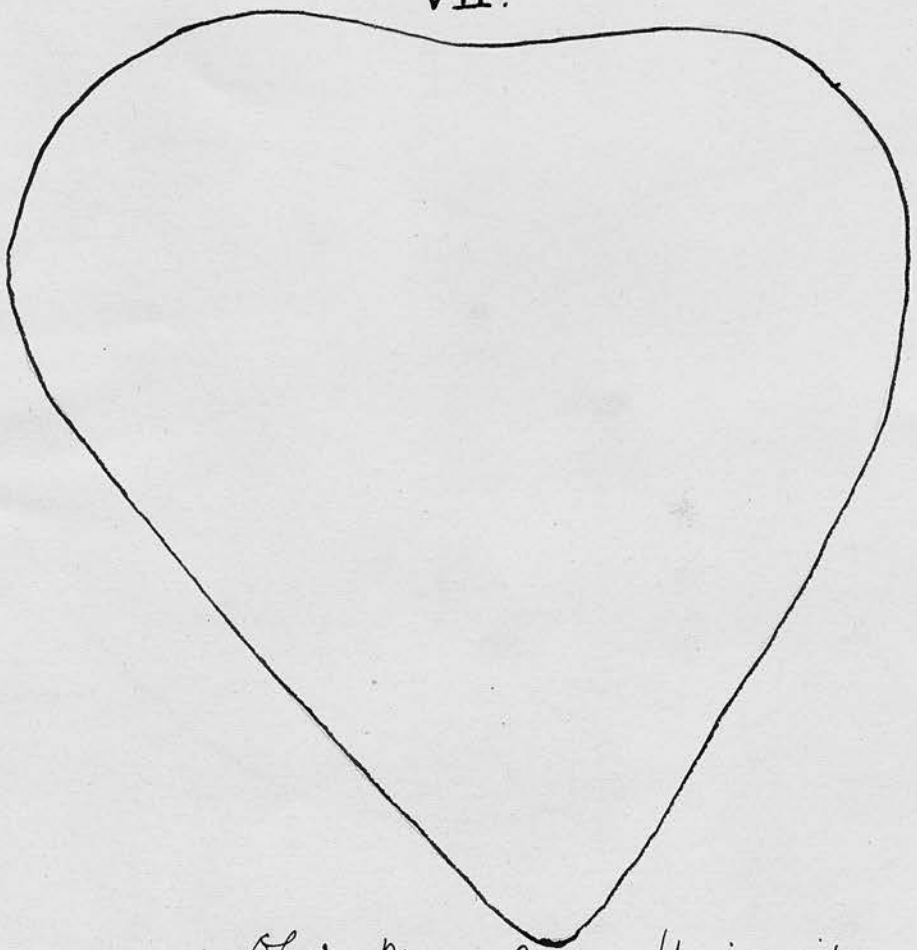

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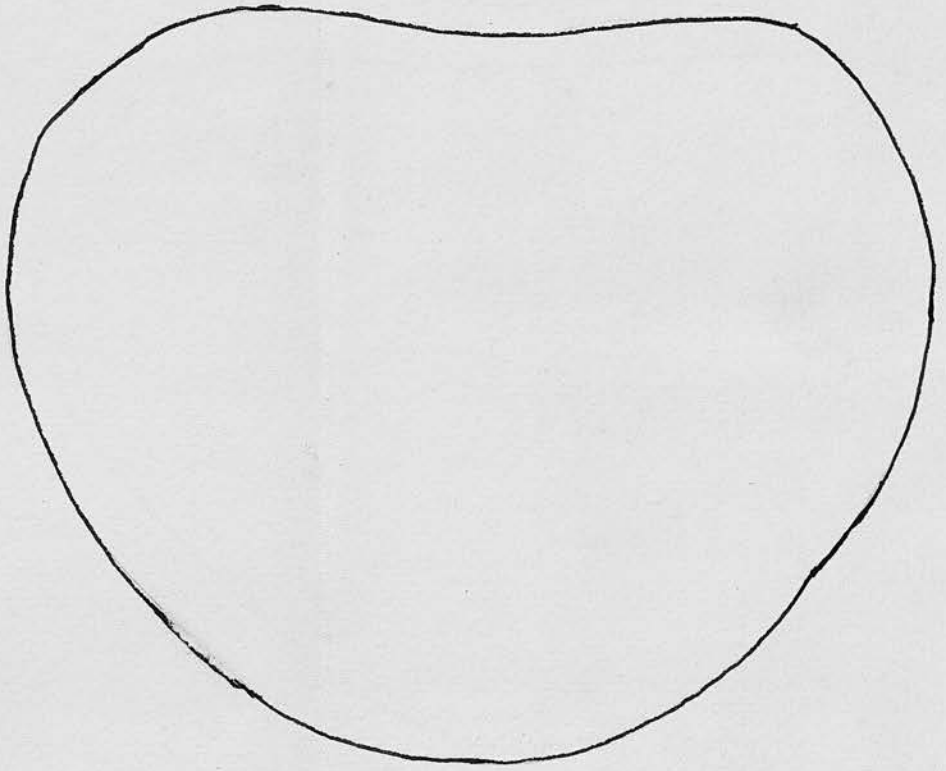
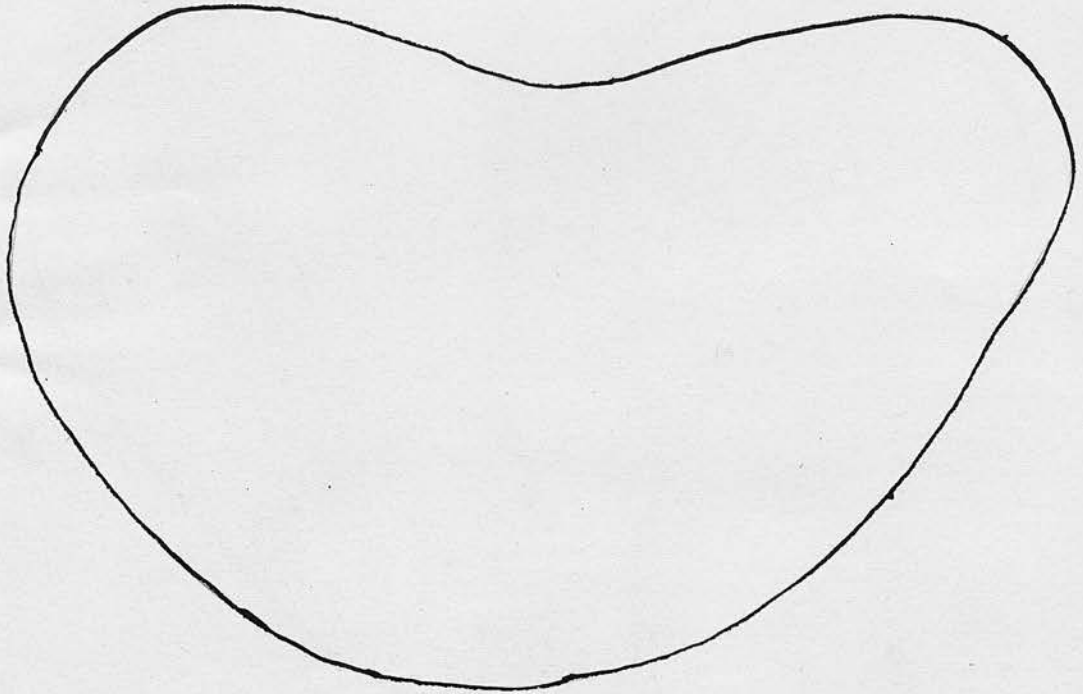


In the writer's possession.

IX.



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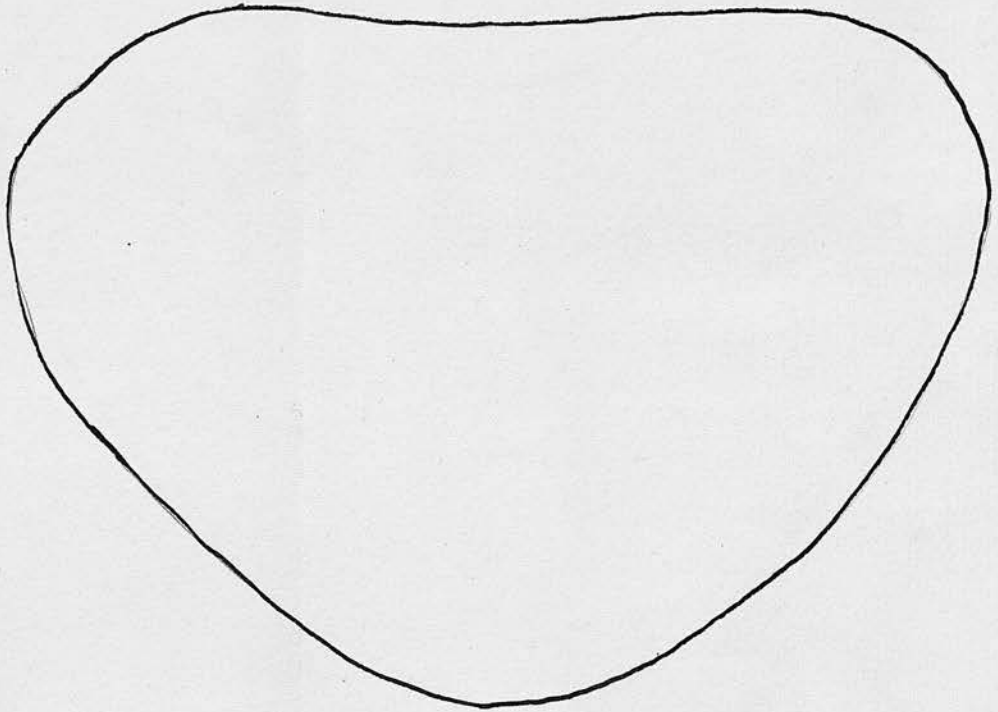
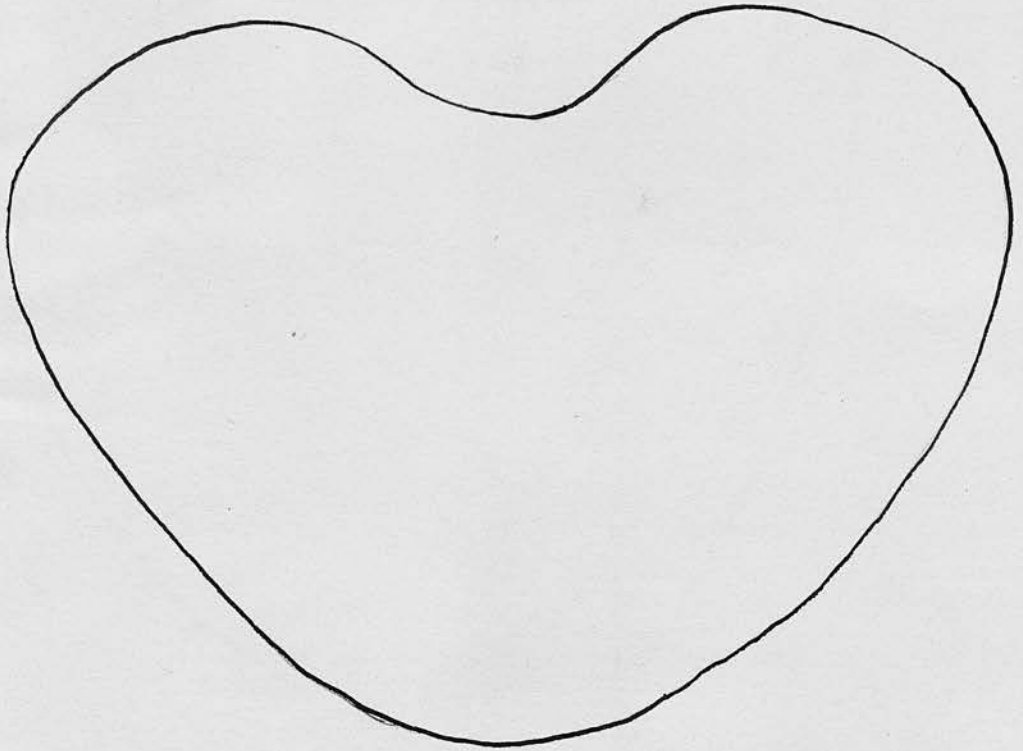


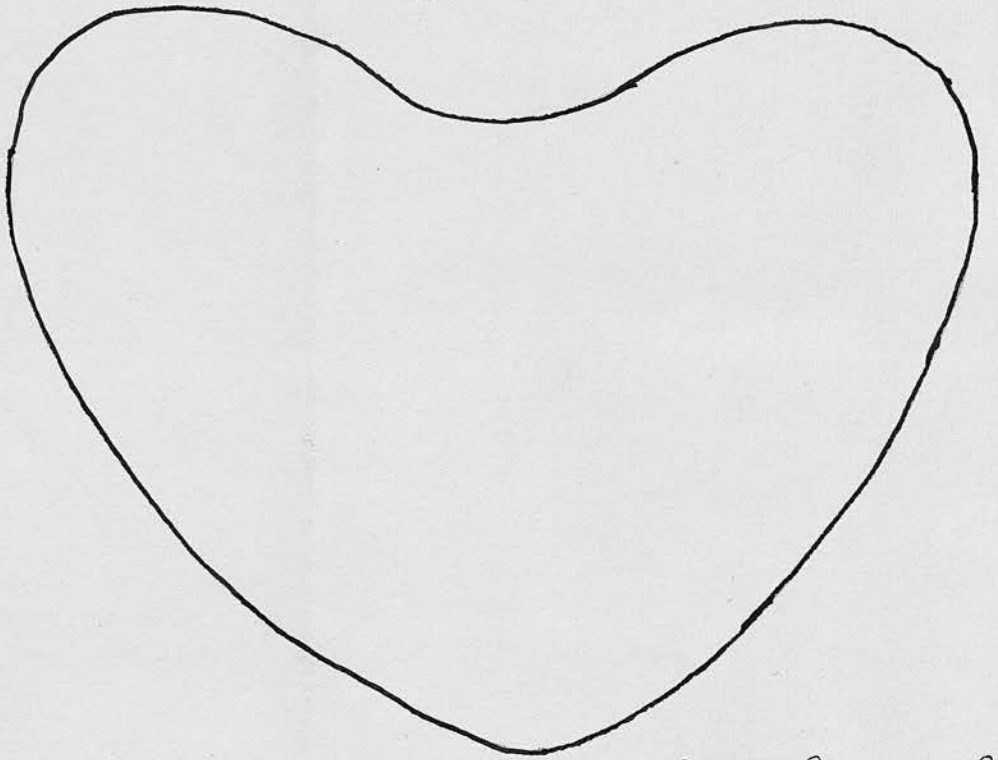
III.B. Mus: of College of Surgeons, Edinburgh.

XI.



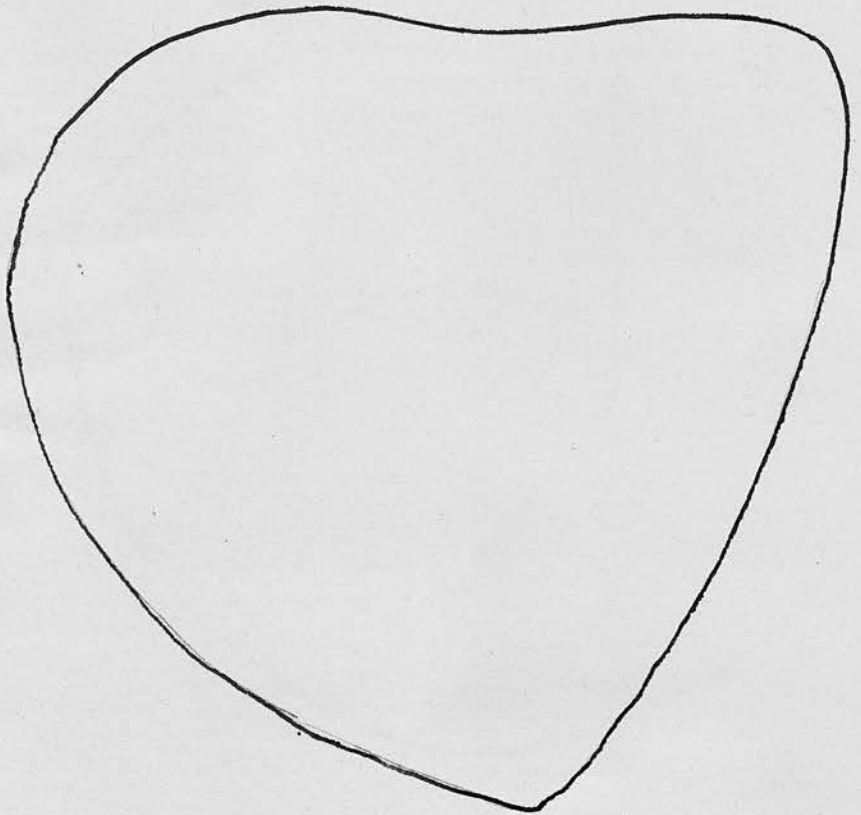
A. 11. Obst: Mus:, Royal College of Surgeons, Edinburgh.

XII.



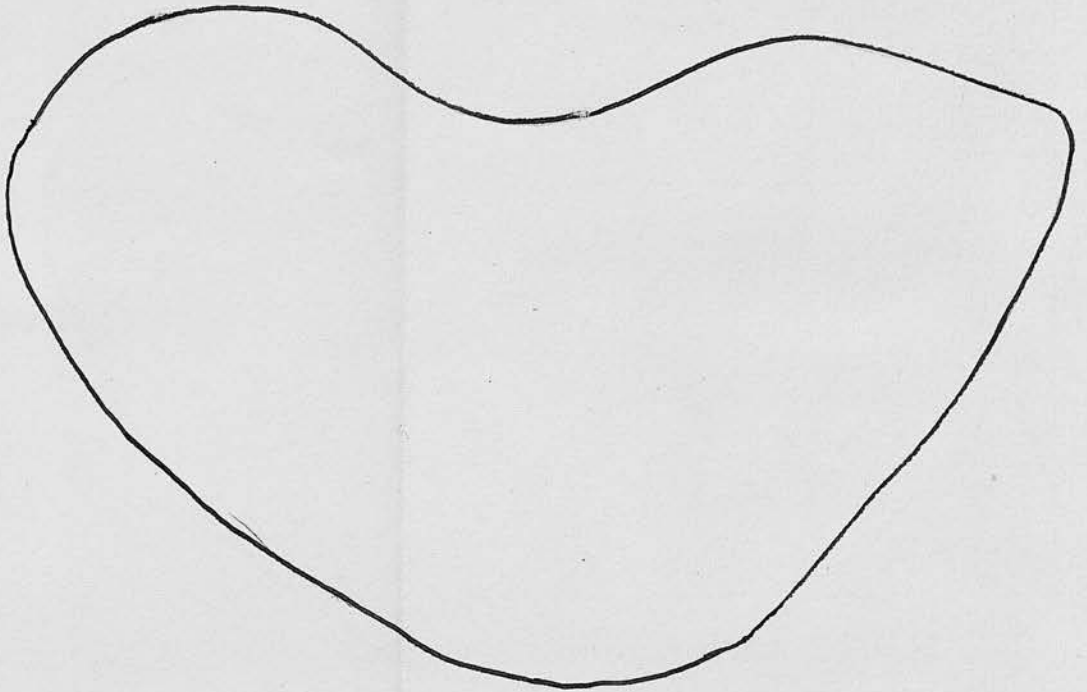
5-85. XXIII. D. Mus: Royal Col: of Surgeons, Edin.

XIII.



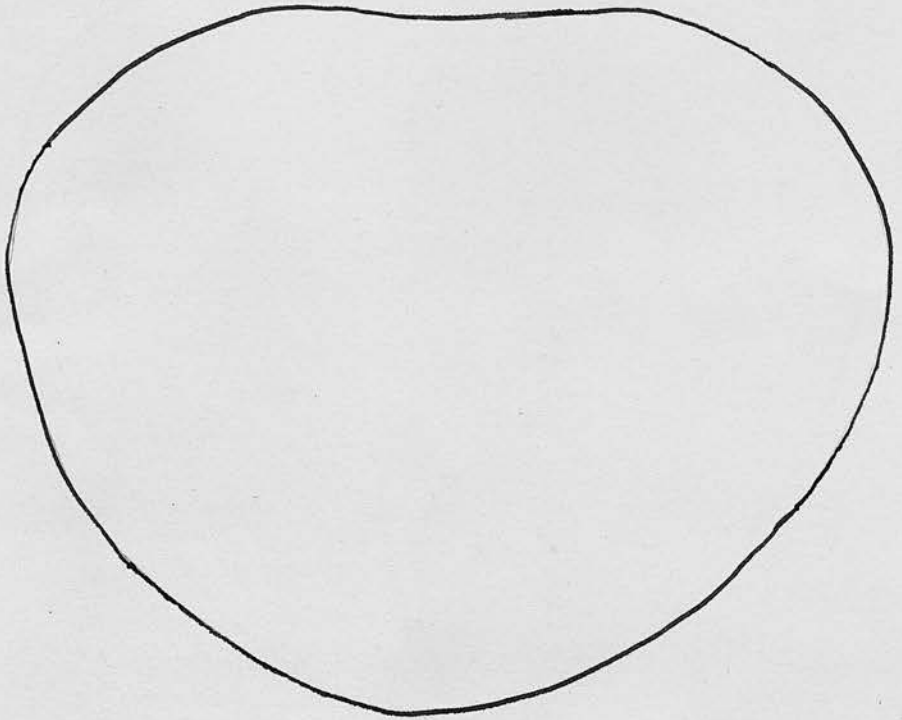
Model. Obst: Mus:, Edin: University.

XIV.



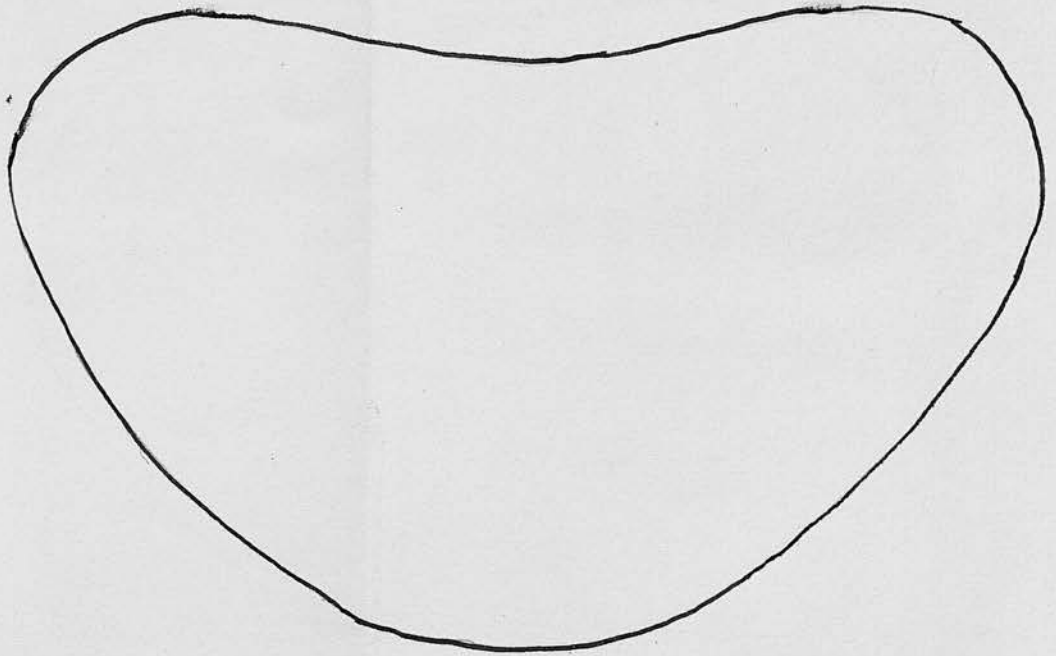
XXIII. D. Mus:, Royal Col: of Surgeons, Edinburgh.

XV.



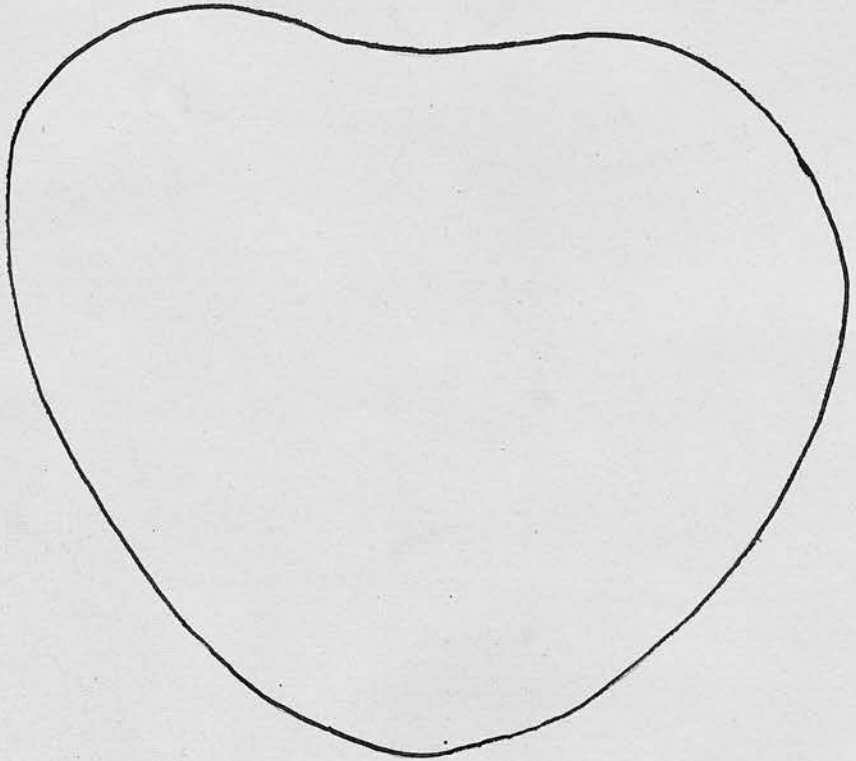
Obst: Mus:, Edin: University.

XVI.



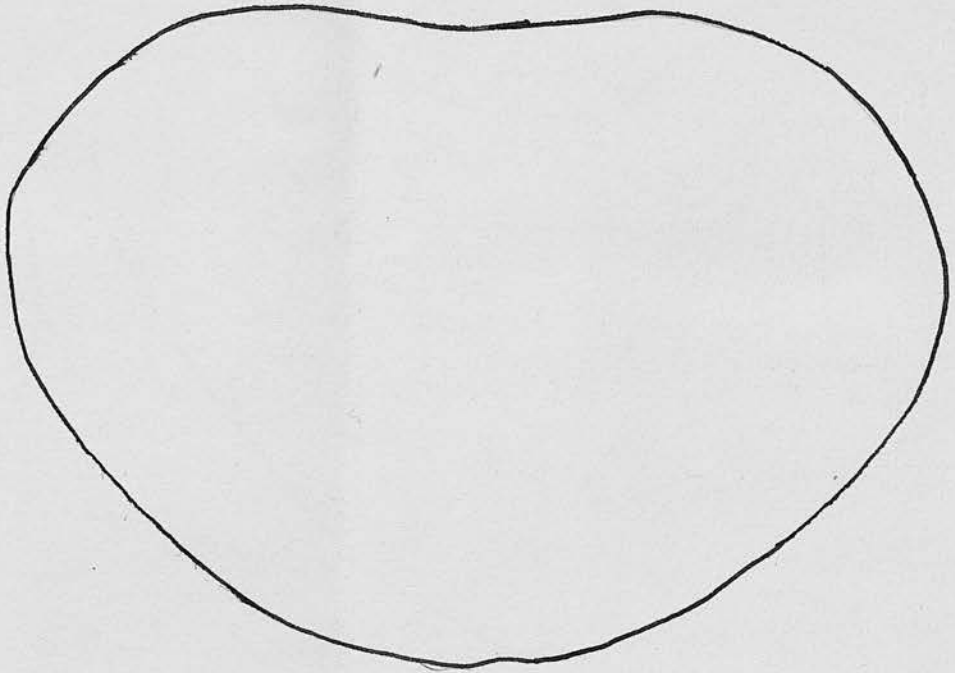
Obst: Mus:, Edin: University.

XVII.



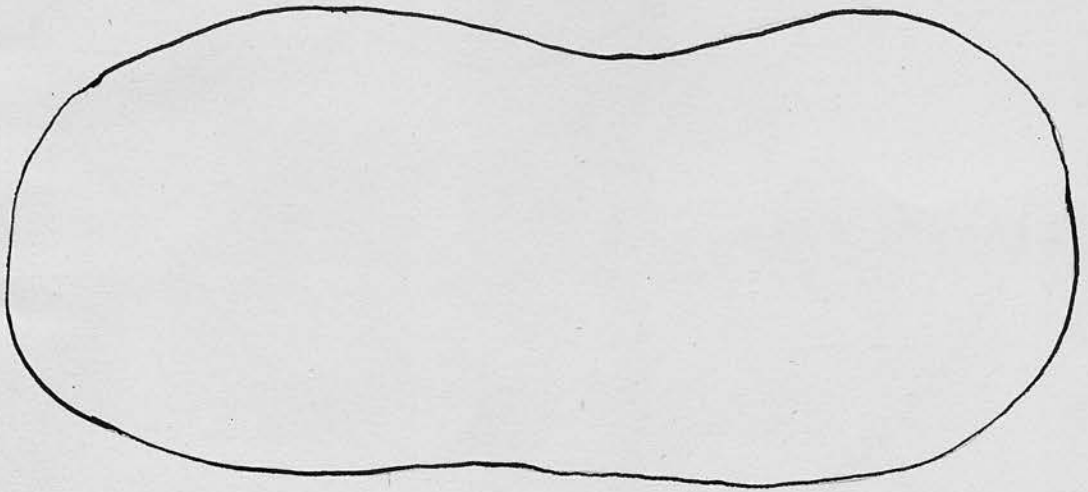
Mus: of Royal College of Surgeons, Edinburgh.
(not marked – next to III. B.)

XVIII.



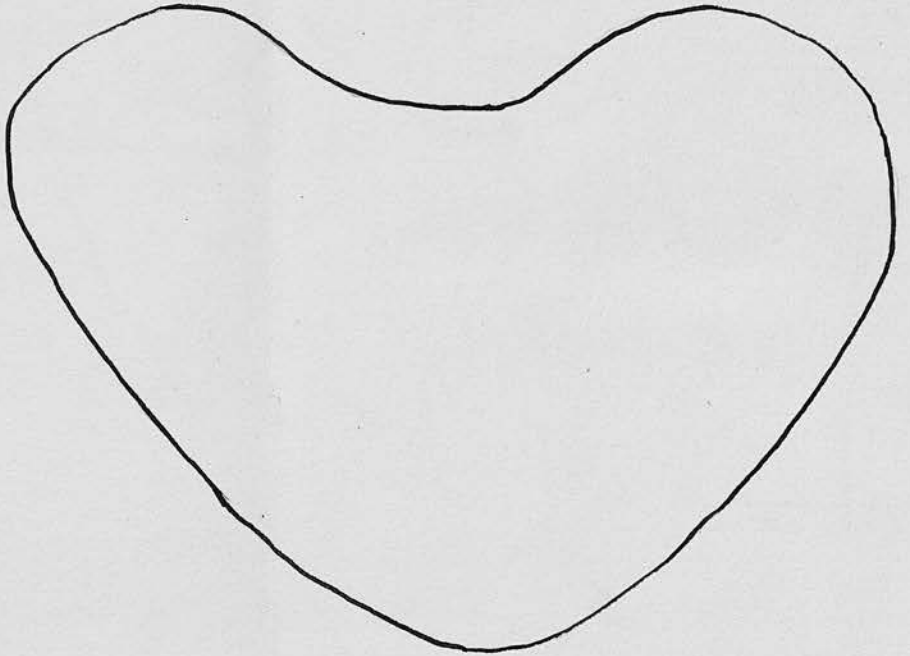
K.4.2. Mus: of Liverpool School of Medicine.

XIX



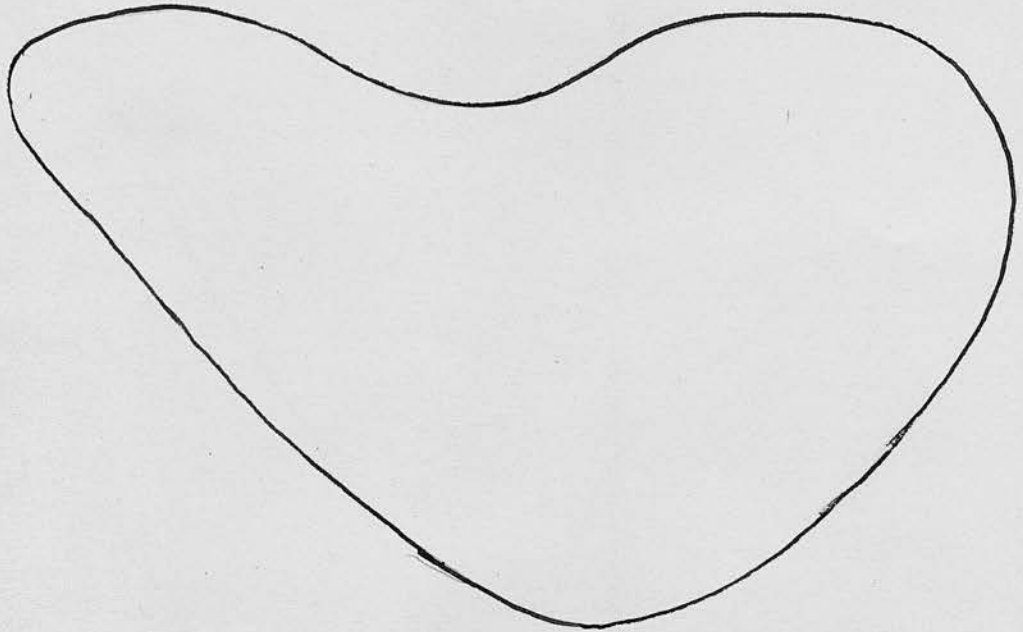
Mus: of Liverpool School of Medicine.

XX.



233 a. Obst: Mus:, Royal College of Surgeons, Edinburgh.

XXI.



Mus: of Liverpool School of Medicine.

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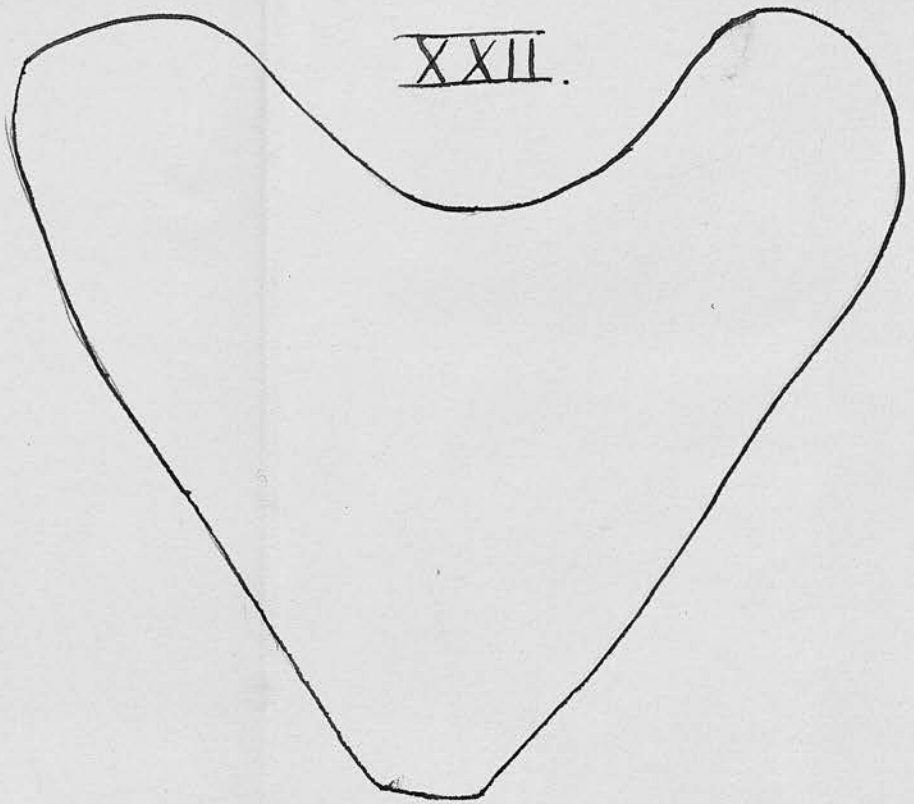
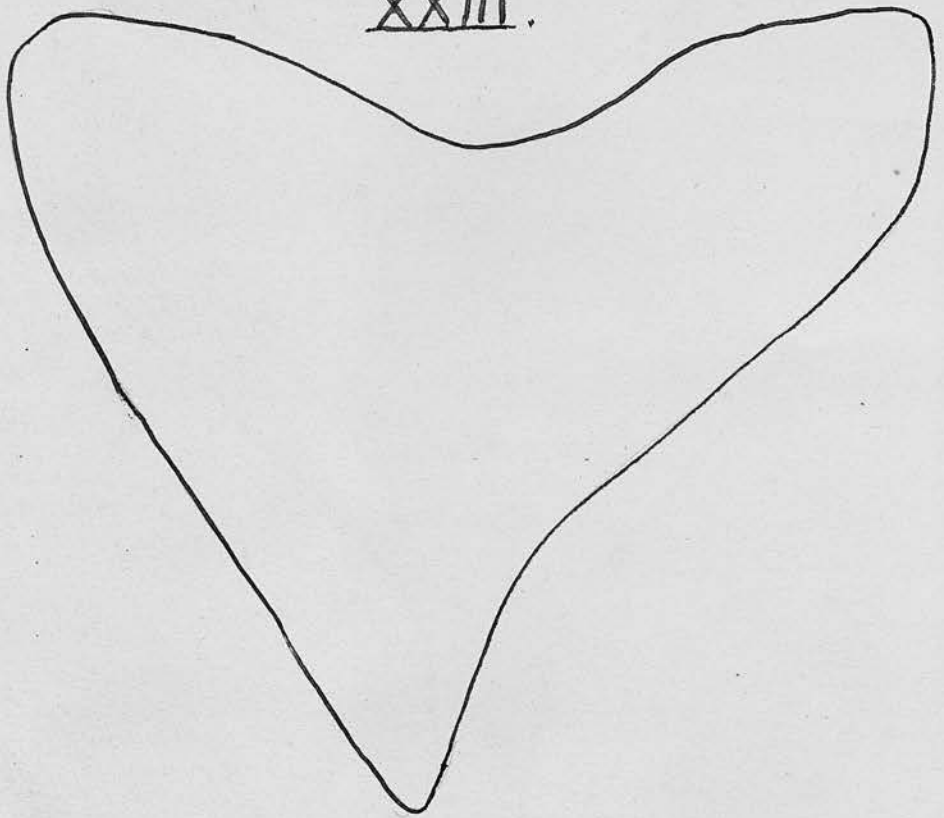


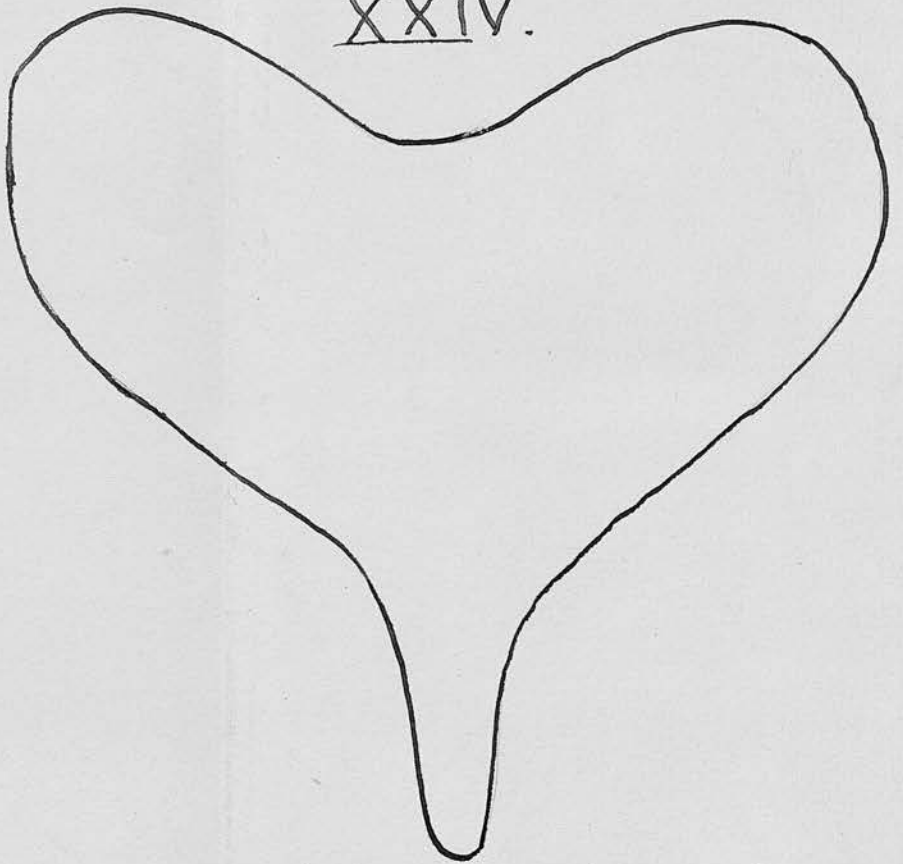
233 a. Obst: Mus:, Royal College of Surgeons, Edinburgh.

XXIII.



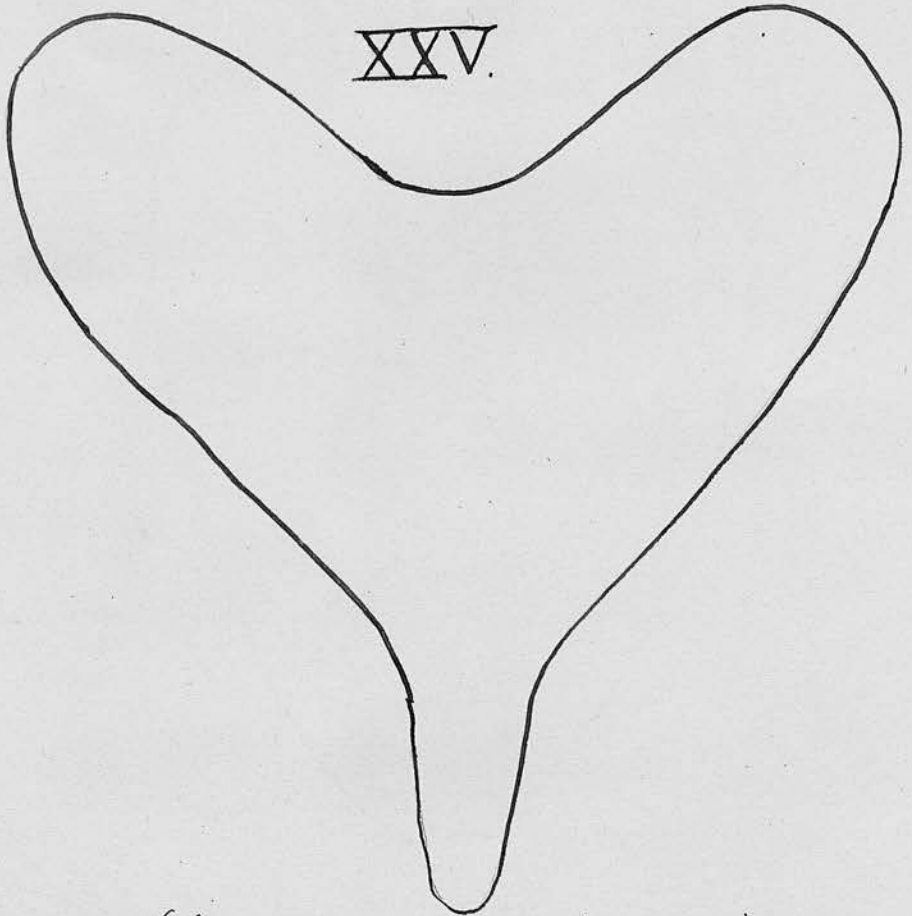
Anat: Mus:, Edin: University.
(True Mollities ossium, bones soft and greasy)

XXIV.



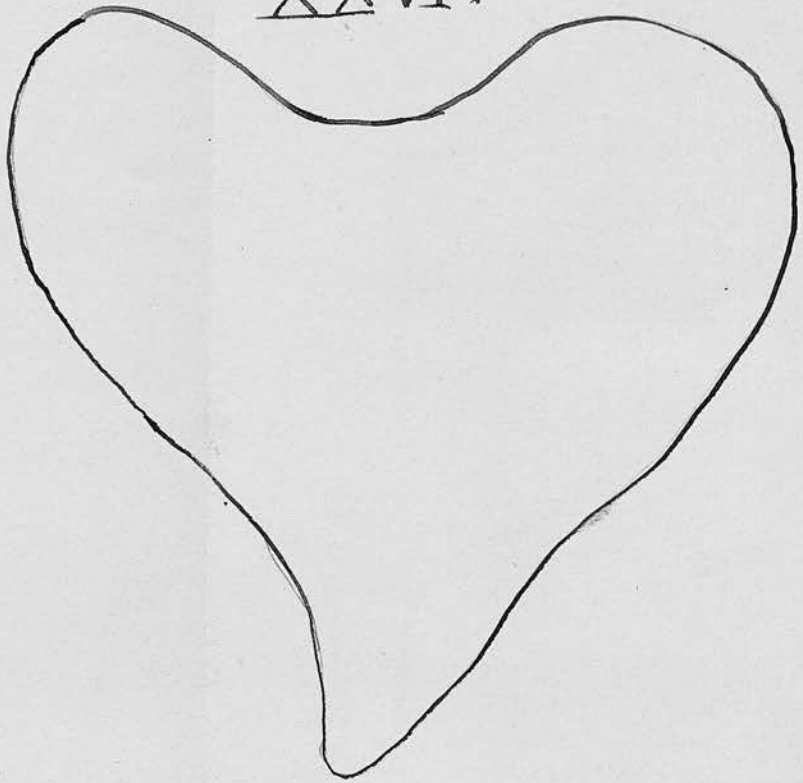
Anat: Mus:, Edin: University.
(Hamilton's Pract: Observations, Plate VIII)

XXV.



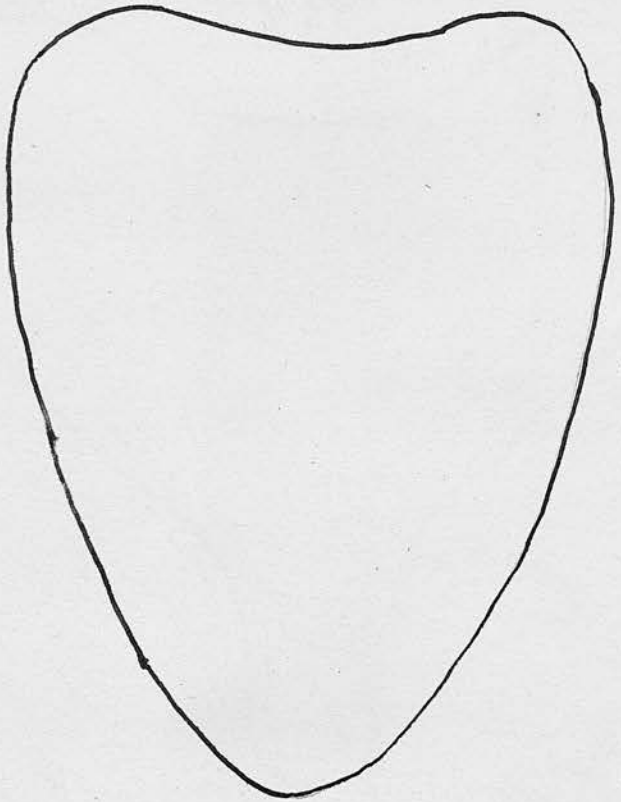
Obst: Mus:, Edin: University.

XXVI.



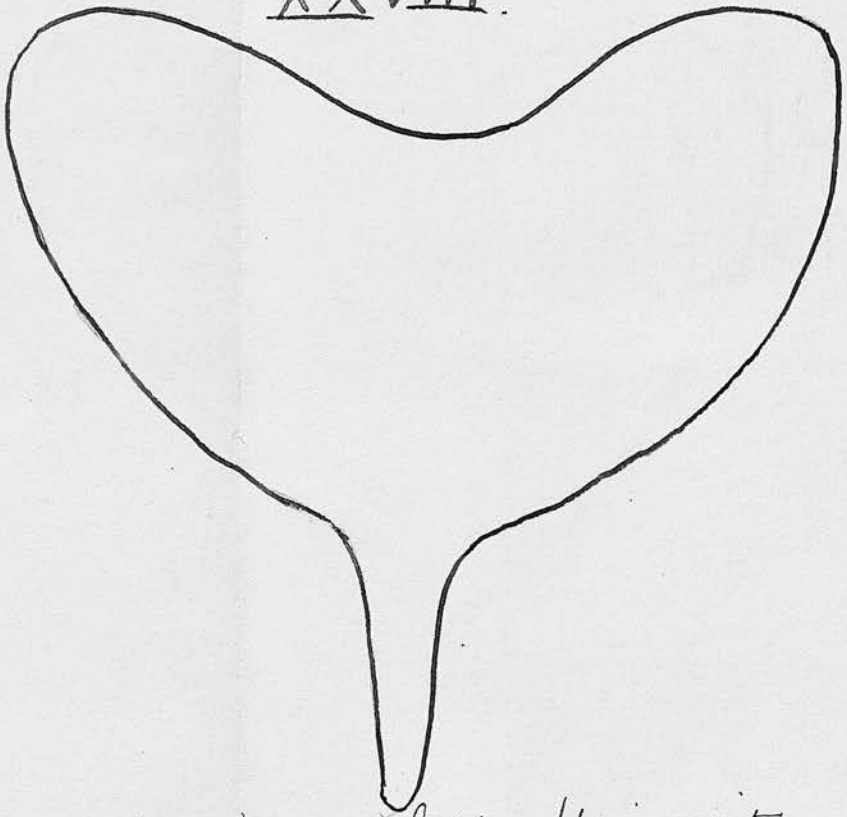
231 g. Obst: Mus:, Royal Col: of Surgeons, Edinburgh.

XXVII.



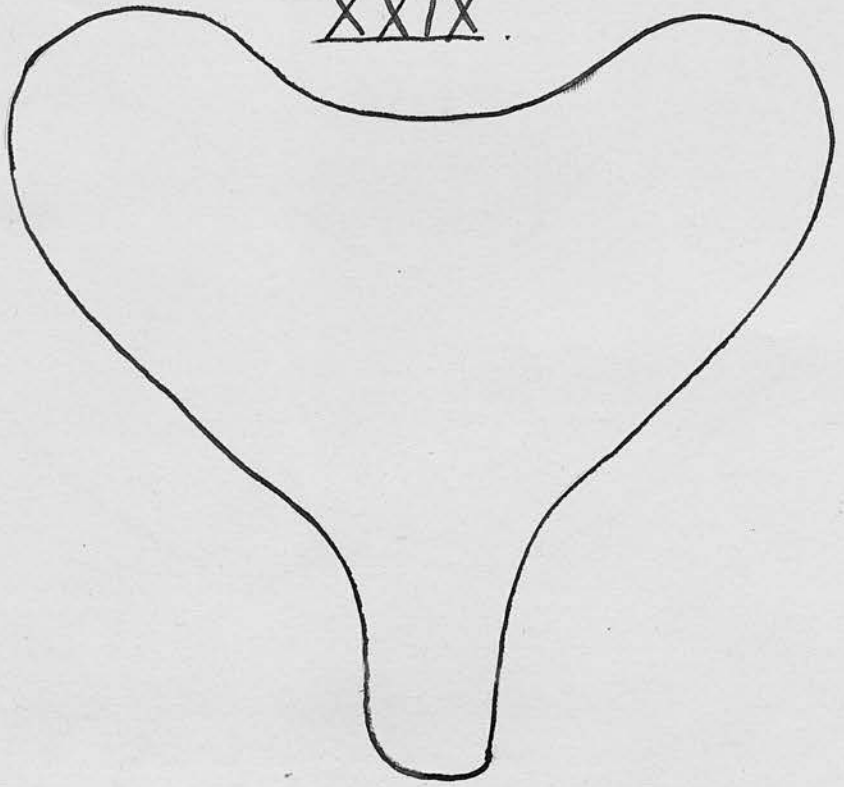
Model - Obst: Mus:, Edin: University.

XXVIII.



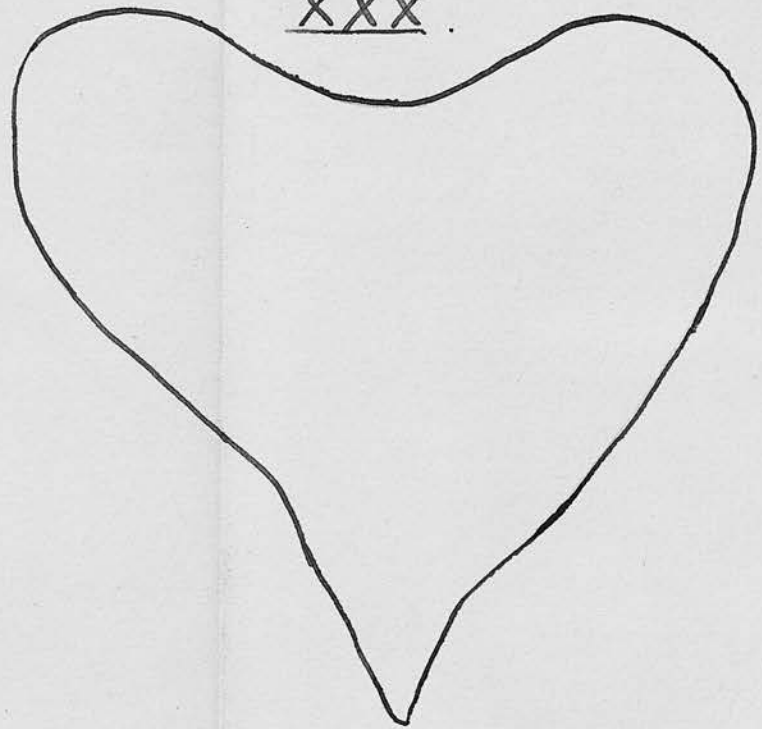
Anat: Mus:, Edin: University.

XXIX.



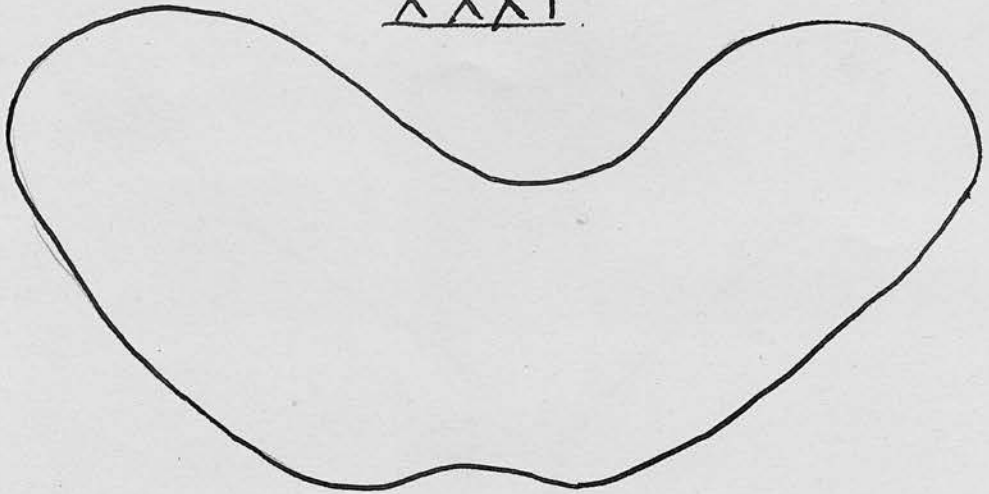
Anat: Mus:, Edin: University

XXX.



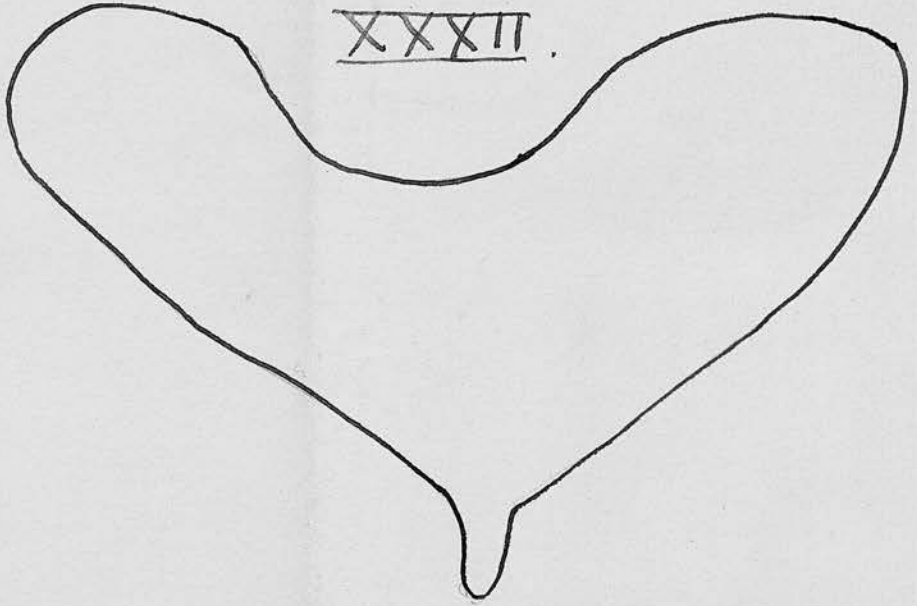
Anat: Mus:, Edin: University.
(Hamilton's Pract: Observations. Plate XVII.)

XXXI.



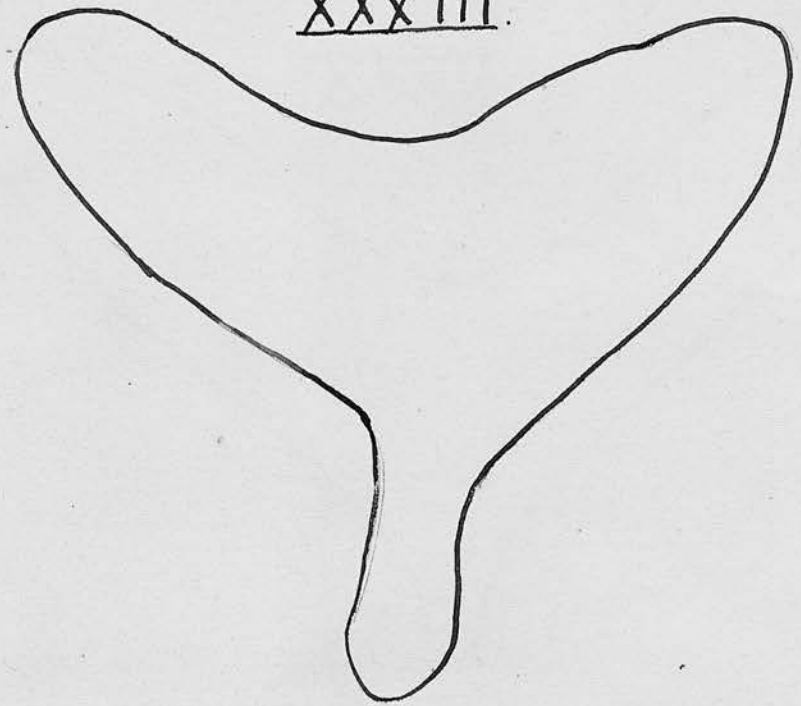
A.F.2. Anat: Mus:, Edin: University.)
(Male pelvis)

XXXII.



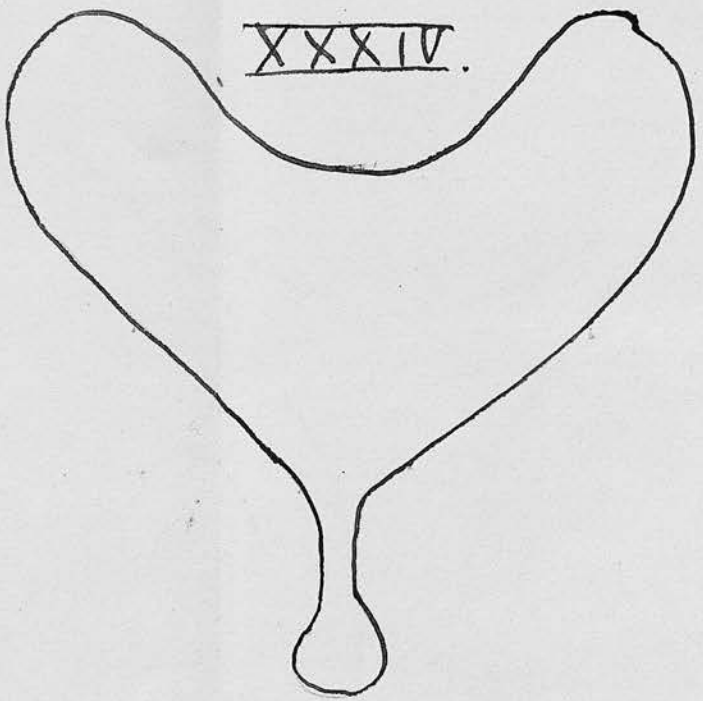
Cast. 229 g. Obst: Mus:, Royal Col: of Surgeons, Edinburgh.

XXXIII.



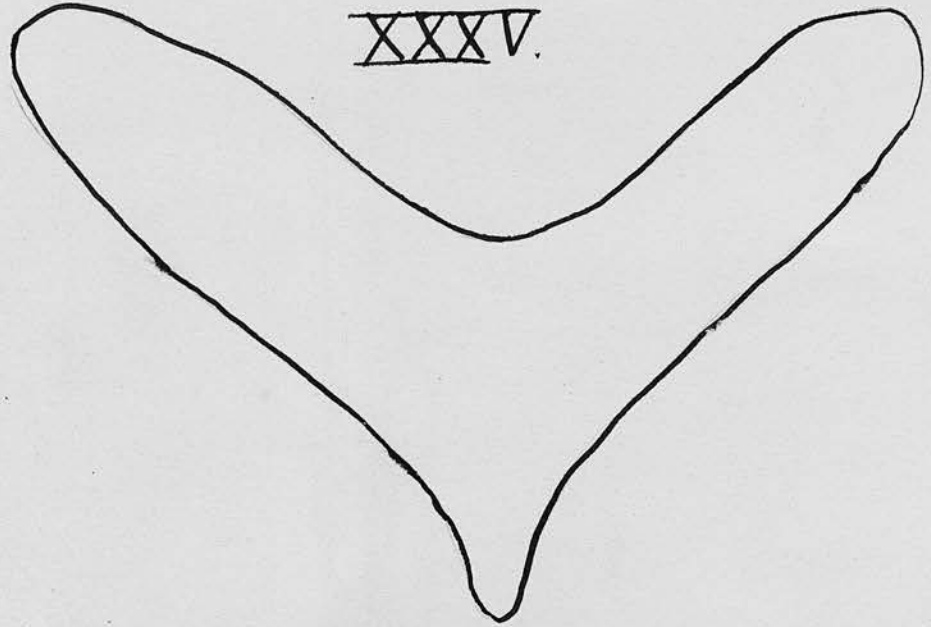
5-17. Anat: Mus:, Edin: University.

XXXIV.



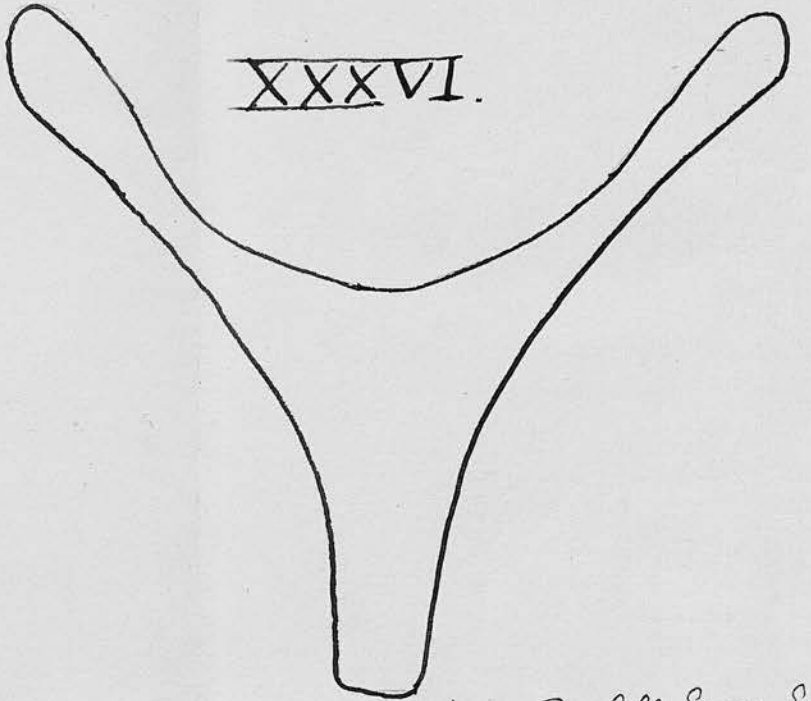
13. Anat: Mus:, Edin: University.

XXXV.

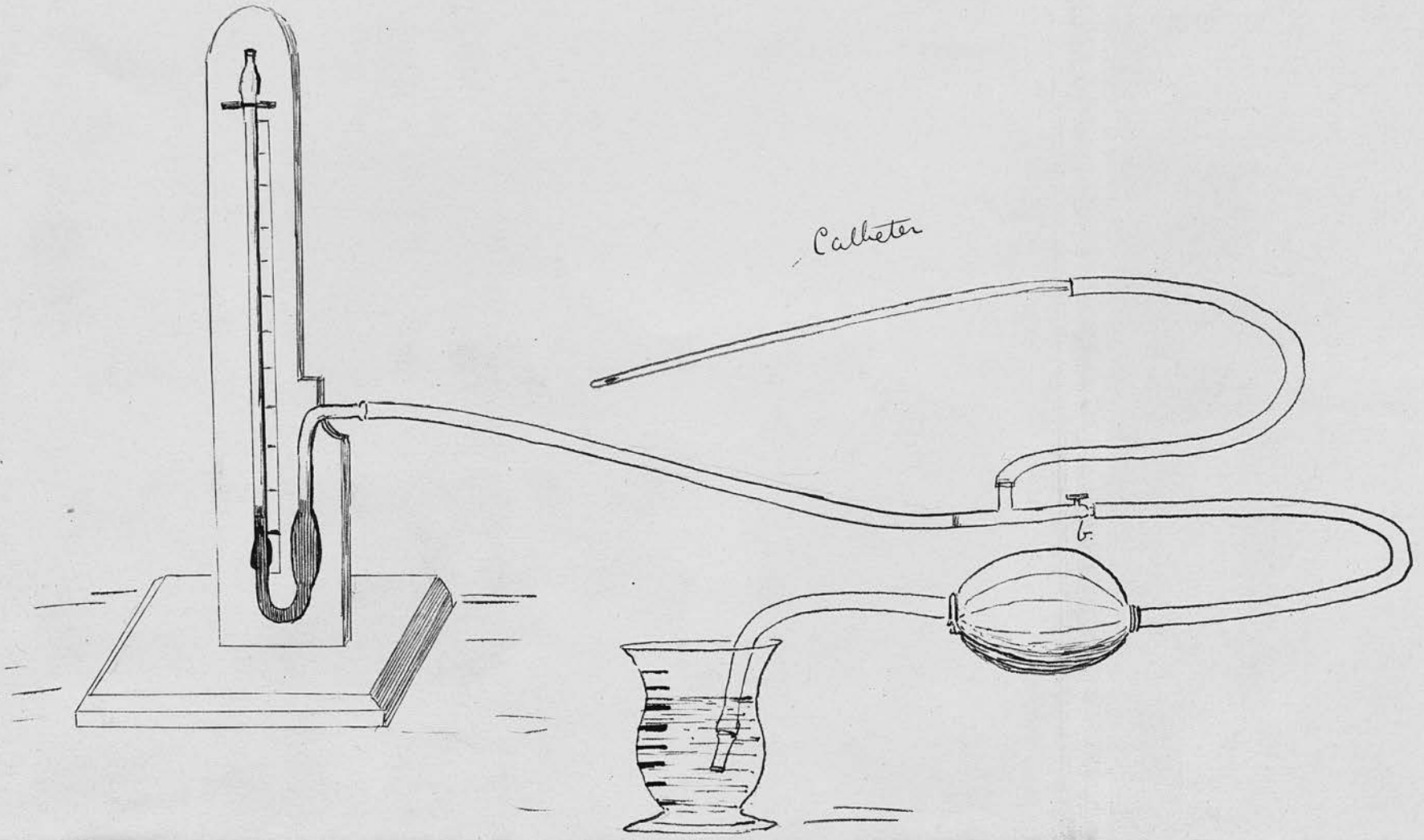


230 g. Obst: Mus:, Royal College of Surgeons, Edinburgh.
(Memoirs of the Med: Society of London. Vol. V)

XXXVI.



228. Cast. Obst: Mus:, Roy: Coll: Surg: Edinburgh.
(Actual specimen N. 583. XXXIII C.)


Catheter
b.

Prof Simpson

× × ×

# Contributions to the Mechanism and Dynamics of Parturition,

a graduation thesis

by Francis Inlach M.B. M.R.C.S.

late house-surgeon to the Lying-in Hospital, Liverpool

"Accurate and minute measurement seems to the non-scientific imagination a less lofty and dignified work than looking for something new. But nearly all the grandest discoveries of science have been but the rewards of accurate measurement and patient long-continued labour in the minute sifting of numerical results."

{ Address to the British Association at its meeting in Edinburgh, by its president Sir W. Thomson.

# Introduction.

Mechanism, according to its scientific definition, is concerned with the construction of a machine and the movement of its parts. Dynamics is concerned with the forces which cause the movements.

This thesis is in three parts, two on the mechanism, and one on the dynamics of birth.

The first part is a study of the mechanism of the birth of the head of the child.

The second part is an investigation into the area of the brim of the pelvis and of the chief cranial planes that engage in the brim.

The third part is an investigation into the power of labour.

No cases are cited in the first part, though it was chiefly composed while the writer was house-surgeon to the Lying-in Hospital Liverpool; and was, as far as possible, verified by observation of numerous cases.

For permission to measure the area of the brim of normal and abnormal pelves, the subject of the second part, the writer has chiefly to thank Professor Turner, Curator of the Anatomical Museum, Edinburgh, Professor Simpson, Curator of the Obstetrical Museum of the University of Edinburgh, and Dr. Bell Pettigrew, Curator of the Museum of the Royal College of Surgeons, Edinburgh.

With regard to the third part the writer is painfully aware of the insufficient number of cases he hopes, however, to be able shortly to pursue this subject further.

The developed female pelvis is a somewhat complex tunnel which may conveniently be considered as composed of two portions, one a nearly straight cylinder of oblique inferior section, the remainder greatly curved — the curve being variously described as circular, parabolic, and irregular.

The symphysis pubis, the anterior wall of the upper portion, measures 1·5 inches. The posterior wall is thus described by Kueneke :- "if we draw at the posterior wall of the pelvis from the promontory outwards a parallel to the direction of the driving power, it is found to coincide with the anterior surface of the two upper bones of the sacrum, passes diagonally through the third vertebra, and then runs behind the sacrum"(1). Its length is about 2·5 inches in a well-formed pelvis. The axis of this portion (neglecting the small angle of about 10° which the walls form with each other) is half their mean length, or 2 inches.

The subpubic ligament is taken by Dr. Hodge(2) as the centre of curvature of the remaining lower portion of the developed pelvis. This is certainly to some extent erroneous as the curvature is not uniform throughout & is probably nowhere circular, but he has shown that the error is less than that contained in Carus' description. The posterior wall measures about 7 inches (3 in. sacrum & coccyx, 4 in. perineum). And the axis measures half this, or 3·5 inches. The amount of longitudinal distension of the perineum in any labour determines the length of the axis.

This distension may be from 1 inch (where the perineum has been extensively lacerated) to 5 inches: hence a possible variation of 2 inches in the length of the axis. The amount of circular distension determines chiefly the position of this portion of the axis. The antero-posterior diameter may be from (say) 3·5 to 5·5 inches: hence a possible variation of 2 inches in the distance of the axis from the subpubic ligament. Assuming the antero-posterior diameter of this portion of the pelvis to be 4·5 inches (& the axis circular) the angle subtended at the sub-pubic ligament is almost exactly 90°.

The whole average length of the anterior wall, therefore, is 1·5 inches, that of the posterior wall 9·5, that of the axis 5·5; and the whole curvature about 186°. Dr. Matthews Duncan says (3) "the length of the axis "may be greatly diminished by rupture of the perineum, & still more if the sphincter ani is torn through. It forms a curve whose amount of bending varies from about 60° to 150°.

## Definitions

The terms point, axis, &c are used, as will be seen by the context, without implying ~~that~~ in the mean time that the position of any point or axis spoken of has been determined with any exactitude.

It is customary to name foetal planes (or imaginary sections through the head) after only one of their diameters, Eg. the suboccipito-bregmatic plane. In such cases the bi-parietal is the second diameter necessary for complete definition.

The head may be said to be at the brim

brim when the head has advanced to the entrance of the pelvis with the greatest area which it presents to it. (This definition is adapted from Naegelé's description of the passage of the brim, p. 19, Rigby's Transl.). ~ Professor Leishman[4] defines the head to be at the brim "when the long diameter occupies its plane". Dr. Hodge says[5] "the child's head may be regarded as having passed through a plane when its parietal protuberances have passed, as these are the most prominent points upon its lateral surfaces. The child's head may be said to be in a plane when these protuberances are opposed to any part of the circumference of such plane. It has not entered a plane when the parietal protuberances are still above its level, however much the head may project through the plane." Exception may be taken to these definitions in as much as the two protuberances may never be in one pelvic plane. However it may be stated generally that the head is in that part of the pelvis in which is the greatest foetal plane engaging its lumen.

## On the movement of the head during labour.

That portion of the mechanism of birth to which the term has until recently been restricted consists in the movement of the head (and other parts) in and through the pelvis. All such movements may be resolved into one or more of three.

1. Progress, or movement in the direction of the axis of pelvic axis.

The whole progress of the head during its parturition is, in ordinary, about equal to the length of the pelvic axis together with the length of the foetal vertical diameter:—

5·5" + 3·75" = 9·25" inches.

2. **Deviation**, or movement in the engaging pelvic plane.

It is evident that the possible deviation ~~in~~ in cases of large pelvis or small head will be greater than in those of small pelvis or large head. The following results are from well known average measurements.

Brim.

a Head engaged transversely in brim, not flexed.

Transverse of brim less occipito-frontal diameter gives possible transverse deviation:—

5·5" — 4·5" = 1 inch

Conjugate of brim less biparietal diameter gives possible antero-posterior deviation:—

4·5" — 3·5" = 1 inch

Or, in many cases:—

4·25" — 3·75" = ·5" inch.

b Flexed.

Transverse of brim less suboccipito-bregmatic diameter gives possible transverse deviation:—

5·5" — 3·75" = 1·75" inch.

The possible antero-posterior deviations is the same as ~~before~~ (a)

Cavity.

a. Head not flexed.

Diameter of cavity less occipito-frontal gives possible deviation in the direction of that foetal diameter:—

5" — 4·5" = ·5" inch.

In the direction of the biparietal diameter:—

5" — 3·5" = 1·5" inch

b Flexed.

Deviation

6. Flexed.

Possible deviation in all directions about

5" − 3.75" = 1.75" inch.

The curvature of the lower portion of the pelvis probably diminishes to some extent the amount here stated, and the bladder, rectum, and soft parts clothing the cavity will have a similar effect.

There is no deviation possible at the outlet.

These statements, however, concern possible rather than actually observed amounts. Sir James Y. Simpson,(6) Dr. Barnes(7), Spiegelberg(8) and others have carefully observed the transverse deviation at the brim with reference to the different cranial diameters which may pass or be made to pass the contracted conjugate. In the cavity of the pelvis there is generally posterior deviation, the head being pushed into the great antero-posterior concavity.

3. Revolving constitutes the third movement. All possible revolvings of the head may theoretically be resolved into equivalent revolving about any three mutually rectangular axes, passing as near as may be through the centre of the mass, together with some small amount of progress or deviation. There are, however, three reasons for not practically attempting such analysis.

1. For evident reasons the selection of mutually rectangular axes is limited to one of two sets:—

| @. | | (b | |
|---|---|---|---|
| Occipito-frontal, | Vertico-mental, | Occipito-frontal, | Vertico-mental, |
| Biparietal. | Bitemporal. | Suboccipito-bregmatic, | Bitemporal. |
| | | Biparietal. | |

But the position of these diameters has not been determined with such exactitude as to fulfil

the conditions required for numerical analysis.

2. Their position is altered by the cranial strains in labour to an unknown extent.

3. The variations (normal and abnormal) in the course of the head through the pelvis have not even yet been described so as to allow of any accurate analysis. Though so much has been written on the mechanism of labour discrepant opinions are still held by different authors. With the exception of Dr Leishman's observations on the head at the outlet, only the ordinary digital examination has been resorted. But to determine the course of the head in labour with any exactitude we require an instrument, self-recording continuously or at short intervals, giving the simultaneous position, relative to the pelvis, of three distant cranial points not in the same straight line. Until some such method has been adopted it does not appear probable that much more will be made out in this department.

Numerical analysis, then, being for the present impossible, some remarks may be made upon the mechanism of labour as ordinarily described.

## Naegele obliquity.

"At the entrance of the pelvis the head does not take a perpendicular but a perfectly oblique direction, so that the part which lies lowest, or deepest, is neither the vertex nor the sagittal suture, but the right parietal bone ..... The higher the head is .... the more oblique is its direction." (9) There is evidence (10) that this is an erroneous description of natural labour. Where it occurs with the head not flexed the occipito-frontal diameter is the axis of revolving. Where it occurs with persistent flexion of the head the axis lies somewhere between that diameter & the trachelo-bregmatic diameter, its exact position being determined by the amount of flexion.

## Flexion.

"The higher the head is the nearer its long diameter corresponds to the lateral diameter of the pelvis ..... As the head prefes lower into the entrance of the pelvis, the posterior fontanelle commonly descends more in proportion than the anterior one does ..... This revolving on its lateral axis takes place especially where the head, as it advances, experiences rather more than the usual degree of opposition &c." (11) Where however the Naegele obliquity is persistent the revolving is not about the cranial lateral axis, but about one between that and the trachelo-bregmatic diameter and coincident with the conjugate.

Spiegelberg has thus described

the passage of the brim contracted in the conjugate diameter.[12] "In simply flat pelvis the head enters with the anterior half of the vertex ... the anterior fontanelle lies a little nearer to the examining finger than the posterior; the coronal suture runs near and parallel to the conjugate diameter; the bitemporal diameter of the head lies in the conjugate itself; the biparietal to that side of the conjugate towhich the back of the head is directed. The sagittal suture runs in a transverse direction very near to the posterior wall, an exaggeration of Naegele's obliquity; the anterior fontanelle is found in the neighbourhood of the promontory on the side to which the forehead is directed. This is what I call Vorder-scheitel-Einstellung.

"In this position the head passes the brim in the following manner.

"1. The posterior parietal bone, which is situated above the promontory, is flattened and depressed against the latter by the powers of labour, and is thereby forced more and more down, the sagittal suture comes nearer the true transverse diameter; that is, to the anterior margin of the brim.

"2. The whole head descends, but not in the axis of the brim; the bitemporal diameter does not descend in the conjugate, and the biparietal on the side of it, but the head is pushed in an oblique direction towards that side where the forehead lies, so that the biparietal diameter while it only approaches the antero-posterior diameter, reaches a parallel plane below the brim. That the movement downwards is truly so described, is shown by the course of the depression caused by the promontory on the posterior parietal bone, running as it does from the parietal

protuberance towards the inferior anterior angle. During this movement the head becomes a little more flexed, the anterior fontanelle rises higher up, the occiput comes down, and now can easily be felt.

"The mechanism, therefore, is composed of two rotations of the head, the one on the occipito-frontal axis [the sagittal suture leaves the posterior border of the brim], the other upon the transverse axis [the occiput comes down]."

Though it is impossible for the bitemporal diameter to be in the conjugate with exaggerated Naegelé obliquity, and though some other statements are equally loose, as a whole the description is precise and may be accepted as true. But the analysis of the mechanism is imperfect. For, first, there is evidently progress and lateral deviations in addition to revolving. And, secondly, as the two revolvings do not succeed each other but, often at least, (the writer believes) occur simultaneously, the axis of this compound revolving ought to have been stated. This is easily found (roughly) to be an axis passing, when the occiput is to the left, through the left frontal eminence and a point midway between the two posterior angles of the right parietal bone, and when to the right, through similar points on opposite sides.

## Synclitism.

During the course of birth the same cranial plane, say the suboccipito-bregmatic, does or does not remain ~~parallel with~~ in succession engaging pelvic planes according as it does

or does not revolve about an (pelvic) ~~antero-posterior~~ transverse axis to an amount equal at any instant to the angle the brim and engaging plane make with each other. In other words, for continued parallelism there must be revolving about a (pelvic) transverse axis relative to the brim, but none relative to successive engaging planes. Revolving about an axis perpendicular to the engaging plane would not, as such, interfere with this parallelism. Revolving about a (pelvic) antero-posterior axis would still, as such, admit of antero-posterior parallelism. The term <u>synclitism</u> has been introduced by Kruneke to express a different parallelism supposed by him to occur, but the existence of which has been disputed. "According to Kruneke's view, the presenting point is always in the mesial line, always in the sagittal suture, and must be so." (13)

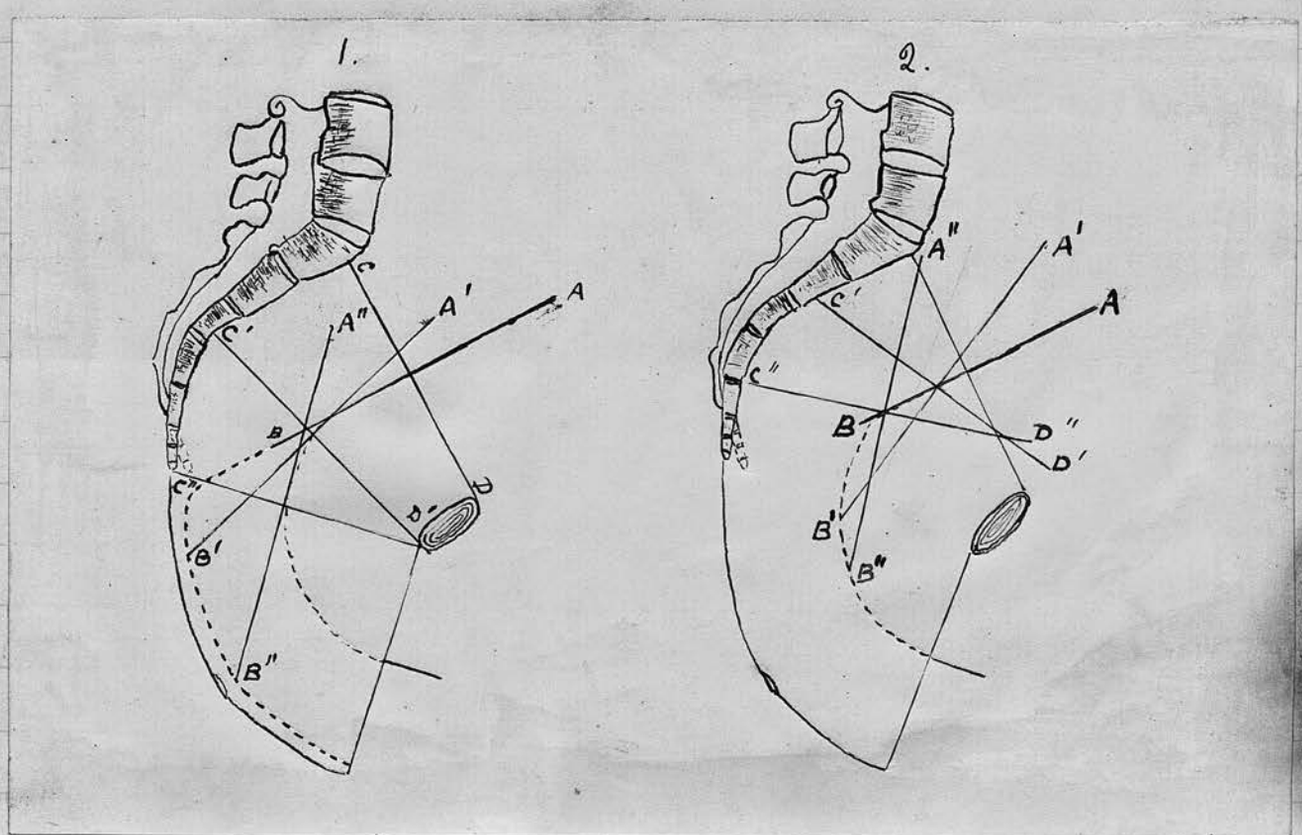



Diagram 1 represents continued coincidence of the engaging cranial & pelvic planes. CD, C'D', and C''D' are successive positions of one cranial plane.

AB, A'B' and A"B" successive positions of the cranial diameter at right angles to it. The dotted line, continuing AB, represents successive positions of the point B. If the course of the head is as here represented it is evident that (neglecting transverse deviation) the original presenting point persists so long as it is in the straight portion of the pelvis, but when it passes into the curved portion the presenting point continually changes, until the engaged cranial plane enters the curved portion, after which there is a new persistent presenting point.

Diagram 2. represents the original presenting point persistent in the curved portion of the pelvis which is apparently what (neglecting transverse deviation) Kuenele's view amounts to. As in the preceding diagram, CD, C'D' and C"D" are successive positions of one cranial plane, AB, A'B' & A"B" successive positions of the perpendicular diameter. Evidently if this represents the true course of the head it is impossible for the same cranial plane to engage in successive pelvic planes.

The observations of Naegelé on obliquity of the head, as explained by Dr. Dumeau, Leishman, & others, appear to be in accordance or at least not inconsistent with the former representations, as the following quotation shows. "In the first half of the head's course through the ligamentous pelvis, a point in or near the sagittal suture is the presenting point .... As it advances, it passes the first bone of the sacrum, the sagittal suture approaches nearer to the sacrum, or rather to its lower portions, and becomes more distant from the symphysis pubis.... The vertex impinges on the posterior wall of the pelvis... ... While advancing at this point of its progress, the presenting part, therefore, is changed. It soon

becomes the upper and ~~right~~ posterior part of the right parietal bone, instead of, as before, a point in the mesial line of the head." (14)

To call this mode of advance oblique, as Dr. Duncan does, is misleading; it should rather be termed the direct mode.

Evidently the head cannot advance in both modes at once, though it may in a one between the two. Yet Dr. Hodge expressly asserts (15) that in his judgment the cervico-bregmatic plane "presents parallel to all the planes of the pelvis and vagina, from the superior strait or brim, until the delivery at the vulva. The axis of this cervico-bregmatic plane is the occipito-mental diameter of the head, which diameter, therefore, is coincident with the axis of the brim, until the top of the head reaches the floor of the pelvis, and then with the axis of each of the successive oblique planes of the lower part of the pelvis and of the distended vaginal canal to its extreme orifice." The exact meaning of the second quoted sentence is rendered certain by the following paragraph (16)

"I cannot help, therefore, agreeing with Kneneke, that this portion of the child's head or vertex, presents towards the centre of the canal from the beginning to the end of descent, and of course, differ from Dr. Duncan and most others, in transferring this portion from the line of the sagittal suture to the anterior parietal bone."

But this is descriptive of an impossible case. If the cervico-bregmatic plane is parallel to an oblique pelvic plane, the occipito-mental [parieto-mental?] diameter must be tangent at

or near its centre to the pelvic axis. But a tangent five inches long cannot be taken as "coincident" with the circumference of a circle with a diameter only equal to the antero-posterior diameter of the pelvis. Its extremity would be about an inch behind the presenting point, — that distance further from the subpubic ligament.

## Rotation.

Sometime during the course of labour, usually when the head presses against the floor of the pelvis rotation of the head occurs. — "The posterior fontanelle at last gradually moves itself by slight degrees, repeated at equal intervals, in a direction from left to right (frequently more or less from above downwards) and the occipital bone advances from the side of the pelvis under the arch of the pubis. It is not, however, the centre of the occiput that advances under the pubal arch, but the head approaches the os externum with the posterior and superior part of the right parietal bone, and remains in this position until it has passed through the outlet of the pelvis..." (17)

Lateral obliquity at the outlet is recognised by almost all authors, and its amount has been determined with some accuracy by Dr. Leishman (18) "The direction of the sagittal suture I have found to be at this time from the left descending ramus of the pubes to the right sacro-sciatic ligament, somewhat nearer its sacral than its ischiatic extremity." It is easily accounted for. The presenting point (or

part) according to Naegelé is persistent, that is to say, the axis of rotation passes through it. But, adopting the view that this is the new persistent presenting point formerly described, it is evident that the axis is not perpendicular to the cranial plane engaged in the pelvis. Hence that plane does not revolve in the pelvic plane, but assumes an oblique position.

In some instances, however, there is little or no obliquity at the outlet, and the sagittal suture (in accordance with the descriptions of the older authors) nearly corresponds with the antero-posterior diameter of the outlet. In such cases, at least in some of them, the presenting point is not persistent. A line passing through the left infra-maxillary articulation and through the right parietal bone at a point one-third of the distance of its protuberance from the sagittal suture midway between the two fontanelles will be found to very nearly represent the axis of rotation when the head is well-flexed and in the first position. A line passing through the root of the left pterygoid process and through a point in the right parietal bone two-thirds of the distance of its protuberance from the sagittal suture midway between the two fontanelles very nearly represents the axis of ~~rotation~~ rotation when the head is in the fourth position. The axes for the second and third positions, of course, pass through corresponding points on opposite sides.

Revolving about one or other of these axes (together with some propreps) is a complete

description of the phenomena of rotation in these cases. The approximate ascertainment of the axes is, of course, only possible with the dried skull and pelvis. Such study, however, is sufficient to show that the coincidence of the sagittal suture with the antero-posterior diameter of the outlet is to be regarded as an abnormity rather than as the proper completion of rotation.

# On the area of the plane of the brim in the normal female pelvis and in various abnormal female pelves.

The size and shape of the plane of the pelvic brim are distinct subjects of inquiry, though the extent of its area has some inverse relation to the irregularity of its distributions. Hitherto the attention of obstetricians has been entirely confined to its distribution and, more especially, to projecting parts in, above and below the plane. Innumerable diameters have been measured, and outline diagrams made, of the brim of all sorts of pelves; and the normal and abnormal distributions of the plane of the brim have thereby been accurately mapped out for comparison. But, so far as the writer is aware, no estimate of the extent of area has been attempted in any case. Yet, if an engineer were considering the problem of a relatively large body having to be pushed through a cylinder by a force often only sufficient to overcome the resistance when exerted during a considerable portion of a limited time, and in some cases (of itself) quite insufficient, and if, moreover, that force were, in part at least, hydrostatic; varying, therefore, to that extent with the area, — no degree of regularity or irregularity in the form of the cylinder would render it less important for him to investigate the area of its lumen.

The following observations are based on an examination of thirty-five female pelves and one (extremely rickety) male pelvis.

It is necessary to define at the outset what is meant by the "plane of the brim." Even in a normal pelvis the circumference of the brim is not exactly in a plane, the so-called plane being in reality a curved surface.(1) The curvature, however, is so small that it may be disregarded. But in (for example) a marked case of malacosteon the brim is often greatly contorted and its surface no longer nearly plane but greatly curved. When the "area of the brim" is given in such cases this curved surface is not meant, but a plane surface — the first plane surface in the lumen of the pelvis that is completely surrounded by a ring of bone. And the circumference, therefore, is not that of the anatomical brim, but of the ring of bone.

The brim of the average normal female pelvis has a definite circumference and area.

In abnormal pelves

1. The circumference remaining the same as in the normal pelvis, the area may be increased or diminished.
2. The circumference being greater or less than the normal, the area may be proportionately increased or diminished;
3 Or, the area may remain of normal extent, or be disproportionately altered.

These abnormities result from

1. Overgrowth, under-growth, or shrinking of the pelvic brim, or a part of it.
2. Strains,(19) (a) in the plane of the brim, and (b) perpendicular to it. The following are the chief varieties of strain.

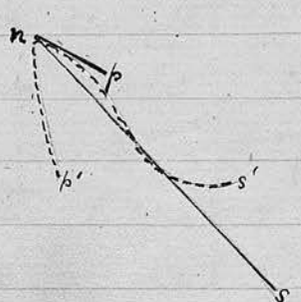
A nearer approach to the circular form. With equal circumference the area is increased.

Change from the (roughly approximative)

circular form to the (roughly approximative) elliptical form, the major axis being transverse. The "simply flat" pelvis is an example. With equal circumferences the area is diminished.

Sinuous curvation of the circumference of the brim in its own plane. Three great incurvations one posteriorly, two antero-laterally, occur in malacosteon pelvis. Two great incurvations, one posteriorly, one anteriorly, occur in a form of rickety pelvis — the figure-of-eight form. One great incurvation posteriorly in another form of rickety pelvis — the reniform pelvis. With equal circumference the area is greatly diminished.

Diag. 3.




Sinuous curvation vertical to the original plane of the brim. Diagram 3 is a projection of the outline of one-half of the brim on the vertical antero-posterior plane passing through the conjugate. ps is the conjugate diameter, and pns the projected outline of the brim in a normal pelvis. p's' and p'n's' corresponding parts in a malacosteon pelvis.

This deformation does not alter the circumference of the anatomical brim. But it diminishes the circumference of the first plane occupying the pelvic lumen, and gives it a more elliptical form by diminishing the antero-posterior diameter while the transverse diameter remains unchanged. Hence the area is more than proportionately diminished.

In order to measure the circumference and area thick drawing paper was cut to such shape and size that the piece accurately fitted into and fully occupied the plane of the brim as above defined. A thread was ~~[illegible]~~ traced round the edge of the paper, and its length measured. The paper was then weighed, and (the weight of a square inch having

been previously determined) the area was easily calculated. Slight error in cutting out the pattern of the brim was inevitable. The calculations presently to be mentioned do not make the error greatly cumulative; hence the results may be termed rough rather than erroneous.

The results are given in Table I. The first column gives the reference number of the pelvis. The second column gives a general description of the pelvis. The third, fourth & fifth columns give respectively the conjugate, transverse and oblique diameters. Here it may be observed that the conjugate diameter is not the same as the antero-posterior diameter of the plane of the brim; for the promontory is generally above that plane. The sixth and seventh columns give respectively the circumference and area. The eighth column gives the area which a normally shaped pelvis with the same circumference as the deformed one would have. This is obtained by the formula

$$a\left(\frac{c'}{c}\right)^2 = x$$

where a is the area and c the circumference of the brim of the normal pelvis, and c' the circumference of the brim of the other. The mean area and circumference of pelves IV & V gave the values of a and c. The loss from deformity is thus readily estimated.

Accompanying this thesis is a sketch book containing exact outline copies of the patterns of all the pelves examined.

# Table I.

| No. of pelvis | Description of pelvis | Conjugate diam. in inches | Transverse diam. in inches | Oblique diameters in in. | Circumference in inches | Area in square inches | Area of brim of Standard Forder, with Sums Circum. |
|---|---|---|---|---|---|---|---|
| I | Large normal | 4·6 | 5·5 | 5·25 | 16·4375 | 21·01 | 20·37 |
| II | Normal | 4·5 | 5·5 | 5·25 | 16·125 | 20·13 | 19·6 |
| III | Oval | 3·625 | 5·875 | 5·25 | 16·25 | 19·46 | 19·93 |
| IV | Normal | 4·0 | 5·5 | 5·25 | 16·0 | 19·24 | 19·31 |
| V | Normal | 4·1875 | 5·0 | 4·625 | 15·25 | 17·69 | 17·54 |
| VI | Rickety | 3·375 | 6·0 | right 4·875 – left 5·125 | 16·5 | 17·53 | 20·54 |
| VII | " | 4·5 | 4·5 | 5·0 – 4·5 | 15·0 | 15·48 | 16·97 |
| VIII | Ag. justo minor | 3·5 | 5·0 | 4·5 | 14·375 | 15·26 | 15·58 |
| IX | Rickety | 3·125 | 5·25 | 4·75 – 5·0 | 15·125 | 15·26 | 17·25 |
| X | " | 3·25 | 5·25 | 4·75 | 14·25 | 14·82 | 15·32 |
| XI | " | 3·5 | 5·125 | 5·0 | 14·875 | 14·82 | 16·66 |
| XII | " | 3·0 | 4·75 | 4·5 | 15·0 | 13·93 | 16·97 |
| XIII | Oblique | 4·0 | 4·0 | 4·25 – 4·75 | 13·75 | 13·9 | 14·26 |
| XIV | Rickety | 2·875 | 5·0 | 4·625 – 5·0 | 14·875 | 13·71 | 16·66 |
| XV | Ag: justo minor | 3·75 | 4·25 | 4·25 | 13·125 | 13·49 | 12·99 |
| XVI | Rickety | 3·0 | 4·875 | 4·625 | 14·5 | 13·46 | 15·86 |
| XVII | Ag: justo minor | 3·75 | 4·25 | 4·5 – 4·0 | 13·37 | 13·14 | 13·48 |
| XVIII | Rickety | 3·25 | 4·75 | 4·5 | 13·75 | 13·13 | 14·26 |
| XIX | " | 2·0 | 5·5 | 4·75 | 14·12 | 11·81 | 15·04 |
| XX | " | 2·875 | 4·75 | 4·125 – 4·0 | 13·25 | 11·37 | 13·24 |
| XXI | " | 2·875 | 4·5 | 5·0 – 4·25 | 14·0 | 11·28 | 14·78 |
| XXII | Malacosteon | 3·125 | 3·625 | 4·3 – 4·37 | 15·0 | 11·28 | 16·97 |
| XXIII | " | 3·5 | 4·875 | 3·8 – 4·5 | 15·0 | 11·0 | 16·97 |
| XXIV | " | 3·75 | 4 3 | 3·8 – 3·6 | 15·125 | 10·47 | 17·25 |
| XXV | " | 3·6 | 4·0 | 4·25 – 4·0 | 16·0 | 10·27 | 19·31 |
| XXVI | " | 3·375 | 3·75 | 3·9 – 3·4 | 13·375 | 9·81 | 13·48 |
| XXVII | P. of Robert | 3·5 | 3·0 | 3·875 | 12·125 | 9·73 | 11·08 |
| XXVIII | Malacosteon | 3·375 | 3·75 | 3·875 | 14·87 | 9·37 | 16·67 |
| XXIX | " | 3·375 | 4·5 | 3·75 – 3·5 | 14·0 | 9·05 | 14·78 |
| XXX | " | 2·0 | 3·0 | 3·75 – 3·0 | 12·375 | 8·4 | 11·55 |
| XXXI | Malerickety | 1·5 | 4·125 | 3·875 – 4·375 | 13·125 | 8·0 | 12·99 |
| XXXII | Malacosteon | 2·25 | 3·25 | 3·5 | 13·25 | 7·41 | 13·24 |
| XXXIII | " | 2·875 | 3·875 | 3·5 – 3·0 | 13·25 | 6·54 | 13·24 |
| XXXIV | " | 2·7 | 3·6 | 2·8 | 12·875 | 5·31 | 12·5 |
| XXXV | " | 3·0 | | 3·5 – 3·25 | 13·625 | 5·67 | 14·0 |
| XXXVI | " | 2·0 | | 3·5 | 14·125 | 3·045 | 15·05 |

Examination of this table brings out important results.

Pelves IV and V are taken as most nearly approaching the standard form and diameters.

## Table II.

| No. of pelvis | Circumference in inches. | Actual area in sq. inches | Area of circle with same circumf. | Difference in area |
|---|---|---|---|---|
| IV. | 16 | 19·24 | 20·38 | 1·14 |
| V. | 15·25 | 17·69 | 18·52 | ·83 |

From this table it is evident that the improved normal form of the brim of the pelvis involves a loss of about one inch in the area of its plane.

Pelves I and II are unusually large, with brims more nearly circular than normal.

## Table III.

| No. of pelvis | Circumference in inches | Actual area in sq. inches | Area of standard form, and with same circumference | Difference in sq. inches |
|---|---|---|---|---|
| I. | 16·4375 | 21·01 | 20·37 | ·64 |
| II. | 16·125 | 20·03 | 19·6 | ·43 |

From which two examples it is evident that in some pelves the outline of the brim is such as to increase the area of its plane by about half an inch ~~be~~above the normal.

Pelves VIII, XV and XVII are approximately equabiliter juxta minor. But the brim of XV is more nearly circular than the normal, and XVII has a slight obliquity.

# Table IV.

| No. of pelvis | Circumference | Actual Area | Area of standard form, with same circumference | Difference |
|---|---|---|---|---|
| VIII | 14·375 | 15·48 | 15·58 | ·1 |
| XV | 13·125 | 13·53 | 12·99 | (—)·54 |
| XVII | 13·375 | 13·14 | 13·48 | ·34 |

No. III is a "simply flat" pelvis, and X, XVI and XVIII "generally contracted flat" pelves. (')

# Table V.

| No. of pelvis | Circumference | Actual Area | Area of standard form, with same circumference | Difference | Ant.-post. diameter of plane |
|---|---|---|---|---|---|
| III | 16·25 | 19·46 | 19·93 | ·47 | 3·56 |
| X | 14·25 | 14·82 | 15·32 | ·5 | 3·56 |
| XVI | 14·5 | 13·46 | 15·86 | 2·4 | 3·125 |
| XVIII | 13·75 | 13·13 | 14·26 | 1·13 | 3·375 |

Such pelvis deformity is so frequent, and consequently so important, that it may prove useful to put these few data in another way. It may be asked — if four women had pelves of a given size, and the brims of these pelves became (from any cause) so distorted that in form they exactly resembled the brims of III, X, XVI & XVIII respectively, — what would be the areas of their planes?

Let the common circumference be 16 inches in order that the areas may be compared with that area of the brim of the normal pelvis IV. The problem is readily solved by the formula

$$a\left(\frac{16}{c}\right)^2 = x$$

Where a is the area, and c the circumference, of the bri

of the deformed pelvis. The following table gives the result together with the calculated antero-posterior diameters.

## Table VI.

| No. of pelvis. | Circumference | Area. | Ant: post: diam: of plane. |
|---|---|---|---|
| IV. | 16 | 19·24 | 4·25 |
| (III) | " | 18·86 | 3·5 |
| (X) | " | 18·71 | 3·9 |
| (XVI) | " | 17·61 | 3·4 |
| (XVIII) | " | 17·88 | 3·9 |

The greatest loss, therefore, would be 1·63 sq. in. in pelvis (XVI).

Pelves XI, XII and XX are rickety. Their right and left halves are approximately symmetrical, and their conjugate diameter is contracted.

## Table VII.

| No. of pelvis | Circumference in inches | Actual Area in sq. inches | Area of standard form, with same circumference | Difference in sq. inches | Ant: post: diameter of plane |
|---|---|---|---|---|---|
| XI | 14·875 | 14·82 | 16·66 | 1·84 | 3·25 |
| XII | 15·0 | 13·93 | 16·97 | 3·04 | 3·25 |
| XX | 13·25 | 11·37 | 13·24 | 1·87 | 2·875 |

Calculating, by the preceding formula, the areas of similar pelves with 16 inches as the common circumference of brim, we get the following result.

# Table VIII.

| No. of pelvis | Circumference | Area | Ant: post: diam. of plane |
|---|---|---|---|
| IV | 16 | 19·24 | 4·25 |
| | " | | |
| (XI) | " | 17·04 | 3·5 |
| (XII) | " | 15·88 | 3·47 |
| (XX) | " | 16·48 | 3·47 |

The greatest loss, therefore, would be 3·36 in pelvis (XII). Comparing tables VII & VIII it is evide that, circumference and antero-posterior diameter bei equal, a simply flat pelvis has a greater area of brim than a reniform rickety pelvis. The mean a of (III) and (XVI) is 18·23 sq. in.; that of (XI), (XII) & (XX) 16·46 sq. in. and the difference, 1·77 sq. in.

Pelvis VII is triangular, and XXII cordiform. Both have a circumference of 15 inches, the effect of incurvation of the sacrum is at once seen by place them together for contrast.

# Table IX.

| No. of pelvis | Circumference | Area | Ant: post: diam. of plane |
|---|---|---|---|
| VII. | 15 | 15·48 | 4·5 |
| XXII. | 15 | 11·28 | 3·1 |

The effect of rickets and malacostéon is shown in the parallel series in Table X. The pelve of Tables V & VII are included under the head of "rickety pelves." The second column in each series gives the actu area. The third gives the loss relative to an assumed standard area, the mean of the areas of pelves IV & V, of 18·47 square inches. The fourth gives the loss from deformations of its circumference from the normal. This column, accordingly, represents the loss from strain in the plane of the brim.

The writer has not been able to discover any

simple law for the rate of diminution of area in either ser
The numerous irregularities of form make this difficult o
impossible.

## Table X.

Rickety pelves. Malacosteon pelves.

| No. of pelis | Actual area. | Loss on average area | Loss from deformity of circumference | No. of pelis | Actual area. | Loss on average area | Loss from deformity of circumference |
|---|---|---|---|---|---|---|---|
| III | 19·46 | (−) 1·1 | ·4 | XXII | 11·28 | 7·2 | 5·8 |
| VI | 17·52 | ·9 | 3·0 | XXIII | 11·02 | 7·4 | 5·9 |
| VII | 15·48 | 3·0 | 1·5 | XXIV | 10·47 | 8·0 | 6·6 |
| IX | 15·26 | 3·2 | 2·0 | XXV | 10·27 | 8·2 | 9·0 |
| X | 14·82 | 3·6 | ·5 | XXVI | 9·81 | 8·6 | 3·6 |
| XI | 14·82 | 3·6 | 1·8 | XXVIII | 9·37 | 9·1 | 7·3 |
| XII | 13·93 | 4·5 | 3·0 | XXIX | 8·48 | 10·0 | 6·3 |
| XIV | 13·71 | 4·7 | 2·9 | XXX | 8·40 | 10·0 | 3·1 |
| XVI | 13·46 | 5·0 | 2·4 | XXXII | 7·41 | 11·0 | 5·8 |
| XVIII | 13·14 | 5·3 | 1·1 | XXXIII | 6·54 | 11·9 | 7·7 |
| XIX | 11·72 | 6·7 | 3·3 | XXXIV | 5·86 | 13·18 | 7·2 |
| XX | 11·28 | 7·2 | 1·9 | XXXV | 5·66 | 12·8 | 8·3 |
| XXI | 11·28 | 7·2 | 3·5 | XXXVI | 3·05 | 15·4 | 12·0 |
| XXXII | 8·0 | 10·4 | 5·0 | | | | |

Finally, the great diminution of area in XX
the pelvis of Robert, and the small diminution (from the
more uniform curvature of the normal or secondarily affected
side) in XXII, a pelvis with the Naegelé obliquity.

# On the area of certain cranial planes in the foetus.

The principal areas of the body to be passed through the pelvis, their diminution and redistribution under pressure, are worthy of minute investigation. A determination of the areas presented to the pelvis in spontaneous evolution, head-locking, hydrocephalus, &c., and after such operations as cephalotripsy & craniotomy, would certainly assist the advance of the science of operative midwifery. Partly, however, for the sake of simplicity, and partly from want of material, the writer has only attempted to determine the area of three chief planes of the head.

Six living children, born at full term, were subjected to measurement. A piece of lead wire of sufficient thickness to retain any imposed form was moulded accurately over the head, and the pattern thus obtained was traced out on thick drawing paper, cut out and weighed. It may be mentioned that in every case the head presented in labour. Table XI gives the results.

## Table XI.

| | 1. Boy 10 hrs. after birth | 2. Girl 17 hrs. after birth | 3. Boy 1 hr. 20 m. after birth | 4.* Boy 8 hrs. after birth | 5. Girl 3 h. 30 m. after birth | 6. Boy 1 hr. after birth | Mean area of planes |
|---|---|---|---|---|---|---|---|
| | inches | inches | inches | inches | inches | inches | |
| Biparietal diameter | 3.75 | 3.69 | 3.5 | 3.375 | 3.625 | 3.75 | |
| Suboccipito-bregmatic " | 4.0 | 4.0 | 3.875 | 4.25 | 4.0 | 3.75 | |
| Occipito-frontal " | 5.0 | 4.5 | 4.75 | 4.75 | 4.375 | .. | |
| Parieto-mental " | 5.25 | 5.5 | 5.12 | 5.0 | 5.375 | 5.625 | |
| | Sq. inches | Sq. inches | Sq. inches | Sq. inches | Sq. inches | | |
| Suboccipito-bregmatic plane | 14.07 | 11.4 | 12.145 | 11.8 | 11.445 | 11.28 | 12.01 |
| Occipito-frontal " | 16.65 | 14.6 | 13.88 | 13.9 | 13.18 | " | 14.44 |
| Parieto-mental " | 17.87 | 16.8 | 15.6 | 14.9 | 15.61 | 15.04 | 15.97 |

* The child of a lunatic.

Hence, the head being of normal size and the vertex presenting, the greatest cranial plane engaged in the pelvis measures twelve square inches when the head is greatly flexed, and fourteen and a half when not at all or only slightly flexed. When the brow presents the cranial plane measures sixteen square inches.

For just comparison of these areas with the area of the brim of a pelvis it is necessary to abstract from the latter the area of the soft parts clothing the brim (peritoneum + subperitoneal cellular tissue), of the rectum, and of the uterus or vagina where they pass through the plane. An exact estimate is impossible. The following, however, is a rough approximate.

Taking the peritoneal and subperitoneal tissue as one-eighth of an inch thick, and the circumference of the brim as sixteen inches long, then the area of the cross section of these parts equals 2 square inches.

Taking the uterine muscle as of the same thickness, and its circumference as fourteen inches, then the area of cross section equals 1.75 square inch.

The area of cross section of the rectum is about .5 square inch.

Hence the whole area to be deducted from that of the brim is 4.25 square inches. In order, however, to be within the mark we may allow that pressure may diminish this by 1.25 sq. in. The area, therefore, to be deducted equals 3 square inches.

From consideration of areas only it is evident, then, that a head of normal size, with the vertex presenting, would pass through pelves I. to VI. inclusive, and might pass, if well flexed, through pelves VII. to IX. But before it could pass through any of the other pelves it would be necessary to reduce its dimensions by cephalotripsy or other operative procedure.

In the above statement it is assumed

that the whole of the area of the plane of the brim in pelves VII and IX might be occupied by the cranial plane engaged in it. A distinction, however, must certainly be drawn between the actual area and the available area, — available either for occupation by a child that may be alive or by a child that must be dead. The area available to a dead child is probably in nearly all cases coextensive with the actual area. But that available to a living child must often be much less extensive. Into this subject, however, the writer does not propose to enter further.

The area of cross section of the forearm of an infant is about an inch and a quarter, and that of the arm and leg about an inch and a half. Hence if the two arms descend with the head the foetal plane engaged in the pelvis is increased by from two and a half to three inches.

It is evident that a part of the pelvic area that is not available to the head may yet be available to an arm, a leg, or the umbilical cord.

# Contributions to the dynamics of pregnancy and labour.

Direct measurement of the power of labour was first definitely proposed and a method suggested by Dr. Duncan in 1867. Since then Schatz has published an elaborate series of investigations on this subject. It is not, however, proposed to give an abstract of his researches, nor to treat the subject generally, but only to state shortly the result of some observations made chiefly during the years 1872 & 1873, before the writer had opportunity of perusing Schatz papers.

## 1. On the intra-uterine pressure during pregnancy.

Two cases have here to be narrated. In neither was chloroform given.

It is interesting to compare the following formula from Schatz with the first case, which in part at least bears it out.[20]

"After the uterine pressure of the interval between the pains has been extensively increased by ~~the pains~~ sudden increase of its contents, after a time the pressure falls back to about its former height, without the uterine contents having been diminished ~~by~~ to its former amount."

Again, Dr. Worm Müller has recently shown[21] that the vascular system also possesses a power of accommodation. He found that on the abstraction of a certain limited amount of blood from a mammal there was only temporary diminution of the blood-pressure, in a short time it returned to its normal height although the circulating fluid remained decreased in amount. Conversely on

injecting fluid into the veins, the increase of pressure consequent on the increased amount of blood in the vessels was only temporary, the pressure soon resuming its normal height; although the circulating fluid remained increased in amount.

Case 1. E.E. æt: 19, admitted into hospital 18 Aug.t 1873. Had been confined of her first child on 10 Aug.t 1872 in hospital, cephalotripsy being resorted to, owing to contraction of the conjugate diameter which was stated in the books to be "exactly three inches" in length. Last menstruation 5th Feby 1873. She was found to be at about the end of the seventh month of pregnancy, and induction of labour was advised and consented to. In order to induce labour the surgeon in charge determined that a large quantity of water should be injected into the uterus. The writer, therefore, asked and obtained permission to connect a mercurial gauge with the apparatus for injection and note the results [See sketch at end of diagrams of pelves.

19th inst. Great care was taken that the apparatus was completely filled with water. The woman lay on her left side, and the mercury in the gauge was eight inches below the level of the horizontally placed catheter, which was paped outside the membranes three or four inches into the uterus. The cervix was closed by the surgeon's fingers. Assuming that the point of the catheter was in a straight line with the portion external to the os, the following noted pressures (from which 6 inches

mercury have been deducted in order to allow for the weight of water from the catheter to the gauge) are the mean intra-uterine pressures, the woman lying on her side.

From 4.10" to 4.20" p.m. 4 oz warm water were slowly injected through the catheter into the uterus. During each injection with the syringe the pressure was about 12 inches mercury (about 6 lbs). After each injection the tap b was turned. The pressure given is that noted after a short interval of time.

At first only a drachm or so of water was injected; pressure about .4 in. (3 oz.) After the first syringe full had been injected the pressure was .9 in. (7 oz. circ.). During the injection of the remainder of the 4 oz, the pressure rose gradually until after the whole was injected it had reached 1.4 in. (11 oz. circ). The finger of the operator was now withdrawn from the cervix, and that of the writer (then housesurgeon) was inserted in its place. Only a small quantity of water escaped, and some more was added to replace it. The manometer was now raised as nearly as possible level with the os uteri. Pressure, after a short interval, 1 in. (8 oz). During this time the patient occasionally coughed. Each cough raised the pressure to nearly 4 in. mercury (2 lbs) At 6.10 p.m. one cough raised the pressure to 6.5 in. After this the water gradually escaped from the uterus. The membranes were found to be entire. The feet presented.

20th inst. 10 a.m. Membranes entire; os nearly fully dilated; thorax presented. The surgeon in attendance accordingly turned and delivered a living child of about the seventh month of pregnancy. The woman did well so far as the labour was concerned, but died of Septicaemia in a somewhat unhealthy hospital.

From this case it appears that the intra-uterine pressure during pregnancy is only about 3 ounces on the square inch, that immediately after the injection of a quart of water the pressure is increased to 11 ounces but gradually subsides to 8 ounces.

Case 2. Mrs R. Æt. 35. Has had five children and three miscarriages. After the birth of the third child patient had numerous fits, said lasting about an hour. They occurred three or four times a day for six weeks, after which they subsided. A sea voyage restored her to apparent health. The seventh pregnancy ended in miscarriage at the fifth month. She states that she had flooding after it, and completely lost her eyesight for a period of twelve days — after which it suddenly returned.

From the 20th to 24th Sept. 1874 the patient was threatened with miscarriage at about the fourth month of pregnancy, during which the writer attended her. The symptoms, however, went off and the pregnancy continued. She was again seen on 29th Dec. She was perfectly blind, being unable to distinguish between light and darkness, and stated that her eyesight had become more & more imperfect since the 16th inst. She had also constant severe headache, vomited nearly all her food, and her mind was very much depressed. The urine was about normal in quantity and without albumen or casts. As regards the urine almost daily examination during several weeks gave similar results. The specific gravity varied from 1015 to 1020.

5th Jan. 1875. Since first report patient has gradually been getting worse in spite of careful dieting &c., and her condition now appears serious. 2 pm to 5 pm. Convulsions not violent but long continued. Chloroform given during the convulsions, and chloral in the evening.

6th. Considerable headache, but no convulsion. Morning pulse 108. Temperature 98°.

7th. 11 a.m. Threatened convulsion; no loss of consciousness, but twitching of arms and legs. Shortly after this she felt three distinct labour pains.

2.45 p.m. Os found sufficiently dilated to admit the finger.

3 p.m. As there was no further appearance of labour being about to set in, and as the patient was at about the eighth month of pregnancy, the writer determined to induce the labour.

The apparatus used was similar to that shown in sketch, only that for the mercurial guage was substituted a Bowdon's guage to be described hereafter. The whole apparatus was carefully emptied of air and filled with water. The patient being in the ordinary obstetric position the guage was brought to a level with the os, the catheter (about no. 8) inserted about three inches into the uterus and the cervix plugged with the finger. About two ounces of water were injected, some of which escaped. The pressure of the syringe during injection was 2 lbs. During the gradual escape of the water this injection was three times repeated with intervals of about five minutes. Immediately after each injection the pressure sank to .6 lb (= about 9.5 g) at which it remained for several minutes. This result was very precisely marked. The catheter was then removed. The further history of the case will be hereafter narrated.

In this case, then, the mean intra-uterine pressure was apparently greater than in the first case. The conditions of the uterus were not, however, precisely similar in each.

Schatz also has ~~endeavoured to~~ measured the intra-uterine pressure in two cases of during pregnancy

and has attempted to distinguish the "pseudo-intra-uterine" pressure (or intra-uterine pressure from the combined effect of the tension of the abdominal and uterine muscles) from the "water-pillar" pressure. The method he adopted was to put the women under chloroform, insert a caoutchouc bag through the os internum and inject it with water. The bag was connected by a tube with a Kymographion and mercurial dynamometer. This method appears to necessitate too much interference with the uterus to yield results of much value. The following, however, is the translation of the general results from observation in the first case.[22] "In a uterus pregnant for the sixth time after the insertion of a balloon filled to measure alongside the ovum in the thirty-eighth week of pregnancy, the pseudo-intra-uterine pressure before the beginning of the birth amounted to exactly the same as in in the birth during the interval between the pains, that is, in the back position, 20 m.m. of mercury. As of these 20 m.m. 15 are caused by by the water-pillar pressure of the uterus, so amounted the intra-uterine pressure caused by the tension of the uterus and the belly muscles, when the uterus is inactive and the woman lying on her back to 5 m.m. mercurial pressure. The inactive musculature of the expanded cervix amounted in comparison to a pressure of only 2 m.m."

He was not quite so fortunate in the observation of his second case, to be a woman near the full term. He thus states the general results.[23] "In a uterus pregnant for the fourth time the intra-uterine pressure before the birth amounted at its highest probably to

5·5 m.m. mercury. The increase of the uterine contents by the greatly filled balloon raises the intra-uterine pressure 3 mm., a result which one must attribute to the stretching of the muscle fibres by the increased distension. But the increase of pressure subsides again through accommodation. The musculature of the cervix caused by very moderate stretching an increase of from ·5 to 1·5 m.m., by greater stretching from this to 8·5 m.m. The first birth pain [which caused the extrusion of the bag and so prevented further observation] had here also no changing influence on the height of the intra-uterine pressure between the pains."

The mean intra-uterine pressure, therefore, during the latter months of pregnancy, according to Schatz, is, when the woman lies on her back, 7·5 + 5·0 = 12·5 mm., or half an inch of mercury.

## 2. The force required to dilate the cervix uteri

The very existence of rigid cervix can never be predicated until we have determined the normal resistance of the cervix to dilatation and have ascertained by direct measurement that in certain cases that resistance is increased. The two subjoined cases are wholly inadequate to determine the required force. They are sufficient, however, to show the direction in which the writer was desirous of working, had he been able to get suitable cases.

Case 1. A woman with a distinct history of syphilis, æt. 39. 11 children of which 6 were born dead. Requested by a midwife to see her on 7th May 1874; found that the membranes had ruptured on the 4th inst., that since then pains had been weak and infrequent,

notwithstanding frequent administrations of ergot.
11 a.m. Cervix soft but undilated, lower segment of uterus hard as if firmly contracted. A foot appeared to present, but the os was too high in the pelvis to allow of this being ascertained with certainty.
2 p.m. A no. 2 Barnes' bag inserted into the cervix uteri and connected with the Bourdon's guage (vide infra). Water was then injected (by a force of 10 lbs on the square inch) until the pressure within the bag remained at 2·5 to 3 lbs when the syringe was disconnected. In quarter of an hour the os uteri was completely dilated, and the bag was extruded. Chloroform was given and the right foot seized and brought down until the child's pelvis was engaged in the cervix. More ergot was then given, but as it failed to bring on uterine contractions the delivery was artificially completed at 3·30 p.m. The child was still born, but the mother made a good recovery.

Case 2. This is the second case described under the heading "intra-uterine pressure during pregnancy." Separation of the membranes proving insufficient to bring on labour, and it being desirable to conclude the labour as soon as possible, chloroform was administered at 6·40 p.m., and no. 2 Barnes' bag inserted into the cervix and distended. From 6·40 to 7 p.m. the pressure of the bag (as shown by the Bourdon's guage) was from 2·8 to 3 lbs on the sq. inch. At the end of this time the cervix was found to have been dilated to the size of a crown piece. At 7 p.m. the largest sized bag was inserted and distended until its pressure equalled 2 lbs on the sq. inch. At 7·25 p.m. this pressure had so dilated the os that the bag was extruded. At 7·40 p.m.

the membranes were ruptured, and the left foot seized and brought down. Ergot and brandy were then given. At 9.15 p.m. a few sharp pains occurred, the child was then artificially delivered. The uterus contracted well, and the patient made a good recovery though the convulsions recurred with great severity for several weeks after the confinement. The child was still-born.

Unfortunately in both cases the pressure within the bags after their removal from the vagina was neglected.

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## 3. The effective pressure during the second stage of labour.

A clinical instrument for precise measurement of the power of labour at all stages, capable of being applied without pairing or injuring the mother or child, is greatly to be desired. Until it has been discovered and extensively applied we can have no exact knowledge of such subjects as rigidity of the os uteri and of the perineum, "powerless" and "obstructed" labour, the effect of chloroform, ergot, &c. And until data so obtained have been duly sifted and compared no scientific rules for treatment are possible.

It is not too much to say that such an instrument would rival in importance the stethoscope and thermometer.

Schatz has, indeed, measured the intra-uterine pressure per square inch throughout the whole course

of labour in twenty-six cases, and has apparently obtained, by the aid of a Kymographion and mercurial dynamometer, very exact results. He connected these by means of tubes with a caoutchouc balloon or bag, into which and along part of the tube a flexible catheter was slipped in order to maintain their patency. After such preparation (and certain precautions had been taken which need not here be narrated) the balloon was introduced into the uterus. "This is best done under chloroform narcosis, and is possible as soon as the os externum is patent to the finger. For the introduction of the balloon one must always insert the whole hand into the vagina, and usually one will use two or three fingers to push it past the os externum, which, when the external os is dilated to the size of a thaler, is often 5 centimetres or more above the pelvic inlet. The balloon is introduced according to the position of the head, always on the abdominal aspect of the child, — for example, in the first position, in the right half of the uterus; and, of course, one avoids, if possible, tearing the membranes. When the whole balloon (somewhat folded on itself) is slipped past the internal os, it is firmly held there (usually near the child's face) with the fingers, and an amount of water, previously found to be sufficient, is injected with a large enough glass syringe." (24)

But by this method one cannot estimate the effective pressure against the cervix after rupture of the membranes, or against the brim or perineum. For we have as yet no means of estimating the area over which the known pressure per square inch is exerted with effect, and no means of estimating the loss of power from the clasping of the child by the body of the uterus, and by the cervix

(after the head has passed), and from frictional resistance in the remainder of the pelvic passage. Moreover, the method necessitates administration of chloroform, is perhaps a little dangerous, and is certainly inapplicable out of a German hospital. Therefore, though Schatz has laid the experimental foundation of the dynamics of labour, he certainly has not invented an instrument fitted for clinical use.

In 1892 and 1893 the writer (being then house-surgeon to the Lying-in Hospital, Liverpool) spent much time in attempting to discover an instrument that should be portable, easy of application and not painful or injurious, and capable of measuring with exactitude the effective pressure of the pains at any stage of labour. Though Schatz' first paper was published in 1871, the writer had no knowledge of his method until after the observations were concluded. As will be observed the two methods adopted differ entirely in their principle.

Evidently the method described above for the measurement of the pressure within the uterus during pregnancy is also applicable during labour until the os uteri becomes dilated. No observations, however, were made in this way.

The following is the principle or method of measurement that was adopted.

During a pain, the whole pressure upon the head, the os being fully dilated and the head in the cavity of the pelvis, was allowed to be directed against a caoutchouc bag partially distended with water. This bag was connected by a flexible tube to a manometer, and the

height to which the pressure within the bag rose was noted. After the labour was over different leaden weights were placed upon the bag until the manometer indicated the pressure previously noted. The weight which raised the pressure to this height was considered the effective pressure of that pain. In the observations no measurement of the duration of the pressure of a pain was usually made.

The Bag. In the first few cases a globular caoutchouc bag, two inches in diameter, was used. It was inserted within the vulva, and counterpressure made with a porcelain ring pessary. After the labour the bag was placed upon the ring pessary before the weights were put on it. One observation where this bag was used is recorded below. The others were tentative and not worth recording as only one or two pains were measured. The objection to this method was that the progress of the head was stopped by the bag, hence continuous observation was impossible, or at least unjustifiable.

A Barnes' bag (no. 2) was next tried. As soon as the head came down upon the perineum, the bag with from 1·5 to 2 oz water was slipped between them. In this way the progress of labour was not at all interrupted during observation; for the whole pressure was transmitted to the perineum. Sometimes the bag remained in situ during the pains without assistance, but occasionally it had to be prevented from slipping out of the vagina by pressure with two fingers. If ordinary care is taken, the perineum undergoes no risk of laceration from the presence of the bag. For at any moment the head may, if desired, be held back by the hand of the attendant, and the bag emptied and removed. After labour the bag (with the same or equal

contents) was placed on a flat table, and then weighted. Cases 2 to 9 (inclusive) reported below were observed with this bag.

A flat caoutchouc bag, two & a half inches long by two wide, not fiddle-shaped was next tried in Cases 10 and 11.

Finally a flat caoutchouc bag, three inches long by two & a half wide, not fiddle-shaped, distended with one ounce and a half of water, was selected as the best suited for this purpose. Cases 12 and 13 were observed with this bag.

Manometers.

In all but the thirteenth reported case the open mercurial guage depicted in sketch was employed. It must be clearly understood that in the reports the pressures stated do not represent pressure per square inch, but the whole pressure upon the perineum (except in Cases 1 and 10 where the perineum was not being distended during observation).

A mercurial guage is satisfactory in all but two respects, — it is somewhat alarming in appearance, and it is not portable. Accordingly an extremely sensitive but very exact Bourdon's guage was constructed for the writer by a well-known Liverpool maker. It measures three and three-quarter inches across, and is one and three-eighths deep. It weighs only fourteen & a half ounces. This beautiful instrument together with the bag found by observation to be the most serviceable is submitted with this thesis as a clinical tokodynamometer, portable, painless and uninjurious in application, and of great exactitude. Continuous observations can be made, if desired, with it from the time the head comes down upon the

perineum to the completion of the labour without interfering with its progress. For the whole of the effective uterine and abdominal pressure is transmitted to the perineum and distributed equally over it.

In order to save the trouble of placing the weights on the bag after each labour, the following observations were made. The bag contained exactly 1·5 oz water.

| Bourdon's guage | Weight on bag. |
|---|---|
| 1 lb per sq. in. | 4 lbs |
| 1·4 | 7 |
| 2·2 | 11 |
| 3·0 | 14 |
| 3·9 | 18 |
| 4·2 | 21 |
| 4·8 | 25 |
| 5·2 | 28 |
| 5·6 | 32 |
| 6·2 | 35 |
| 6·6 | 39 |
| 7·2 | 42 |
| 7·6 | 46 |
| 8·0 | 49 |

From these data a scale, sufficiently exact for practical purposes, may easily be calculated.

## Table XII.

| Bourdon's Guage | Weight in lbs. | Bourdon's guage | Wt. in lbs. | Bourdon's guage | Wt. in lbs. | Bourdon's guage | Wt. in lbs. |
|---|---|---|---|---|---|---|---|
| 1 | 4 | 3 | 14 | 5 | 26·5 | 7 | 41·7 |
| 1·5 | 7·5 | 3·5 | 16·25 | 5·5 | 30·3 | 7·5 | 45·5 |
| 2 | 10 | 4 | 19 | 6 | 34 | 8 | 49·2 |
| 2·5 | 12 | 4·5 | 21·8 | 6·5 | 37·9 | 8·5 | 53 |

No pressure has been observed higher than this during labour. The following however are the calculations.

9·0 — 56·8 — 9·5 — 60·35 — 10 — 64·36

The following reports of 13 cases in which the effective power of labour was measured are given almost exactly as they were taken — only that the more ordinary data are collected in a table for the sake of convenience.

Table XIII.

| No. of case. | Name of case. | Age. | No. & char. of previous labours. | Date of present labour. | Presentation &c. | Labour began... | Membranes ruptured.. | Labour ended... | Duration of Labour. | Sex and Condition of child. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1873 | | | | | | |
| 1. | M.G. | 22 | 0 | 17 March | Head | 10' a.m. | 2' p.m. | 8' p.m. | 10'. | |
| 2. | G. | 20 | 0 | 24 " | " | 12'30" p.m. | 2'30" " | 8'30" " | 8' | |
| 3. | M. | 24 | 2 nat. | 16-17 April | " left occ. post. | 8' " | 12' " | 1'45" a.m | 5'45" | f healthy |
| 4. | A. | 24 | 1 " | 16 May | Head | 1' " | * | 9'40" p.m. | 8'40" | |
| 5. | V. | 20 | 0 | 9-10 June | " | 1' " | 7'30" " | 2'40" a.m | 13'40" | m large healthy |
| 6. | B. | 27 | 0 | 4-5 July | " rt. occ. post. | 8'30" a.m. | 2'30" a.m | 12' " | 21'30" | m healthy |
| 7. | K. | 19 | 0 | 15-16 " | Head | 4' p.m. | 3'45" " | 8' " | 16' | " " |
| 8. | L. | 31 | 0 (once aborted at the 3rd month) | 23-24 " | " | 10' " | 6' " | 9'30" " | 23'30" | m large healthy |
| 9. | D. | 29 | 3 {2 premature 1 nat. | 1 Aug.t | " | 11' a.m | 7'55" p.m. | 8'30" p.m. | 9'30" | f " " |
| 10. | B. | 28 | 0 | 2 " | Face to pubes | 7' a.m | rupd of 1st inst | 11' " | 16' | m still |
| 11 | S | 24 | 2 {1 instrum. 1 nat. | 10 " | Head | 7 p.m. | 11'45" p.m. | 11'50" " | 4'50" | f large healthy |
| 12 | B. | 34 | 0 | 23 " | " | ? | ? | 1' " | ? | m " " |
| | | | | 1874 | | | | | | |
| 13 | ** J. | 32 | 4 nat. | 6 May | " | 12 noon | 8'30" " | 8'45" " | 8'45" | " " " |

* Liquor amnii slowly discharged throughout the labour.

** Uterus bicornis. After the child was born the uterus was observed to have an unusual amount of obliquity to the right. A firm rounded tumour was felt attached to its left side, about the size of a hen's egg. After removal of the placenta the whole hand was passed into the uterus without any pain being caused. By combined external & internal examination the apparent tumour was found to be the left cornu of the uterus. The right cornu in which the placenta had been, was somewhat larger than the left. An external antero-posterior depression or furrow and an internal prominence or ridge marked the segmentation of the uterus. The internal ridge was more sharply marked than the external furrow, but was not sufficient to completely divide the uterine cavity.

Case 1. McG. Natural labour with pains of apparently average strength - The head having approached the perineum about 6 p.m. a round caoutchouc bag, two inches in diameter, was filled with water and inserted ~~into~~ within the vulva, and its tube was connected with the mercurial guage formerly mentioned. The tube passed through a porcelain ring pessary, by which counter-pressure was made. Numerous pains were measured and found to vary from 18 to 27 lbs. The catheter requiring to be passed, the bag was withdrawn for that purpose. Before drawing off the urine the catheter was connected by a tube with the guage. Two or three pains gave a pressure varying from 2 to 2·5 lbs on the square inch. The force of the last expulsive pains was not measured.

Case 2. G. Natural Labour with frequent pains of apparently average strength. No chloroform or ergot. Observations between 6·30" and 7'30" p.m. Barnes' bag, no. 2, inserted within vulva so as to lie between the perineum and the child's head, moderately distended and connected with the guage. Numerous observations made. Pains gradually rose from 19 to 37 lbs. The final expulsive pains were not measured.

Case 3. M. Same bag similarly situated and distended with 2 oz water. Labour natural, pains apparently of average strength, little outery. No chloroform or ergot. Observations between 12'30" and 1'45" a.m. During absence of pains the pressure on the perineum always remained about ·75 lbs. During the first half hour the pressure rose regularly during the pains to about 15 lbs, and after that, as regularly, to about 30 lbs until ten minutes before the completion of birth. Then came two or three pains during which the pressure rose to nearly 40 lbs. The last of these caused the bag to slip out. The head was born during the next pain.

Case 4. A. Natural labour, apparently average pains No chloroform Apparatus as before. Observations between 8.15". and 9' 25" p.m. The head came down to the perineum at 8 p.m. At first the pressure during several pains rose only to 14 lbs. Brandy 3ss and ergot 3ss accordingly were given. At 9 p.m the pressure during the pains was again measured and found to equal 33.75 lbs. In one instance the pressure rose to 36.75 lbs. About this time during each pain the pressure rose to a certain height at which it remained for a few seconds, rose again to a greater height at which it again remained for a few seconds, then reached its maximum, maintained that height for a few seconds and suddenly fell. For example, one pain lasted fifteen seconds. The pressure quickly rose to 8 lbs at which it remained for five seconds, then rose to 14.35 lbs at which it remained for the next five seconds after which it reached a maximum of 38.75 lbs. This was maintained for another five seconds, & then suddenly the pressure sunk. The bag was withdrawn at 9' 25" and 9'40" the child was born by pains that seemed no stronger than those measured.

Case 5. V. Natural labour, pains were frequent and appeared stronger than the average. No chloroform or ergot. Observations between 12'30" and 2'30" a.m. Continuous observation was made, that is every pain was measured during two hours, but only the average result during each successive twenty minutes was noted down. The pressure of the pains rose gradually and with great regularity from 22.5 to 53. lbs. The following table then gives the amount of pressure of the majority of the pains during each successive twenty minutes.

| Time | Pressure on perineum |
|---|---|
| 12' 30" a.m. ----- | 22·5 lbs. |
| 12' 50" " ----- | 29 " |
| 1' 10" " ----- | 36·5 " |
| 1' 30" " ----- | 41·5 " |
| 1' 50" " ----- | 48 |
| 2' 10" ----- | Pains at first became less frequent & less strong, then ~~became~~ followed in rapid succession, the pressure rising to 53 lbs. |

The birth was now evidently about to be concluded, the bag was withdrawn, and the head was born with the next pain.

Case 6. B. Labour lingering throughout. At 2.30 a.m. the cervix uteri being well dilated the membranes were ruptured. Patient was kept under chloroform from this time to 4'30". Manometric observations between 2' 30" and 5' 45". From 2'30" to 4' the pains were infrequent, and appeared weak. Measurements, however, showed them to press on the perineum with a force equal to from 15 to 29 lbs. At 4 a.m came a few pains varying ~~from~~ between 29 and 36·5 lbs. At 4'50" the bag (Barnes No 2 as in other cases) was removed for ten minutes. From 5'15" to 5'45" the pains were more frequent and appeared stronger, — by measurement they were found to have a pressure of 33·5 lbs, but sometimes the pressure diminished to 29 lbs, and occasionally rose to 36·5 lbs. The bag was now removed, and the head born ten minutes after during pains apparently no stronger than those which had been measured between 5'15" and 5'45".

Case 7 K. Lingering labour. Chloroform from midnight till 2' a.m. 3'45" membranes ruptured. Chloroform then given and continued until 4'15" a.m. Observations

between 3'45" and 8', as the head came down on the perineum almost immediately after the membranes ruptured. Pains were infrequent, and appeared not strong, making little impression on the perineum. During the interval of the pains the pressure on the perineum was ~~3 lbs~~ at first 3 lbs, towards the end of the observations it had risen to about 6 lbs.

3'45" Pressure of pains equal to from 17 to 33 lbs. A pain whose pressure was equal to 17 lbs appeared no stronger and gave rise to no more outery (the woman was not deeply under chloroform) than a pain whose pressure was equal to 33 lbs. 5'30" Brandy ℥ij.

5'40" to 6'40" continuous manometric observation. Pains varied greatly in strength, having sometimes a pressure of only 17 lbs, sometimes 23 lbs, sometimes 31·5 lbs, and occasionally 33 lbs. They were as irregular in their frequence as in their strength. The woman appeared somewhat exhausted. From 7'20" to 7'50" the pains became apparently stronger, and had a considerable effect upon the perineum. Most of these pains measured from 33 to 36 lbs, but occasionally they were less. For example, a pain occurred whose pressure was 23 lbs. This was followed by one with a pressure of 31·5 lbs. And next came a long sustained pain with a pressure of 33 lbs which greatly distended the perineum. Five minutes after this the head was born during a pain that was apparently little stronger than that last recorded. It was not, however, measured, the bag having been removed a few minutes previously.

Case S. L. Lingering labour. 5'40" p.m. Head down upon perineum. No sensible caput succedaneum. Manometric observation from this time to the end of the birth of the head at 9'30" p.m — 5'40" p.m. From this

outcry and posture, the pains, which recurred every ten minutes or oftener, would have been considered of at least average strength, but though the head was fairly down upon the perineum they caused no distension of that part, and their pressure was found equal only to from 4 to 6 lbs — a cough or voluntary bearing down gave as much. Manual pressure from above during the absence of a pain equalled 12·5 lbs. This observation was repeated several times with a similar result. 12·5 lbs, therefore, may be taken as the amount by which labour can be assisted by pressure upon the abdomen, the woman being on her left side and the assistant at her back. 6 p.m. Brandy ℥i. The pressure of the pains remained as before. 6'20" Ext: Ergotæ liq: min XX Pressure of pains as before — 7' Brandy ℥i, Ether: Sulph: min. XX. From 7' to 7'30" pressure of pains = 12·5, 15·5 and occasionally 22 lbs. At this time the pains became rather more frequent, and a pressure of 7·5 lbs was, for a while, maintained in the interval between them, but this soon subsided. 7'30" to 8' pressure of pains from 20 to 27 lbs. About the beginning of this half hour, the pressure of the pains being pretty constantly 20 lbs, the caput succedaneum quickly formed: 8'30" Pressure of pains 25 lbs, different pains varying very little in strength. Considerable impression was made upon the perineum. 8'45" pressure of pains frequently reached 27 and 28 lbs; greater impression upon the perineum. The pains were now frequent. They often occurred in series of two: thus, a pain of 15·5 lbs was quickly followed by one of 20 lbs, and then there was a pause; a pain of 18 lbs was quickly followed by one 27 lbs, and then there was a pause: or in series of three, — thus three pains quickly followed each other whose pressures were respectively 15, 20 and 25 lbs in one instance, and in another

18, 22 and 27 lbs, — a pause following in each instance — 9'15" Pains now succeeded each other more & more quickly. For ten minutes their pressure only amounted to 25 lbs, but that pressure was maintained for a considerable time. Then two or three pains followed of 31 lbs pressure. These were succeeded by one of 33 lbs pressure, and then by several of only 25 lbs. By this time, 9'30", the perineum was completely distended, and the head about to be born. It being that in this case the perineum was not likely to be lacerated the bag was left in situ during the birth of the head. The pressure upon the perineum of this pain that expelled the head was exactly 38 lbs. The perineum was carefully examined and found to remain entire.

Case 9. D. Natural Labour. No chloroform. The membranes having ruptured at 7'55" the head came immediately down upon the perineum. Manometric observations from 8' to 8'30." During this half hour pains occurred every two or three minutes. 8'. Pressure of pains, 11 lbs, occasionally 16 lbs. 8'10". Pressure of pains, 22 lbs. The perineum was now partially stretched during each pain, and caput succedaneum began to form. 8'20" Pressure of pains, 27 lbs, occasionally 32 lbs. More pains whose pressure equalled 27 lbs greatly stretched the perineum. Only twice or thrice was the pressure equal to 32 lbs. 8'30" Head about to be born. The perineum being considered safe, the bag was allowed to remain in situ. The pain during which the head was born had a pressure upon the perineum of only 22 lbs. The perineum was not injured.

Case 10. B. Face to pubes. Labour terminated by forceps. No chloroform until the forceps were about

to be applied. Manometric observations between 5-'15" and 9-'50" p.m. The membranes had ruptured on the previous evening, but there had been no sensible labour pains until 7 a.m. - 5-'15" Os uteri fully dilated. Head had entered the pelvis, but not come down upon the perineum. The Barnes' bag, moderately distended, was inserted past the perineum along the wall of the sacrum until it reached the part against which the head pressed. The bag had a great tendency to slip out of the vagina during each pain, and required to be retained in position by the hand. The lower portion of the sacrum and the hand, therefore, afforded in this case the counter-pressure, not the perineum.

5-'30" Pressure of pains 14 lbs, occasionally 22 lbs
5-'40" " " 22 " 27
5-'42" A rough analysis of a pain was attempted. During this pain, the pressure rose rapidly to 18lbs, sunk to 14, rose to 18, sunk to 14, rose to 22, sunk to 14, rose to 29·5, sunk to 14, rose to 29·5, sunk to 14, rose to 32, and finally fell with rapidity at the end of the pain. This pain may expressed by the following formula, the number below the line representing the constant pressure, the numbers above the line the fluctuating pressures.

$$\frac{18.\ 18.\ 22.\ 29{\cdot}5.\ 29{\cdot}5.\ 32}{14}$$

The fluctuations was probably almost entirely due to variations in the abdominal pressure. Several observations of a similar nature were made, but after Schatz' exact determination of the fluctuations by the use of the Kymographion, they are not worthy of further notice.

To 6 p.m. the pressure of the pains was about 27 lbs, but occasionally less. After this two or three pains occurred with a pressure of 32 lbs. The bag was accordingly removed in

the expectation that the power would be sufficient to finish the labour, but no progress was made.
6'40" Bag reapplied, pressure of pains only 14 lbs.
7' As the presence of the bag in the vagina appeared to excite the pains, and so hasten rather than retard the labour, it was maintained in position, and during the next thirty two minutes the pressure of every pain was measured. The result was as follows.

| | | | |
|---|---|---|---|
| 7' | A pain whose pressure amounted to | | 22 lbs. |
| 7'2" | " | " | 14 " |
| 7'5" | " | " | 22 " |
| 7'7" | " | " | 22 " |
| 7'10" | " | " | 22 " |
| 7'14" | " | " | 27 " |
| 7'20" | " | " | 22 " |
| 7'23" | " | " | 27 " |
| 7'25' | " | " | 14 " |
| 7'29" | " | " | 18 " |
| 7'32" | " | " | 22 " |

Again, at 7'40" the pressure of a pain was 24·5 "
and at 7'41" " " 14 "
From 9'25" to 9'35" the pressure of the pains varied from 22 to 27 lbs. At 9'44" the pressure of a pain was 27, and at 9'50" that of another 29·5 lbs.
At 11" it became evident that the combined abdominal and uterine pressure was insufficient to complete the labour, chloroform was given, and the forceps applied. Considerable traction force was required before the head could be delivered.

Case 11. S. Natural labour; no chloroform.
The os uteri being fully dilated, the membranes were ruptured at 11'45", and the head came down immediately upon the perineum. Pains

occurred every minute or oftener. 11'45" Pressure on perineum during pains only 11 lbs. The next two or three pains followed in rapid succession, their pressure amounting to 17 lbs. Others followed with a pressure of 19 lbs; then two of 23 lbs pressure, by the last of which the head was born. The bag was allowed to remain in situ. The perineum was not injured.

Case 12. B. Natural labour; no chloroform.

9'30" a.m. Membranes had ruptured on the previous evening. Os fully dilated, head on perineum, caput succedaneum beginning to form. Manometric observations from this time to the termination of the labour at 1 p.m.

There was a constant pressure of 2 lbs upon the perineum between the pains. The following gives the pressure of successive pains from 9'30" to 10'14".

| | | | |
|---|---|---|---|
| 9'30" a.m. | A pain with pressure | equal to | 15 lbs. |
| 9'38" | " | " | 10 |
| 9'56" | " | " | 10 |
| 10' | " | " | 8 |
| 10'4" | " | " | 8 |
| 10'7" | " | " | 8 |
| 10'10" | " | " | 9'5 |
| 10'11" | " | " | 8 (a very short one) |
| 10'14" | " | " | 6 |

For some time the pains continued feeble.

11' Pains with pressure varying from 13 to 18 lbs.
11'5" A pain with pressure equal to 13
11'9" " " 15

During the next fourteen minutes the pains followed in rapid succession, the pressure rising in nearly every instance to 13 lbs. At 11'28" the pressure during the pains rose to

15 lbs., and at 11.25" to 18 lbs. These pains had a considerable effect upon the perineum. 11'30" Pressure during pains 18 lbs, during interval 4 lbs. 11'45" to 12' pressure during pains varies from 8 to 15 lbs. 12.30" to 12'45" Pains very frequent with 21 lbs pressure. 1' Head expelled by a pain with 25 lbs pressure. Bag remained in situ; no harm done to perineum.

Case 13. Natural labour; no chloroform. Membranes artificially ruptured at 8'30" p.m. as the os was fully dilated. Manometric observations from this time to the birth of the head at 8'45". The head came down immediately upon the perineum, and the pains were frequent and of apparently average strength. The first four or five pains had a pressure of 14 lbs, then followed two or three of 19 lbs, and last one of 34 lbs by which the head was born. The bag was left in situ, and no harm done to the perineum.

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No very precise conclusions need be drawn from these reports. They were observed rather for the purpose of discovering the best instrument for, and the chief points worthy of, observation than for the purpose of formulating any of the dynamical laws of labour. The series is preliminary, unmethodical, tentative, short. Still, however, a few of the more obvious points may be noticed.

The following note was appended to the original report of case J. K. The remainder of the series supported the conclusions then arrived at:- In this labour, as in the others, the power of the pains on the perineum increased slowly and gradually, being least when the head first came down upon

it and greatest about the time of expulsion. At any period the pains had what may be termed a standard strength for that period — a weak pain being usually followed by a stronger, and that by a stronger still, until the standard strength was reached. Occasionally there would be even a stronger pain than this — one belonging, as it were to the next period. Such a pain would be repeated at shorter and shorter intervals until at length, say in half an hour, they became the standard pains.

It must, however, be observed that these variations are only variations in the effective pressure upon the perineum, not necessarily variations in the uterine or abdominal effort.

The pressure on the perineum between the pains varied from 2 to 7 lbs.

Caput succedaneum formed slowly when the pressure of the pains was about 13 lbs, quickly when it was 20 lbs.

In five cases the strength of the pain that expelled the child was measured. The maximum pressure was 38 lbs, the minimum 22 lbs, & the mean 28.4 lbs. The following are the cases: —

| | | |
|---|---|---|
| Case 8 | 38 lbs | primiparous |
| 9 | 22 | multiparous |
| 10 | 23 | " |
| 12 | 25 | primiparous |
| 13 | 34 | multiparous |

Generally the pain that expelled the child was a few pounds greater than the pain immediately preceding, but sometimes it was less. In no case in which the bag was left in situ was any injury done to the perineum. In some cases the bag was born with the head, in others it remained in situ. In the latter cases

it was emptied and removed before the shoulders were born.

References.

(1) Translated by D. Matthews Duncan – Mechanism of Natural & Morbid Parturition pp. 194-8
(2) The Principles & Practice of Obstetrics - by Hugh L. Hodge M.D. Philadelphia p. 25.
(3) Mechanism of Natural & morbid Parturition p. 54.

(4) System of Midwifery. p. 318.

(5) "On the "Synclitism" of the foetal head in Natural Labour." American Journal of Medical Science - Oct. 1870 pp. 329-30.
(6) Obstetric Works by Priestley & Storer Vol I p 515 &c -

(7) Obstetric Operations Lect. XVII.

(8) British Medical Journal Oct. 1873.

(9) Mechanism of Parturition by C. J. Haegele - Ryley's Translation pp. 13-14 & p 16.
(10) Duncan ibid Chap XI. Leishman - Mechanism of Parturition Chap III, & others.
(11) Haegele, ibid pp 16 & 18

(12) Address on the Mechanism of Labour in the Common forms of Contracted Pelvis - by Otto Spiegelberg M.D. Brit. Med. Journal Oct 1873. p 453.
(13) Duncan - ibid p 195.
(14) Duncan - ibid pp 188-189.
(15) Hodge. "On the Synclitism &c" p. 329.
(16) Do Do - p. 328.
(17) Haegele ibid pp. 22-23.
(18) Leishman - Mechanism of Parturition p 84.
(19) "Strain is any definite change in the dimension or form of a body. Stress is the force which causes such change"

(20) Archiv für Gynaekologie - 1841 - p. 132. Schatz.
(21) Dr. Worm Müller - "Die Abhängigkeit des arteriellen Druckes von der Blutmenge." Leipzig Dec 1873
(22) Archiv für Gynaekologie. Schatz. p. 115.
(23) do do p. 119.
(24) " " p. 79