A S T U D Y

OF THE FEMALE PELVIS IN

NORMAL AND ABNORMAL DELIVERY.

T H E S I S

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INTRODUCTION.

In modern obstetric practice the aim of the accoucheur is to obtain a vaginal delivery where possible, but only if this object can be reached without injury to mother or child. Because of this attempt to obtain delivery per vias naturalis the maternal pelvis has been the subject of close study by obstetricians for many years. Attempts to measure the pelvis in the living subject has resulted in many varieties of pelvimeter and manual methods of measurement, but it was not until the improvement in X-ray technique that an accurate study of the pelvic architecture was possible and reliable measurements made.

A large bibliography has accumulated on the study of radiological technique in the pregnant woman, both in this country, Europe and America, and some of these papers will be referred to later. On studying the published series, especially from Britain, it was apparent that there was a considerable variation in the results, and it seemed to me that it would be worth studying the problem in this area, i.e. the South-East of Scotland. I considered that by obtaining a fairly large series of cases and correlating this with various findings such as maternal height, baby weight and duration of/

of labour, one would have a basis on which to assess future cases in our own hospital.

Another valuable contribution that X-ray pelvimetry makes possible to us in this region in which all the maternity hospitals are congregated in a small area, is to be able to assess a case that may be delivered elsewhere. Many cases are delivered in Cottage hospitals or at home, often at a distance of 50 miles from the main centres, and one is frequently sent cases by their general practitioner with a request to ascertain whether labour will be normal or not. While I do not underestimate the value of abdominal and vaginal examination with an estimate of cephalo-pelvic disproportion, the fact remains that in many women there is pelvic contraction at a lower level than the brim of the pelvis, and this may be difficult to assess antenatally in some patients. Nowadays many general practitioners are unwilling to undertake any operative delivery themselves, even a low forceps, and they expect an obstetric opinion to eliminate these when possible. Even in a good home a forceps delivery is often undesirable,and this point was brought out by Aitken (1955) speaking on behalf of the general practitioners of South Lincolnshire at the British Congress of Obstetrics at Oxford.

MATERIAL

In order to investigate the pelvis radiologically in a large number of women who were potentially normal, it seemed desirable to obtain the X-rays of women who had a spontaneous delivery. I decided that it would be necessary to use only the films of primigravidae delivered by the vertex. My reason for using only films of primigravidae was that not only do parous women behave differently in labour, but the management of the case is often prejudiced by previous dystocia or foetal loss. I also decided that only by taking cases delivered by the vertex could the case be looked upon as normal. I obtained 520 such cases to form the first part of my series. It must be understood that these cases were X-rayed antenatally for a variety of reasons such as suspected disproportion, small size of the mother or a breech presentation which subsequently underwent version. They are a completely unselected series - the only common factor being that X-ray pelvimetry had been performed nearly always in the ante-natal period.

The next part of my series consists of 260 primigravid forceps deliveries in which X-ray pelvimetry has been done. This series is consecutive as I considered that only by taking all forceps/

forceps deliveries over a certain length of time would it be possible to include both the large and the small pelves. This, of course, has meant post-natal X-rays in 75% of these cases, mostly in those in whom no difficulty was expected, but in which it was experienced not infrequently. The only point about post-natal pelvimetry is that there is no foetal head present should one want to measure it. Against this is the fact that one is not prejudiced towards early interference on the X-ray report alone at the time of delivery. I might emphasise here that primigravid women only were used, because forceps are relatively rarely necessary in parous patients. If required there is generally a fairly serious indication and once again the previous history may colour the picture darkly.

The last part of my series consists of 50 consecutive cases of women in whom labour was allowed but who required abdominal delivery. Some of these patients were known to have a contracted pelvis but were thought to be suitable for a trial of labour. All these patients were head presentations and all primigravidae. This part of my series is small, but it took the longest time to collect/

collect, and it was a temptation to include all cases of Caesarean section in primigravidae. A few minutes' thought, however, showed that cases of pre-eclampsia, hypertension, elderly primigravidae and breech presentation delivered by elective section were quite unsuitable for my series, so must all cases of elective section, even contracted pelvic brim or outlet be excluded.

There remained a third group to be considered, neither elective section nor women in labour. These were cases of postmaturity in whom labour was induced by artificial rupture of the membranes, and in whom foetal distress made Caesarean section obligatory before labour started. As labour had not commenced and the pelvis was not really at fault, I eliminated these also.

I must emphasise here that the time factor is not common to my series. The spontaneous deliveries were spread over a period of 4 years, while the forceps deliveries were obtained in a continuous series of nearly 2 years. The Caesarean section group were also a consecutive series, slow to accumulate as only about 14 cases suitable for my series occurred each year. It can be seen that this series also took nearly 4 years to gather.

SCOPE/

SCOPE OF INVESTIGATION.

This investigation comprised a total of 830 primigravida women made up of 520 delivered spontaneously, 260 forceps deliveries and 50 Caesarean section. Most of these women were booked cases, in that they had attended the ante-natal clinic at least twice, while the unbooked cases were usually sent in in labour often of great duration. In my series I have not differentiated between the two categories, as even if a patient is admitted in labour, it should practically always be possible to obtain a live child. By omitting unbooked cases I would have cut down my figures considerably, especially the Caesarean section group, in which prolonged labour was common.

As well as the radiological information which was obtained in each case, and which will be discussed fully later, the following information was elicited.

1. Height of Mother.

The stature of the mother is usually measured at the first ante-natal visit, but if not, the patient is measured once she is out of bed.

In order to obtain the average height of the women in my series, the measurements were taken to the nearest quarter inch.

In the comparative tables I have divided the series into 3 categories :

(a) Small - under 5 feet in height.

(b) Average - 5 feet to 5 feet 3 inches.

(c) Tall - over 5 feet 3 inches in height.

2. Weight of Child:

The weights of the babies were divided into 4 ounce increments in order to obtain am average.

In the comparative tables I have split the weight of the child into 4 categories :

(a) Premature - under 5½ lbs. in weight.

(b) Small - 5½ lbs. to 6 lbs.15½ ozs.

(c) Average - 7 lbs. to 8½ lbs.

(d) Large - over 8½ lbs.

3. Results to child :

While the outcome of the delivery as regards survival of the child, or otherwise, is not statistically comparable in the three groups of cases in my series, the fact remains that they are most interesting.

I have divided them as follows :

(a) Alive and well.

(b) Stillborn - reason at post-mortem.

(c) Neo-natal death - reason at post-mortem.

4. Duration/

4. Duration of Labour :

The duration of labour has been calculated to the nearest hour in order to find the average time it lasted. For comparative purposes I have taken increments of 6 hours as this enables both the time of 30 hours and 48 hours to be easily calculated, as these figures are on the borderline of prolonged labour, depending on which figure one uses.

5. Maternal age :

I have divided the maternal age into 5 year increments for discussion purposes. The importance of age in operative delivery will be shown later.

6. Reason for Operative Delivery :

A. Forceps Delivery :

I have divided the reasons for application of forceps into 5 main categories. If there seems to be a multiple indication for instrumental interference I have always taken the major one to be a malposition of the head if present.

The/

The indications are as follows :

(1) Maternal Distress.

(2) Second Stage delay.

(3) Foetal Distress.

(4) Deep Transverse arrest of the head.

(5) Persistent occipito-posterior position of the vertex.

B. Caesarean Section :

In the Caesarean section group there is again a combination of indications for abdominal delivery in some cases, for instance Group 2 below is common to most of the other groups. I have, however, allowed one major indication in each case - as below, but also show the minor indications which may influence the decision to operate.

(1) Disproportion.

(2) Disordered Uterine action.

(3) Elderly Primigravidae.

(4) Foetal Distress.

(5) Malpresentation of head.

X-RAY PELVIMETRY TECHNIQUE :

A full X-ray pelvimetry was undertaken in every case in my series. This involved using 4 X-ray/

X-ray plates, the largest measuring 12" x 10" for the true lateral, and the other 3 measuring 10" x 8" as described below.

I. (a) True Brim :

This film is taken with the patient reclining at 40° to the horizontal by means of a back-rest. In this position the plane of the brim is parallel to the X-ray plate. The focus film distance is 100 cm. and the tube in centred 5 cm. behind the symphysis pubis. As this film gives a true picture of the pelvic brim, its shape can be seen from it. Although it is possible to measure both the inlet antero-posterior and inlet transverse of the pelvic brim from this film, this has not been done in my series. The only measurement taken from the film is the ischial bispinous. These can usually be clearly seen and measured on the film, a correction factor being applied for the depth of the pelvis.

(b) Modified Brim:

For the latter period of my series a different picture has been taken of the pelvic brim. This is nearer a true antero-posterior of the/

the pelvis and the reason for changing the technique was to lessen the radiation dose in the region of the foetal gonads. This has meant that it has not been possible to estimate the shape of the pelvic brim in the second 260 spontaneous deliveries. I have, however, managed to retain the original technique in my caesarean section group, and fortunately the forceps group were also taken by the original method. The ischial bi-spinous is once again the only measurement taken from this film.

2. True Lateral Film :

Before taking this exposure it is necessary to position the patient carefully. She lies on an X-ray table and is held on her side by a broad belt, so that the two femoral heads are exactly one above the other. If a good result is obtained in this view the femoral heads should be exactly superimposed on the film. The coccygeal film distance is measured and from this the focus film distance is calculated by multiplying this by 5. The antero-posterior of both pelvic brim and outlet are measured directly on this film and reduced by 25% to give the true measurement.

The important antero-posterior measurement of/

of the pelvic brim is the available antero-posterior, which may be smaller than the true antero-posterior if the sacrum is straight or convex. The available antero-posterior is taken from the supero-posterior part of the symphysis pubis to the nearest point on the sacrum, which as already stated may be lower down than the promontory of the sacrum.

The outlet antero-posterior is measured from the lower part of the symphysis pubis to the tip of the sacrum.

3. Parallax method of measuring Transverse of Pelvic brim.

The essential technique of this method of measuring the transverse of the pelvic brim is that two exposures are taken on the same film, the X-ray tube being moved a definite distance between exposures. The patient lies recumbent with a pillow under the lumbar spine. Again using a focus film distance of 100 cm. a film is taken of the pelvic brim similar to that described in I(b). The patient lies still and the X-ray tube is moved 10 cm. laterally, another exposure being made on the same film. By measuring the transverse diameter on the film, and also the parallax shift, it is/

is possible to calculate the true measurement from tables.

4. Sub-pubic Arch :

This measurement is made by a modified Chassard Lapine method. The patient sits on the film casette at the edge of the table leaning well forwards, so that the X-ray tube is above the sacrum and centred on the ischial tuberosities. The focus film distance is again 100 cm., and as the sub-pubic arch is parallel to the X-ray film no correction factor is necessary. From this film the size of the sub-pubic arch can be measured, either by a protractor or by fitting in discs of various sizes.

INFORMATION RECEIVED FROM X-RAY FILMS.

From the four films described above it is possible to study both the architecture and size of the pelvis in its various planes. One realises that the study of each individual pelvis is most important as regards various factors which are difficult to measure, such as the depth of the sacro-sciatic notch, convergence of the lateral walls of the pelvis, and the length and shape of the/

the sacrum. Also in a case of suspected disproportion either ante-partum or intra-natal it is of great value to see the position and degree of engagement of the foetal head. In this series which includes quite a large number of post-natal X-rays, I have avoided all mention of cephalometry, the child's weight having a most important bearing on the method of delivery.

PELVIC MEASUREMENTS :

(1) Brim.

As already stated the antero-posterior of the pelvic brim, or, more important, the available antero-posterior of the brim is measured from the lateral film. The transverse of the pelvic brim is most accurately obtained from the parallax film.

From these two measurements it is possible to estimate the area of the brim by Nicholson's (1938) method. The area is found by multiplying the antero-posterior by the transverse of the brim; this figure being multiplied by $\overline{11}$ and divided by 4. More simply is 'a' represents the/

the antero-posterior, and 'b' the transverse -

$$\text{brim area} = \frac{\overline{II}\ a\ b}{4}$$

The value of the area of the pelvic brim is mainly found in those patients who have both a small antero-posterior and transverse of the brim although the former is not contracted. I have made a good deal of use of this measurement in my comparative tables.

(2) Pelvic Outlet :

The pelvic outlet is described in British literature as that part of the pelvis at and below the plane of least pelvic measurement. I have therefore used this terminology throughout my paper. The antero-posterior of the outlet is measured in the lateral film as already described.

For the transverse measurement of the pelvic outlet I have taken the ischial bispinous diameter which is measured from the film of the pelvic brim.

From these two diameters one can calculate the area of the pelvic outlet using the same formula as for the brim area - i.e. $\frac{\overline{II}\ a\ b}{4}$ where a and b represent the antero-posterio r and transverse respectively. Allen (1947) suggests that the transverse of the pelvic outlet should be measured/

measured from the flat surface of the ischial bone in front of the spine. While this possibly gives a more accurate figure for the total area of the plane of the outlet, I feel certain that it gives a far less accurate measurement of the available area. It is well-known that prominent ischial spines often cause delay in labour and even abnormal delivery, and I think this is not only because of the shortening of the measurement but because of the wasted space both in front and behind the spines.

A further point about the outlet area is that the antero-posterior and transverse diameters are at slightly different levels, but in actual practice I have found this a most useful measurement in assessing the outcome of many cases.

The final measurement that I have made is the sub-pubic angle, which is taken from the special X-ray film. I tried various methods of recording the value of the sub-pubic angle before deciding that the simplest and most accurate was to measure the angle with a protractor. My reason for this was that while the method of fitting a disc measuring 9.5 cm. as described by Williams and Arthur (1949), under the arch seemed more logical as the waste space could thereby be accurately/

accurately measured, the fact remained that this waste space had to be plotted on the lateral film and a new figure, the available antero-posterior, obtained. Many of the lateral films were not exactly true and to plot the waste space on the inferior pubic ramus was inaccurate. I therefore reluctantly came to the conclusion that this method was really not feasible, and that to measure the sub-pubic angle personally using the same technique on each film would be of more value.

I measured the angle by taking the apex under the symphysis pubis equidistant from each pubic bone, while for the lower point I took the point where the inferior pubic ramus joins the ischium. One must admit that some patients had norman arches in which the true value of the arch was not fully measured but usually these arches were very ample in size. On the other hand, in a few cases the arch was very small and the position was complicated by the pubic ramus being convex. In these cases it was necessary to take a reading inside the arch sufficient to allow for this bulging.

(i) Pelvic Architecture

(i) The shape of the pelvic brim could be seen in the film taken of the true brim. It is thus/

thus possible to describe the shape of the pelvic brim after the original method of Turner (1885), Thoms (1940), of Caldwell and Moloy (1933). I personally looked at every film in this series and attempted to classify them in the categories described by the latter authors. I decided that as I was unable to demonstrate the shape of the pelvis in 260 of the spontaneous group, and therefore had a total of under 600 cases at my disposal, it would be better to use only the four parent types of pelvis rather than a total of 14 types and sub-types as Caldwell, Moloy and D'Esopo (1934) described. Another point was that these authors had a precision stereoscope at their disposal which made the study of the whole pelvis more accurate. Their method of describing the anterior and posterior part of the pelvis separately is very dependent on the observer's sense of shape. I decided that the most accurate way to obtain the shape of the pelvis was to make use of the pelvic index. This will at once divide the pelvic types into their four main categories as follows:

(1) Anthropoid - pelvic index 100 or more.
(2) Gynaecoid - pelvic index 80 to 100.
(3) Android - pelvic index 80 to 100.
(4) Platypelloid - pelvic index below 80.

The/

The first and last categories are self-explanatory although it must be realised that some of the platypelloid cases were pathological rather than developmental types. Later on I will describe these cases where there is contraction of the pelvic brim.

In order to differentiate between the gynaecoid and android cases I not only carefully studied the shape of the pelvis but measured the exact point on the film where the widest transverse diameter crossed the antero-posterior of the brim. If the length of the posterior segment is less than 30% of the total antero-posterior of the brim, then the pelvis is classified as android. Nicholson and Allan (1946) called this the sagittal index. I must emphasise here that the study of pelvic architecture as described refers only to the shape of the pelvic brim. I found that while often the pelvic brim was classically android in shape the lower pelvis did not conform to the pattern described by Caldwell and Moloy, but was frequently capacious with a large subpubic angle.

(ii) Shape of the Sacrum :

While studying the X-ray films in this series, I was most impressed with the frequency with/

with which the sacrum was deformed. The importance of this is that if there is flattening of the sacral curve there may not be sufficient room in the mid-pelvis for the head to rotate. Roth (1953) describes six basic types of sacrae, but they are really all variations of the normal except the straight type. I decided to count as abnormal only those sacra which were either straight in the upper four segments or were definitely convex.

RESULTS.

A. PELVIC BRIM.

(1) Available inlet antero-posterior :

As already stated the available antero-posterior was measured in 520 spontaneous deliveries, 260 forceps deliveries and 50 Caesarean Sections. In Table I I have charted the results in the three groups, but have put them in percentages to facilitate comparison of results. I have placed all those measuring below 10.2 cm. (4") in one group as this is the standard below which a pelvic brim is conceded to be contracted, and this group will be considered separately later.

At/

At the upper end of the scale I have placed all measurements over 13.1 cm. (5.1") in one group although in working out the averages of the various categories, it was essential to make use of the correct measurements.

TABLE I.

AVAILABLE ANTERO-POSTERIOR OF PELVIC BRIM.

	Type of Delivery.		
	Spontaneous. (520)	Forceps. (260)	Caesarean Section (50)
cm. Over 13.1	6	7	-
12.6-13.0	6.7	12.3	-
12.1-12.5	12.3	12.3	12.0
11.6-12.0	16.3	20.4	8.0
11.1-11.5	22.5	17.3	20.0
10.6-11.0	18.5	16.1	22.0
10.2-10.5	13.5	9.2	16.0
Under 10.2	4.2	5. 4	22.0

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11.1-11.5	22.5	17.3	20.0
10.6-11.0	18.5	16.1	22.0
10.2-10.5	13.5	9.2	16.0
Under 10.2	4.2	5. 4	22.0

TABLE /

TABLE 2.

AVERAGES OF ANTERO-POSTERIOR OF PELVIC BRIM.

Spontaneous Delivery	:	11.66 cm. (4.575 inches)
Forceps Delivery	:	11.68 cm. (4.58 inches)
Caesarean Section	:	11.0 cm. (4.316 inches)
Average of Total	:	11.64 cm. (4.563 inches)

In Table 2 I have shown the average of the various groups and the average for the total 830 cases. It is interesting to note how closely the spontaneous and forceps groups correspond in each individual measurement and also in the total average. The Caesarean Section group shows, as one might expect, that over 20% of this group have a contracted pelvic brim. One can also see that the pelvic brim in this group does not contain any cases measuring more than 12.5 cm.

While the average figure for pelvic brim antero-posterior may not be of much value in assessing an individual case, it is of interest to compare pelvic size in this and other areas in/

in this country and abroad. In Table 3 I show the results obtained by various authors.

TABLE 3.

COMPARISON OF ANTERO-POSTERIOR OF PELVIC BRIM.

Nicholson (1938)	= 11.64 cm.
Ince and Young (1940)	= 11.97 cm.
Moir (1946)	= 11.8 cm.
Thoms et al (1939)	= 11.6 cm.
Grossloss et al (1948)	= 11.4 cm.
Mengert (1954)	= 11.8 cm.
Brown	= 11.64 cm.

As can be seen my own figures tend to be very slightly smaller than most of the other British ones, (the first three in the table), but one is struck by the uniformity of the results, considering that the figures cover a period of nearly 20 years and are from widely spread centres.

(2) Transverse diameter of Pelvic Brim.

This is normally defined as the greatest diameter between the arcuate lines. Again I have divided/

divided the results into three categories, spontaneous, forceps and Caesarean section. In order to facilitate interpretation of the results I have again put these in percentages. At the lower limit of normal I have taken the figure of 11.5 cm. and as can be seen in Table 4 there are very few cases below this level apart from the Caesarean group where the number is 6%. At the upper limit I have chosen the figure of 14.5 cm. and it is rather surprising to find the Caesarean group is the largest with 8%, presumably due to the large number of flat pelves.

TABLE 4.

TRANSVERSE DIAMETER OF PELVIC BRIM.

	Type of Delivery.		
	Spontaneous.	Forceps.	Caesarean Section.
cm. Over 14.5	3.3	5.4	8
14.1-14.5	5.4	5.8	6
13.6-14.0	17.2	18.4	2
13.1-13.5	24.8	25.4	16
12.6-13.0	26.8	21.1	30
12.1-12.5	15.2	17.0	18
11.6-12.0	5.8	5.0	14
11.5 and less	0.77	1.9	6

Table/

TABLE 5.

AVERAGE TRANSVERSE OF PELVIC BRIM.

Spontaneous Delivery	: 13.17 cm.(5.167 inches)
Forceps Delivery	: 13.23 cm.(5.188 inches)
Caesarean section	: 12.91 cm.(5.066 inches)
Average of total	: 13.18 cm.(5.168 inches)

Table 5 shows the averages in each of the three groups under review, together with the average figure of the total 830 cases. The forceps cases once again show the biggest average and the Caesarean section the lowest. It can be seen, however, that the difference between these two figures is just under one third of a centimeter. In comparing the results found here with other published works, I have used the same authors as in Table 3. Table 6 shows the similarity of the figures apart from those of Thom's.

TABLE /

TABLE 6.

COMPARISON OF TRANSVERSE OF PELVIC BRIM.

Nicholson (1938)	: 13.23 cm.
Ince and Young (1940)	: 13.06 cm.
Moir (1946)	: 12.9 cm.
Thoms et al (1939)	: 12.34 cm.
Grossloss et al (1948)	13.7 cm.
Mengert (1954)	: 12.7 cm.
Brown	: 13.18 cm.

3. Area of Pelvic Brim.

I have already explained that the area of the pelvic plane is calculated after Nicholson's method. The value of the area is that it enables one to see the spatial value of any particular plane. The great disadvantage is that if one diameter is markedly contracted and the other elongated a false impression may be gained as to the pelvic capacity. As a comparative measure, however, the area is of great value. In Table 7 I have once again taken the three groups of cases, spontaneous, forceps and Caesarean section and have recorded these in square centimetres. At the top end of the scale I have taken 145 sq.cm. although in both the spontaneous group and the forceps/

forceps group the figure of 160 was reached once. At the lower level I have taken the figure of 90 sq.cm., although 85 sq.cm. was seen on two occasions. I have, of course, corrected for the figures outwith the common range in working out the averages. As in previous tables I have placed the figures in percentages.

TABLE 7.

AREA OF PELVIC BRIM.

	Type of Delivery.		
	Spontaneous. (520)	Forceps. (260)	Caesarean Section. (50)
sq.cm. 145 +	3.3	3.4	0
140	3.3	5.4	2
135	6.2	5.4	0
130	5.0	8.4	2
125	14.4	16.5	12
120	16.0	15.0	10
115	16.7	16.0	4
110	14.8	17.1	24
105	10.9	8.0	20
100	6.9	4.2	12
95	1.5	2.3	8
90 -	1.0	2.3	6

TABLE/

TABLE 8.

AVERAGE AREA OF PELVIC BRIM.

Spontaneous Delivery	: 117.1 sq.cm.
Forceps Delivery	: 119.1 sq.cm.
Caesarean Section	: 108.9 sq.cm.
Average of total	: 117.3 sq.cm.

As can be seen from Table 7 26% of the cases delivered by Caesarean section have a brim area of 100 sq.cm. or less while in both the spontaneous and forceps groups the total is less than half of this. Table 8 shows that the forceps group has the biggest average brim area while the Caesarean group is markedly less than the other two.

In Table 9 I show the comparison of results of other authors. As can be seen in this table, I have fewer references, mainly because the pelvic area is not commonly quoted in the American literature.

TABLE 9/

TABLE 9.

COMPARISON OF AREA OF PELVIC BRIM.

Nicholson (1938)	: 121.0 sq.cm.
Ince & Young (1940	: 126.8 sq.cm.
Allan (1947)	: 130.2 sq.cm.
Bernard (1952)	: 122.2 sq.cm.
Grossloss et al (1948)	: 122.3 sq.cm.
Brown	: 117.3 sq.cm.

It is interesting to note that my figure is the lowest published one. This is presumably due to the smallness of the inlet antero-posterior which, as I have shown in Table 3, was the smallest found, together with that of Nicholson. The large number of cases of contracted pelves, a total of 47 with an inlet antero-posterior contracted to less than 10.2 cm. may possibly have some bearing on the fact. However, both my forceps and spontaneous groups are smaller than any other figures.

B. PELVIC OUTLET.

(i) Outlet antero-posterior :

The outlet antero-posterior was measured in each case in my series and once again the results are/

are charted in percentages in the three main groups. In Table 10 I have taken 10.2 cm. (4 inches) as the lower limit of normal although on two occasions the figure of 8.7 cm. was recorded. At the upper limit of normal I have taken 13.1 cm. although there were quite a few cases above this, the top figure being 14.5 cm.

TABLE 10.

OUTLET ANTERO-POSTERIOR.

	Type of Delivery		
	Spontaneous. (520)	Forceps. (260)	Caesarean Section. (50)
cm. Over 13.1	11.2	9.3	-
12.6-13.0	9.9	11.1	4
12.1-12.5	10.9	5.3	6
11.6-12	20.1	21.5	10
11.1-11.5	23.1	18.5	22
10.6-11.0	13.1	20.8	24
10.2-10.5	5.2	4.2	26
Under 10.2	6.5	9.2	8

TABLE 11/

TABLE 11.

AVERAGE OF OUTLET ANTERO-POSTERIOR.

Spontaneous Delivery	: 11.42 cm. (4.48 inches)
Forceps Delivery	: 11.32 cm. (4.44 inches)
Caesarean Section	: 11.13 cm. (4.36 inches)
Average of Total	: 11.37 cm. (4.46 inches)

As can be seen in Table 11 the Caesarean group has once again the smallest average diameter. What is also interesting is that the forceps group, for the first time in my series, is smaller than the spontaneous. The forceps group has the highest percentage of cases with an outlet diameter under 10.2 cm. (4"), nearly one-tenth of the total. These cases will be considered later under the heading of contracted pelvic outlet.

In Table 12 I have compared the results of the published figures from the literature.

TABLE 12./

TABLE 12.

COMPARISON OF PELVIC OUTLET ANTERO-POSTERIOR.

Nicholson (1938)	: 12.7 cm.
Ince and Young (1940)	: 11.97 cm.
Moir (1946)	: 11.7 cm.
Grossloss et al (1948)	: 11.68 cm.
Brown	: 11.37 cm.

The smaller number of references in the present series is because in America the "mid-plane" is usually measured from the lower border of symphysis pubes passes through the ischial spines and meets the sacrum at the junction of the fourth and fifth segments. This measurement is not comparable with those quoted above which are at a slightly lower level. Once again my results show a smaller result than any of the other series.

2. ISCHIAL BISPINOUS DIAMETER.

This measurement was taken in each case from the antero-posterior film, either true brim or modified brim. As the lower limit I have taken the figure of 9 cm. below which as can be seen few cases occurred. At the upper end of the scale/

scale I have taken the figure of 11.5 cm. which is well above the usual quoted figure of intraspinous distance. Table 13 shows the result in each of the three different groups in my series in percentages.

TABLE 13.

ISCHIAL BISPINOUS DIAMETER.

	Type of Delivery.		
	Spontaneous. (520)	Forceps. (260)	Caesarean Section. (50)
cm. Over 11.5	8.1	3.1	6
11.1-11.5	14.8	9.6	6
10.6-11.0	24.6	16.2	24
10.1-10.5	26.3	31.1	28
9.5-10.0	18.3	24.6	12
9.0- 9.5	6.2	11.9	16
Under 9	1.7	3.5	8

TABLE 14/

TAPLE 14.

AVERAGE OF ISCHIAL BISPINOUS DIAMETER.

Spontaneous Delivery	: 10.37 cm. (4.07 inches)
Forceps Delivery	: 10.13 cm. (3.97 inches)
Caesarean Section	: 10.36 cm. (4.06 inches)
Average of Total	: 10.29 cm. (4.04 inches)

As can be seen from Table 14 the forceps group has the smallest bispinous diameter, the Caesarean group being only very slightly smaller than the spontaneous group. It is interesting to see that if one takes the figure of 9.5 cm. as the lower limit of normal, one notices that the Caesarean group actually has the greatest number of cases in this category, 24% as against 14% forceps and 8% of the spontaneous group. At the upper end of the scale it is quite obvious that the spontaneous group has by far the largest number of cases, nearly a quarter being over 11 cm.

In Table 15 I have compared the figures obtained from the literature. In this table I have included more American authors than has been possible in many of the tables. This is because this diameter is thought to be of major importance on the other side of the Atlantic.

TABLE 15/

TABLE 15.

COMPARISON OF ISCHIAL BISPINOUS DIAMETER.

Nicholson (1938)	: 10.54 cm.
Ince and Young (1940)	: 9.95 cm.
Moir (1946)	: 10.45 cm.
Thoms et al. (1939)	: 10.17 cm.
Eller & Mengert (1947)	: 10.5 cm.
Grossloss et al.(1948)	: 10.26 cm.
Brown	: 10.29 cm.

Ince and Young's figure can be seen here to be the only one under 10 cm. but apart from this all the figures are remarkably close together.

3. AREA OF PELVIC OUTLET.

This area is calculated in a similar manner to that of the pelvic brim, using, in this case, the lower antero-posterior and the bispinous diameters. As before I have charted the three types of delivery and show the results in percentages in Table 16.

At the upper limit I have taken 115 sq.cm. because there are relatively few pelvic outlets above this figure, although on a few occasions

135 sq.cm. was seen. As the lower limit I have taken 70 sq. cm., although a figure of 65 sq. cm. was seen on a very rare occasion.

TABLE 16.

AREA OF PELVIC OUTLET.

	Type of Delivery.		
	Spontaneous. (520)	Forceps. (260)	Caesarean Section. (50)
sq.cm. 115+	4.4	3.1	-
110	4.8	2.7	2
105	12.7	6.5	16
100	16.5	8.1	10
95	16.7	11.9	6
90	14.8	22.7	14
85	12.1	18.5	14
80	13.2	20.7	20
75	3.1	3.4	8
70-	1.7	2.3	10

TABLE 17/

TABLE 17.

AVERAGE OF PELVIC OUTLET AREA.

Spontaneous Delivery	: 92.8 sq. cm.
Forceps Delivery	: 89.79 sq.cm.
Caesarean Section	: 88.8 sq.cm.
Average of Total	: 91.74 sq.cm.

As can be seen from Table 17 the average figures work out fairly close together, the forceps and Caesarean group being within 1 sq.cm. of each other, while the spontaneous group was only 4 sq.cm. larger than the Caesarean section.

Of greater importance, however, is the large number of cases at the lower end of the table in the forceps and Caesarean groups, especially the 18% of the latter cases with an outlet area of 75 sq.cm. or below. Later I will show the relationship of contracted pelvic brim to these cases of small outlet area.

In Table 18 I have compared the published figures from the literature.

TABLE 18/

TABLE 18.

COMPARISON OF PELVIC OUTLET AREA.

Nicholson (1938)	: 106.7	sq.cm.
Ince & Young (1940)	: 93.7	sq.cm.
Allen (1947)	: 90.	sq.cm.
Grossloss et al (1948)	: 94.4	sq.cm.
Brown	: 91.74	sq.cm.

Nicholson's figures are surprisingly large but it will be remembered that the antero-posterior of the outlet in his series was nearly 1 cm. longer than anyone else's and this naturally makes the area larger. Although his figures are nearly 20 years old they were from a rural population, presumably of healthy stock.

4. SUB-PUBIC ANGLE.

As already described this measurement was obtained in each case in the three categories in my series by direct measurement with a protractor. In Table 19 I have plotted the results in percentages. At the upper end of the scale I have taken the figure of 100° as few cases were above this measurement. At the lower level I have taken/

taken the figure of 70°.

TABLE 19.

SUB-PUBIC ANGLE.

	Type of Delivery.		
	Spontaneous. (520)	Forceps. (260)	Caesarean Section. (50)
Over 100°	2.9	1.9	4
95-99	8.1	4.6	2
90-94	21.0	12.7	14
85-89	29.8	27.3	18
80-84	22.7	23.5	26
75-79	11.9	18.8	24
70-74	2.8	7.7	12
70 -	0.7	3.5	0

TABLE 20.

AVERAGE of SUB-PUBIC ANGLE.

Spontaneous Delivery	: 86.88°
Forceps Delivery	: 84.3°
Caesarean Section	: 83.5°
Average of Total	: 85.25°

As/

As can be seen in Table 20 the average of the three categories is fairly close together. As might be expected the spontaneous group has the largest average. Table 19 shows that in both the forceps and Caesarean groups over 10% of the sub-pubic arches are under 75%.

In Table 21 I have charted the published figures from the literature.

TABLE 21.

COMPARISON OF SUB-PUBIC ANGLE.

Nicholson (1938)	: 84.8°
Ince and Young (1940)	: 93.5°
Moir (1946)	: 86.0°
Brown	: 85.25°

All these figures are from the British literature, as in America the outlet measurements used are the ischial bituberous and the posterior sagittal, both of which are difficult to measure accurately by X-rays.

It is surprisingto find that Nicholson's figures are the smallest after the previous measurement - the outlet area - being so large.

(b) PELVIC/

(b) PELVIC ARCHITECTURE.

(i) Shape of Pelvic brim :

I have already mentioned in the introduction that I was unable to classify the shape of the pelvic brim in the latter half of the spontaneous delivery cases owing to a changed radiological technique. In Table 22 I have tabulated the shape of the pelvic brim in the 260 spontaneous cases, 260 forceps deliveries and 50 Caesarean sections - a total of 570 cases.

TABLE 22.

SHAPE OF PELVIC BRIM.

Type of Delivery.	Gynaecoid.	Anthropoid.	Android.	Platypelloid.
Spontaneous	73.1%	6.1%	5%	15.8%
Forceps	68.0%	8.1%	9.3%	14.6%
Caesarean	56.0%	2.0%	16.0%	26.0%
Averages	69.3%	6.7%	7.9%	16.1%

In attempting to compare the results of different series of cases from the literature one cannot avoid the influence of Caldwell and Moloy in the/

the American literature. Also one finds their results quoted in British obstetric text-books. In more recent years, however, the British literature has tended to minimise the value of pelvic shape. In Table 23 I have used two of Caldwell and Moloy's tables and as can be seen the figures differ considerably. In the paper by Kenny(1944) I have separated out the pure android, anthropoid, and platypelloid firstly; she has various mixed forms of gynaecoid-android and android-gynaecoid as well as pure gynaecoid and I have grouped all these under gynaecoid. Nicholson and Allen(1946) have doubts as to whether a narrow pelvic outlet has anything to do with pelvic shape, while their figures are in round numbers. Bernard (1952) has taken tall and small women for his series and he only finds one case of "scutiform" pelvis in the whole series. It can thus be seen that there is a wide variation in interpretation and values.

TABLE 23/

TABLE 23.

Author.	Gynaecoid.	Anthro-poid.	Android.	Platy-pelloid
Moloy - Western Reserve (White) (1951)	41.4	23.5	32.5	2.6
Moloy - Sloan Hospital (White) (1951)	44.2	27.6	22.6	5.6
Walsh (1940)	56.0	17.25	23.75	3.0
Steele & Javert (1942)	56.3	17.0	19.6	7.1
Kenny (1944)	70.9	6.4	20.3	2.4
Nicholson & Allen (1946)	70.0	10.0	10.0	10.0
Bernard (1952)	76.0	3.0	0.5	20.5
Brown	69.3	6.7	7.9	16.1

It is interesting to note that the British figures are fairly similar in many respects especially in the high incident of gynaecoid pelves. The low incidence of platypelloid pelves and high one of android in Kenny's series is, I am sure, due to the fact that sense impression rather than measurement took precedence.

In Table 24 I have compared the results found in each of the four types of pelvis with the size/

size of the pelvic brim area. I have divided the pelvic area into :-

(i) large - 125 sq.cm. or over.

(ii) average -105-120 sq.cm.

(iii) small - 100 sq. cm. or less.

As will be remembered the average brim area worked out at 117.3 sq. cm. so it is possibly placing the emphasis on the small pelves. The spontaneous group and the forceps group contained the same number of cases, so in order to make the Caesarean group comparable, I have placed the results in percentages.

See TABLE 24 on following page.

From this table it can be seen that in the small gynaecoid pelves the incidence of Caesarean section is twice as large as spontaneous delivery. The anthropoid pelvis, as might be expected, had only one small pelvis. The android pelves contained only 12% of small pelves compared with 24% in the platypelloid group. Another interesting point is that the ratio of large to small pelves is/

TABLE 24

COMPARISON OF THE SIZE OF PELVIC BRIM WITH ITS SHAPE

Size of Pelvic Brim	Gynaecoid			Anthropoid			Android			Platypelloid		
	S.D.	F.D.	C.S.	S.D.	F.D.	C.S.	S.D.	F.D.	C.S.	S.D.	F.D.	C.S.
Large	23.8	29.9	10.0	3.5	6.1	-	-	2.0	2.0	2.7	1.5	6.0
Average	42.3	33.4	31.0	2.3	2.0	2.0	4.2	6.1	12.0	10.0	10.4	13.0
Small	7.0	5.0	14.0	0.4	-	-	0.8	1.1	2.0	3.0	2.6	8.0

is greatest in the anthropoid pelves, less in the gynaecoid, equal in the android and reversed in the platypelloid.

It seemed advisable to make a similar comparison in the case of the pelvic outlet area. Here I divided the size as follows:

(i) Large group : 100 sq.cm. and above.
(ii) Average : 80 - 95 sq. cm.
(iii) Small : 75 sq.cm. or less.

The average outlet area was 91.74 sq.cm. for my whole series, so it would seem that I have allowed emphasis to be placed on the small outlet.

See TABLE 25 on following page.

As can be seen from Table 25 the ratio of large to small pelvic outlets is greatest in the gynaecoid group and next is the platypelloid group. The android and anthropoid groups are small and possibly somewhat distorted but it is interesting to note that the anthropoid has the smallest ratio of all four types of pelvis. The large proportion of the women in the Caesarean group who had a small pelvic outlet is worth noting - 20% as against 5.7% in both the spontaneous and forceps groups.

2. SHAPE/

TABLE 25

COMPARISON OF THE SIZE OF THE PELVIC OUTLET WITH THE SHAPE OF THE BRIM

Size of Pelvic Outlet	Gynaecoid			Anthropoid			Android			Platypelloid		
	S.D.	F.D.	C.S.	S.D.	F.D.	C.S.	S.D.	F.D.	C.S.	S.D.	F.D.	C.S.
Large	24.7	16.1	12.0	2.0	1.2	-	2.3	1.2	6.0	4.2	2.0	10.0
Average	43.5	47.1	32.0	4.2	6.2	-	2.3	8.1	8.0	10.8	12.1	12.0
Small	5.1	4.2	12.0	-	0.8	2.0	-	-	2.0	0.8	0.8	4.0

2. SHAPE OF THE SACRUM.

As already mentioned I have inspected each lateral film in the whole series in order to ascertain which pelves have a flat or convex sacrum. In Table 26 I have tabulated the shape of the sacrum according to the shape of pelvis in each of the different delivery groups. It was, of course, only possible to ascertain this in half of the spontaneous deliveries, all the forceps and all the Caesarean sections. There were 43 straight sacraes in the spontaneous deliveries, 32 in the forceps group and 7 in the Caesarean sections.

TABLE 26.

FLAT SACRAE BY PELVIC SHAPE.

Type of Delivery.	Gynae-coid.	Anthro-poid.	Android.	Platy-pelloid.	Average
Spon-taneous (260)	36	2	3	2	= 16.5%
Forceps (260)	17	1	8	6	= 12.3%
Caesarean Section (50)	4	-	-	3	= 14.0%

It/

It is interesting to note in this table how commonly flat sacrae are found in gynaecoid pelves in the spontaneous group, while the high incidence in android pelves in the forceps group is obvious. In the Caesarean group the number of gynaecoid and platypelloid pelves is nearly the same, but all these flat pelves were contracted at the pelvic brim; probably due to rickets.

In the right hand column in Table 26 I show the percentage of the totals which have flat sacrae. It is interesting to note that the spontaneous group is the biggest, but on adding in the other half of the spontaneous group - the ones in which pelvic shape was not ascertainable - I found the total average of the spontaneous dropped to 11.7%. Therefore out of my total of 830 cases the average of straight or convex sacrae is 12%. In Table 27 I show some results obtained from the literature for comparison.

TABLE 27.

COMPARISON OF FLAT SACRAE.

Roth (1953)	= 18%.
Snow (1952)	= 25%.
Posner et al (1955)	= 21.3%.
Brown	= 12%.

I/

I thought it would be of interest to compare the size of the pelvic brim area and the outlet area in these cases of flat sacrae with a normal series. For the control series I used the figures of Tables 24 and 25, but I made a composite tablet of inlet and outlet areas. I have made this table a percentage one so that the figures can be easily compared - see Table 28 on p. 51.

From this table it can be seen that the brim area is very similar in both the pelves with flat sacrae and the controls, apart from the small pelvis group delivered by Caesarean section. The cases with flat sacrae have nearly twice as high an incidence in this group.

Regarding the outlet area, the flat sacrae have a much greater number with a large pelvic outlet, while the average outlet is almost exactly similarly reduced in size. The small pelvic outlet is very similar in the spontaneous and forceps groups while in the Caesarean group the more frequent incidence is dependent upon the size of the brim already referred to.

These figures would suggest that a small pelvic brim area, 100 sq. cm. or less associated with a flat sacrum does tend to increase the incidence/

TABLE 28

COMPARISON OF BRIM AND OUTLET AREA IN CASES WITH FLAT SACRAE WITH NORMAL

	Type of Delivery	Brim Area			Outlet Area		
		Large	Average	Small	Large	Average	Small
Flat Sacrae	Spontaneous	26.3	60.3	12.8	42.5	51.9	5.1
	Forceps	40.5	52.7	6.5	28.7	64.8	6.5
	Caesarean Section	14.2	42.6	42.6	42.6	28.4	28.4
Control	Spontaneous	30.0	58.8	11.2	33.2	60.8	5.9
	Forceps	39.5	51.9	8.7	20.5	73.6	5.8
	Caesarean Section	18.0	58.0	24.0	28.0	52.0	20.0

incidence of Caesarean section. The table also shows that cases with flat sacrae do tend to have an adequate outlet in most cases.

CORRELATION OF VARIOUS FACTORS IN PELVIC SIZE.

To obtain a comparison of various measurement plotted one against the other, in order to be able to appreciate pelvic configuration more accurately, I have firstly charted pelvic brim area against pelvic outlet area. This enables one to see how much narrowing there is from pelvic brim to the plane of least pelvic dimensions. The average brim area in my series was 117 sq. cm. and the outlet area 92 sq.cm., a difference of 25 sq.cm. It seemed to be that it would be of interest to see how many cases had a much larger brim than outlet, a brim equal to the outlet, and in some cases an outlet bigger than the brim. Owing to the large variation in pelvic brim area, I decided to take a top level of 130 sq.cm. and a lower one of 90 sq. cm. for inlet area, with 105 sq.cm. to 70 sq. cm. for outlet area. In the next Table (29) I have taken the three methods of delivery separately. I have in the next section of my paper attempted to compare/

TABLE 29.

COMPARISON OF PELVIC BRIM AREA BY OUTLET AREA.

SPONTANEOUS DELIVERY (520 cases)

Inlet area in sq. cm.	Outlet area in sq. cm.							
	105.	100.	95.	90.	85.	80.	75.	70.
130	45	20	13	7	6	1	-	-
125	16	18	20	9	1	8	2	1
120	18	20	17	14	9	5	-	1
115	16	17	14	16	11	11	-	2
110	13	8	9	14	16	10	5	1
105	4	-	10	8	10	16	6	3
100	2	2	4	8	4	13	2	1
95	-	1	-	1	3	3	-	-
90	-	-	-	-	4	-	1	-
								25.

FORCEPS DELIVERY (260 cases).

Inlet area in sq.cm.	Outlet area in sq. cm.							
	105.	100.	95.	90.	85.	80.	75.	70.
130	15	11	7	11	3	10	1	1
125	9	3	9	8	10	4	-	-
120	4	2	7	12	3	11	-	-
115	1	4	2	13	11	9	1	-
110	2	1	4	5	11	8	1	2
105	1	-	1	6	2	6	3	2
100	-	-	-	2	6	2	1	-
95	-	-	-	1	2	2	1	-
90	-	-	1	1	-	2	1	1
								15.

CAESAREAN/

TABLE 29 - contd.

CAESAREAN SECTION (50 cases).

Inlet area in sq.cm.	Outlet area in sq. cm. 105.	100.	95.	90.	85.	80.	75.	70.
130	2	-	1	-	-	-	-	-
125	3	2	-	1	-	-	-	-
120	-	1	-	-	3	1	-	-
115	-	-	-	-	-	2	-	-
110	2	-	1	2	1	2	1	3
105	1	2	-	2	2	1	1	1
100	-	-	1	1	1	2	-	-
95	1	-	-	-	-	2	-	1
90	-	-	-	1	-	-	1	1
							9.	

compare the incidence of funnel pelvis. I decided that if the difference between inlet area and outlet area was more than 35 sq. cm. then the case should be considered as one of funnel pelvis, see Table 30. The reason I chose 35 sq.cm. was that if one compares the difference between inlet area and outlet area in the published figures from the literature, in only one case, that of Allen (1947) is the difference as large as/

as 40 sq. cm., the average being 28 sq. cm.

TABLE 30.

DIFFERENCE BETWEEN INLET AREA and OUTLET AREA.

	Inlet area.	Outlet area.	Difference.
	Sq.cm.	sq.cm.	sq. cm.
Nicholson (1938)	121.0	106.7	14.0
Ince & Young (1940)	126.8	93.7	33.0
Allen (1947)	130.2	90.0	40.0
Brown	117.3	92.0	25.0
		Average =	28 sq.cm.

In Table 31 I have shown the results obtained from my series, taking the figure of 35 sq.cm. or above as the level of the pelvic funnelling.

TABLE 31.

INCIDENCE OF PELVIC FUNNELLING.

Spontaneous Delivery	34	= 6.5%
Forceps Delivery	54	= 20.8%
Caesarean Section	4	= 8.0%

It is worth noting that the highest incidence of pelvic funnelling is seen to be in the forceps group - 3 times as great as the spontaneous group/

group. When one remembers that the average pelvic brim area of the forceps group is only 2 sq.cm. larger than the spontaneous group, and the outlet area of the forceps 3 sq.cm. smaller than the spontaneous, the large number of cases with a difference in size in excess of 35 sq. cm. seems surprising.

On investigating equality of size of brim and outlet areas, I found only 13 in spontaneous deliveries, 2 in the forceps group, and 1 in the Caesarean sections.

Investigation of outlet area bigger than brim area showed only 5 cases in the spontaneous group and none in the other two groups.

One last point about the relationship of brim area to outlet area is the wide variation in pattern. While a large inlet area has usually a fairly large outlet area, in not a few cases it was quite the opposite. In one particular case the inlet area at 140 sq. cm. was exactly double that of the outlet area at 70 sq. cm.

2. CONTRACTED PELVIC BRIM, ANTERO-POSTERIOR.

I showed in Table I that there were a total of 47 cases in whom the available antero-posterior of the pelvic brim was under 10.2 cm.(4") This/

This is the level at which pelvic brim contraction is recognised, both in the Simpson Memorial Maternity Pavilion and in Johnstone and Kellar (1955). Other authors such as de Lee and Greenhill (1947) and Brews (1948) suggest that if the antero-posterior is 1 cm. less than normal the pelvis should be considered contracted. If I had used this definition I would have made the level of contracted pelvis 10.6 cm. which appears rather large to me.

I have mentioned before that while the area of the pelvic brim is morphologically important, it does not always denote a contracted pelvis. To emphasise this point in Table 32 I show the cases of contracted pelvic brim antero-posterior charted against the pelvic area of the inlet. (Table 32 on p. 58.)

From this table it can be seen that 27 cases of contracted antero-posterior of pelvic brim had an area of 100 sq. cm. or less, but on the other hand 20 cases of contracted brim antero-posterior had an area above 100 sq. cm. up to 120 sq.cm. in one case. From these findings it would appear essential to ascertain the antero-posterior of the pelvic brim and not to rely on the pelvic brim area alone.

TABLE 32

CONTRACTED BRIM ANTERO-POSTERIOR against BRIM AREA

Brim A.P. in c.m.	120	115	110	105	100	95	90	Brim area in sq. c.m.
10 + 10.1	1 F.D.	1 S.D. 1 F.D.	1 S.D. 2 F.D. 2 C.S.	6 S.D. 1 C.S.	2 S.D. 2 F.D. 1 C.S.	2 S.D. 2 F.D. 1 C.S.	1 C.S.	26
9.7-9.9			1 S.D. 1 C.S.		1 S.D. 1 F.D.	1 S.D. 3 C.S.	1 F.D.	9
9.4-9.6			1 F.D.	1 S.D.	1 S.D.	1 S.D.	1 S.D. 1 F.D.	6
9.1-9.3						1 S.D.	1 S.D. 1 F.D.	3
8.8-9.0				1 F.D.			1 S.D. 1 C.S.	3
Total	1	2	8	9	8	11	8	47

S.D. = Spontaneous Delivery 22
F.D. = Forceps Delivery 14
C.S. = Caesarean Section 11

As well as the comparison of the pelvic brim antero-posterior and brim area it seemed essential to compare the contracted brim antero-posterior with the outlet area. In Table 33 I have made such a comparison.

See Table 33 on p. 60.

From this table it can be seen that only 6 cases of brim antero-posterior contraction had a pelvic outlet of less than 80 sq. cm. out of a total of 47. This would suggest that in most cases of contracted pelvic brim antero-posterior it is generally possible to allow a trial of labour; but if the outlet also is contracted it would appear doubtful to permit this as half those cases required caesarean section.

3. CONTRACTED TRANSVERSE OF PELVIC BRIM.

In Table 4 I showed that only a total of 12 cases altogether had a brim transverse measurement of 11.5 cm. (4½") or less. The incidence was greatest in the caesarean group where the incidence was 6%. Contracted transverse of the pelvic brim is most commonly found in generally contracted pelves and anthropoid pelves. The former type of pelvis/

TABLE 33

CONTRACTED BRIM ANTERO-POSTERIOR against OUTLET AREA

Inlet A.P.	105	100	95	90	85	80	75	70	Outlet area in sq. c.m.
10.0-10.1	1 S.D. 1 C.S.	1 S.D.	4 S.D.	1 S.D. 1 F.D. 1 C.S.	4 S.D. 5 F.D.	1 S.D. 1 F.D. 2 C.S.	1 F.D. 1 C.S.	1 C.S.	26
9.7-9.9	2 C.S.				1 S.D. 1 F.D.	1 S.D. 1 C.S.	1 S.D.	1 F.D. 1 C.S.	9
9.4-9.6		1 F.D.		1 S.D.	2 S.D.	1 S.D. 1 F.D.			6
9.1-9.3					1 S.D.	1 S.D. 1 F.D.			3
8.8-9.0				1 F.D. 1 C.S.	1 S.D.				3
Total	4	2	4	6	15	10	3	3	47

very frequently causes severe dystocia, and one may embark on a vaginal delivery which results in at least strong traction with the forceps, or at the worst a failed forceps or dead child. In view of this, I feel that although the numbers are small, it is worth tabulating the brim and outlet area in these cases. One interesting point is that none of these cases of contracted transverse of the brim had a contracted antero-posterior as well.

Table 34 shows that a transversely contracted pelvic brim results in most cases in a pelvic brim area of 100 sq. cm. or less. In two of the spontaneous deliveries and one of the forceps the pelvis was anthropoid in shape, in all the other gynaecoid, or justo-minor. It is interesting to note that of the 5 cases with a brim area of 90 sq. cm. Caeaarean section was only required once.

Table 35 illustrates that a contracted transverse of brim does not necessarily mean a small outlet. One third of these cases had an outlet area of 75 sq. cm. or below, but on the other hand another third were 90 sq. cm. or above, which is not much below the average of 92 sq.cm.

In spite of there being no foetal loss in this/

TABLE 34

CONTRACTED TRANSVERSE BRIM against INLET AREA

Transverse of brim in c.m.	120	115	110	105	100	95	90	Brim area in sq. c.m.
11.5	-	-	-	1 F.D. 1 C.S.	1 S.D. 1 C.S.	1 F.D.	1 S.D. 1 F.D. 1 C.S.	8
11.25	-	-	-	-	-	-	1 F.D.	1
11.0	-	-	-	1 S.D.	1 S.D.	-	1 F.D.	3
10.25	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	12

TABLE 35

CONTRACTED TRANSVERSE BRIM against OUTLET AREA

Transverse of brim in c.m.	95	90	85	80	75	70	Outlet area in sq. c.m.
11.5	1 S.D.	1 F.D. 1 C.S.	1 S.D.	1 C.S.	1 F.D. 1 C.S.	1 F.D.	8
11.25	-	-	-	-	1 F.D.	-	1
11.0	1 F.D.		1 S.D.	1 S.D.	-	-	3
10.75	-	-	-	-	-	-	-
Total							12

this group of patients in my series, one should very carefully observe such patients in labour and be prepared for Caesarean section at any time, even after a trial of forceps.

PELVIC OUTLET.

I showed in Table 10 the incidence of outlet antero-posterior of the pelvis and it may be remembered that in the whole series of 830 cases, a total of 62 had a measurement of less than 10.2cm. (4"). Many observers including Morris,(1947), Williams and Arthure (1949) and Hawkworth and Allen (1951) consider that this measurement alone, or in corrected form, depending on the size of the subpubic angle, is the all important one. While not disagreeing with these authors I feel that the outlet area is most important. In Table 36 I have shown the relationship of contracted outlet antero-posterior to the area of the pelvic outlet. It will be remembered from Table 29 that there were a total of 49 women with an outlet area of 75 sq.cm. or less and the present table illustrates that 24, or just about half, have an outlet antero-posterior of less than 10.2 cm. From this it would appear that knowledge of the ischial bispinous is necessary to diagnose contracted pelvic outlet/

outlet.

Table 36 on p. 66.

Before making a table to show the relationship of bispinous diameter to the pelvic outlet area, it seemed essential to decide at what level the bispinous diameter could be considered contracted. In Table 4 I showed that the average for my whole 830 cases was 10.3 cm. a figure less than most of those published. I therefore decided to take all cases whose bispinous was 9.5 cm. or less, which added up to 11.3% of my cases (94). This seems rather a large total, but by taking away the first or second columns it is possible to reduce the figures to below 9 cm.

TABLE 37 on p. 67.

One interesting point regarding these two latter tables is that in only 5 cases, out of the total of 49 with contracted outlet, did the same pelvis appear in both tables. This means, therefore, that it is necessary to ascertain both the antero-posterior and transverse outlet before definitely knowing the possibility of contracted pelvic outlet.

One other point of interest is that the outlet/

TABLE 36

CONTRACTED ANTERO-POSTERIOR OF PELVIC OUTLET against AREA OF PELVIC OUTLET

Outlet A.P. in c.m.	95	90	85	80	75	70-	Outlet area in sq. c.m.
10-10.1	-	-	3 S.D. 4 F.D.	8 S.D. 9 F.D.	2 S.D. 1 F.D. 1 C.S.	1 S.D. 2 F.D. 1 C.S.	32
9.7-9.9	-	1 F.D.	1 S.D.	5 S.D. 2 F.D. 1 C.S.	1 S.D.	5 S.D. 1 F.D.	17
9.4-9.6		1 S.D.	1 F.D.	1 S.D.	3 S.D. 1 F.D. 1 C.S.	-	8
9.1-9.3						3 S.D. 1 F.D.	4
8.8-9.0	-	-	-	1 F.D.	-	-	1
						24	Total 62

TABLE 37

BISPINOUS DIAMETER against AREA OF PELVIC OUTLET

Bispinous Diameter in c.m.	95	90	85	80	75	70	Outlet area in sq. c.m.
9.5	1 S.D. 1 F.D.	3 S.D. 4 F.D. 1 C.S.	4 S.D. 4 F.D. 1 C.S.	6 S.D. 6 F.D.	2 S.D. 2 F.D. 2 C.S.	-	37
9.25	-	1 S.D. 2 F.D.	3 S.D. 3 F.D. 1 C.S.	6 S.D. 8 F.D. 1 C.S.	3 S.D. 2 F.D.	2 S.D. 3 C.S.	35
9.0	-	1 F.D.	2 F.D.	1 S.D. 1 F.D.	2 S.D.	1 C.S.	8
8.75	-	-	2 S.D. 1 C.S.	1 S.D. 1 F.D.	1 F.D. 1 C.S.	1 S.D. 1 C.S.	9
8.5	-	-	-	1 S.D.	1 F.D.	-	2
8.25 or less	-	1 S.D.	-	1 F.D.	-	1 F.D.	3
						25 Total	94

outlet transversely contracted group had a total of 8 Caesarean sections as against only 4 in the contracted antero-posterior group. The forceps and spontaneous groups were practically equal allowing for the antero-posterior contraction being 1½ times less often found than the transverse. This would suggest the transverse measurement was the more important of the two.

Table 33 showed that only 6 cases of contracted antero-posterior of brim had a contracted outlet area (75 sq.cm. or less), while Table 29 showed that only 11 cases with a small brim area (100 sq. cm. or less) had a contracted outlet area. This would therefore suggest that brim contraction and outlet contraction tend to be separate entities, but that if they do occur together the chance of Caesarean section is at least 25%.

SUB-PUBIC ANGLE.

The last part of the pelvic outlet which I have left to discuss is the sub-pubic angle. The sub-pubic angle is really a transverse measurement of the pelvis and it seemed to me that as I have made use of the ischial bispinous diameter to measure the size of the transverse of the outlet at the upper level of the pelvic outlet, so/

so it should be feasible to use the sub-pubic angle for measuring the lower level. In the American literature the ischial bituberous is made much use of as an outlet measurement, but it is difficult to measure accurately, and I have not made use of it myself, nor of the posterior sagittal where the anterior end-point is difficult to define.

I thought it would be possible to establish a relationship between the ischial bispinous and sub-pubic angle, so in Table 38 I have plotted one against the other in all the 830 cases in the series.

TABLE 38 on p. 70.

From this table it can be seen that there is a fairly definite relationship of ischial bispinous to sub-pubic angle. If one takes 9.5 cm. as the lower limit of normal, it will be noticed that the sub-pubic angle has an average of 79.5° for this group of 94 cases.

On the other hand if one takes those cases whose sub-pubic angle is below 75°, one finds the average of the ischial bispinous is 9.9 cm. in these 54 cases.

These/

TABLE 38

ISCHIAL BISPINOUS against SUB-PUBIC ANGLE

Ischial Bispinous in c.m.	100°+	95-99	90-94	85-89	80-84	75-79	70-74	70-	
11.6 and above	7	8	15	11	5	5	2	-	
11.1-11.5	8	14	23	28	21	8	2	-	
10.6-11.0	4	14	46	56	41	16	4	-	
10.1-10.5	1	12	39	83	56	28	11	2	
9.6-10.0	1	6	21	47	42	35	10	4	
9.1-9.5	1	1	4	11	17	24	8	6	
9.0 or less	-	-	1	1	8	7	4	1	94
	77						54		

These figures show that a contraction at one level does not necessarily mean there will be a contraction at the other, but the averages are definitely below normal. Reference to Table 20 shows that the average sub-pubic angle was 85°, while Table 14 shows that the average ischial bi-spinous is 10.29 cm.

One might therefore consider it advisable to assess the pelvis carefully in any cases where the sub-pubic angle is found to be unduly narrow on vaginal examination of the pelvis. X-ray pelvimetry would seem the logical answer to suspected narrowing at the level of the ischial spines.

I next considered the question of how much space is wasted by the narrowing of the sub-pubic angle. I have already mentioned the difficulties and disadvantages of assessing this with a disc of definite size. In Table 39 I have charted the outlet antero-posterior against the sub-pubic angle. I have done this separately for each type of delivery. In this table I have not attempted to level up the figures in any group, but it will be remembered that the spontaneous group was twice as large as the forceps group and over 10 times larger than the Caesarean group.

It/

It will be recalled that the average sub-pubic angle for my whole series was 85° so if one allows 10° on either side of this, one finds that 77 or 9.3% are above 95° and 54 or 6.6% below 75°. It is this lower figure on which I want to focus attention. It will be noted that only 19 or 3.6% of the spontaneous group had a sub-pubic angle in this lower category, while in the forceps group there were 29 or 11.1% in this category. The Caesarean section group was slightly higher than this at 12%. These figures would suggest that the sub-pubic angle narrowing does tend to increase the incidence of operative delivery, although, of course, the Caesarean figures are an indication of pelvic smallness, rather than the reason for operative delivery.

It will be noted that in all three groups of cases, the narrow sub-pubic angle is associated with all lengths of the outlet antero-posterior diameter. In fact, it is interesting to note that at the lower limit of this antero-posterior diameter, i.e. 10.1 cm. or less, there were very few cases of narrow sub-pubic angle, only 5 under 75°. As 2 of these are in the spontaneous group and 2 in the Caesarean section group it cannot be said to have increased the incidence of operative vaginal delivery.

TABLE/

TABLE 39.

ANTERO-POSTERIOR OF OUTLET OF PELVIS against SUB-PUBIC ANGLE.

SPONTANEOUS DELIVERY (520 cases).

O.A.P. in cm.	100°+	95°-99°	90°-94°	85°-89°	80°-84°	75°-79°	70°-74°	69°-
13 cm.& over	3	4	9	12	17	10	1	2
12.5-12.9	4	4	10	14	10	8	1	-
12.0-12.4	-	6	10	22	14	4	1	-
11.5-11.9	2	7	16	30	33	10	4	1
11.0-11.4	-	8	25	42	26	17	2	-
10.5-10.9	4	8	18	15	12	8	3	-
10.2-10.5	2	3	10	8	-	4	1	1
10.1 or less	-	2	11	12	6	1	2	-
	57						19	

FORCEPS DELIVERY (260 cases)

O.A.P. in cm.	100°+	95°-99°	90°-94°	85°-89°	80°-84°	75°-79°	70°-74°	69°-
13 cm.& over	1	1	2	6	6	6	1	1
12.5-12.9	-	1	2	6	10	6	3	1
12.0-12.4	-	-	2	3	4	2	2	1
11.5-11.9	1	3	7	10	15	15	4	1
11.0-11.4	-	2	8	14	7	7	6	4
10.5-10.9	1	3	6	19	12	9	3	1
10.2-10.4	-	-	3	5	1	2	-	-
10.1 or less	2	2	3	8	6	2	1	-
	17						29	

CAESAREAN/

TABLE 39 (contd)

CAESAREAN SECTION. (50 Cases)

O.A.P. in cm.	100°+	95°-99°	90°-94°	85°-89°	80°-84°	75°-79°	70°-74°	69°-
13 cm.& over	-	-	-	1	-	1	-	-
12.5-12.9	-	-	-	-	1	1	1	-
12.0-12.4	-	-	1	3	-	-	-	-
11.5-11.9	2	-	1	2	3	1	1	-
11.0-11.4	-	1	2	-	3	2	1	-
10.5-10.9	-	-	1	3	4	5	-	-
10.2-10.4	-	-	1	2	-	1	1	-
10.1 or less	-	-	1	-	-	1	2	-
	3						6	

PART/

PART II.

CONSIDERATION OF OTHER FACTORS IN RELATION TO PELVIS

1. Height of Mother :

I explained in the introduction to this paper that the stature of the patient is measured at the first ante-natal visit if a booked case. If unbooked the height is taken before the patient leaves hospital. I thought the first piece of information which required investigation was the average height in each group of cases. I worked this out to the nearest quarter inch, but for the tables I show this in whole inches as it is merely an illustrative table. I have charted the height of the patients in Table 40 in percentages in order that comparison will be easier.

TABLE 40 on p.76.

This table is taken from 5' 6" down to 4' 10". There were, of course not a few cases outwith these figures, the tallest was 5' 10" and the shortest 4' 4". One interesting point is the low total of forceps deliveries in the group of smallest women. Apart from this group the figures are fairly similar in all three groups.

In/

TABLE 40.

MATERNAL HEIGHT IN DIFFERENT TYPES OF DELIVERY.

Maternal height.	Types of Delivery.		
	Spontaneous.	Forceps.	Caesarean Section.
5' 6"+	4.1	3.8	8
5' 5"	5.8	8.9	4
5' 4"	9.1	9.7	2
5' 3"	9.6	13.8	4
5' 2"	12.9	13.9	32
5' 1"	18.2	19.7	12
5'	16.6	17.2	10
4' 11"	11.3	8.6	12
4' 10"	6. 2	3.7	8
Under 4' 10"	6.2	0.7	8

In Table 41 I show the average height in 3 groups of deliveries. It will be noticed that the forceps group is quite markedly the tallest group. There is not much difference between the spontaneous group and the Caesarean group, while the average from all three groups is just under 5' 2".

TABLE 41/

TABLE 41.

AVERAGE HEIGHT IN DIFFERENT DELIVERY GROUPS.

Spontaneous Delivery	:	5' 1.69"
Forceps Delivery	:	5' 2.45"
Caesarean Section	:	5' 1.85"
Average of Total	:	5' 1.93"

In the opening chapter of my paper I described how I had divided the women in my series into 3 categories in respect of their height. Tall over 5' 3", average 5' to 5' 3", small under 5'. Table 42 shows the percentage of each type of delivery in these three categories.

TABLE 42.

HEIGHT OF WOMEN BY TYPE OF DELIVERY.

	Type of Delivery		
	Spontaneous. (520)	Forceps. (260)	Caesarean. Section (50)
Small (under 5')	23.7%	13.0%	28.0%
Average(5'-5'3")	47.7%	50.8%	54.0%
Tall (over 5'3")	28.6%	36.2%	18.0%

It is important to note that approximately half of the women in all types of delivery were of average height, but that small women were in the/

the minority in forceps delivery. The considerably higher proportion of small women in the spontaneous group, nearly double that of the forceps group, is worthy of comment.

It is rather surprising that scant attention is paid to maternal stature in the average obstetrical text-book. Even in specialised text-books, such as Antenatal and Postnatal Care - Browne,(1955), and Operative Obstetrics, Munro Kerr (1949), no mention is made of maternal height.

At our ante-natal clinic we always measure every patient on booking and it has been our practice to book for hospital delivery any primigravid patient under 5 feet in height. It is partly because of this that I chose 5 feet as the level below which women were considered to be small. I notice that Bernard (1952) also took this figure for small women, but while I have taken over 5'3" as tall, he has taken the figure of 5' 5". This seemed unduly large because a glance at Table 40 will show that even in the forceps group there were only 13% of women of this stature, while in the spontaneous group and Caesarean section group the figure was nearer 10%. Bernard, however, was on a different track to that which I am following: - he was attempting to show that tall women had a larger/

larger pelvic brim area than small women. He showed that the difference in area in these two categories of women was 30.8 sq.cm. The next table (43) shows the relationship of the area of the pelvic brim to maternal height. I have taken 130 sq. cm. and above as the upper limit and 90 sq. cm. and below as the lower. The height has been divided into small, average and tall as already described.

TABLE 43 on p. 80.

As can be seen from this composite table there were a total of 171 small women in my whole series; this represents a figure of 20.5% of whom 48, or just over one quarter had a small pelvic brim area, i.e. under 100 sq.cm. It is interesting to note that a further 36 women had a small brim area, but, as will be seen from the table, they nearly all were in the average stature group, only 2 being tall. These 36 women were, of course, a very small proportion of the remaining women, only just over 5%.

At the other end of the scale, it can be seen that only 1 small woman had a pelvic area of 130 sq.cm. and there were relatively few above 120/

TABLE 43

PELVIC BRIM AREA AGAINST HEIGHT OF MOTHER

	Spontaneous (520)			Forceps (260)			Caesarean Section (50)			
	Small	Average	Tall	Small	Average	Tall	Small	Average	Tall	
130+	1	28	62	-	15	44	-	-	3	
125	7	40	26	1	19	23	1	2	3	
120	13	49	25	3	20	16	-	4	1	
115	18	46	23	3	34	4	-	2	-	
110	25	45	5	4	27	3	4	8	-	
105	32	21	5	9	8	4	2	6	2	
100	19	17	-	7	4	-	1	4	-	52
95	4	2	2	4	2	-	4	-	-	18
90	4	1	-	3	3	-	2	1	-	14
Total	123	249	148	34	132	94	14	27	9	84

120 sq. cm. I calculated the pelvic brim area for the 171 small women in my series and the result was 107.48 sq.cm. which was very similar to Bernard's figure of 106.8 sq.cm. One point of interest about my findings is that the average brim area for the whole series was 117.3 sq. cm., so it is rather surprising to find the small women only 10 sq. cm. less than the average figure.

It seemed worth investigating the height of patients with a contracted pelvic brim antero-posterior in view of the fact that in a previous paper on contracted pelvis, I found that 60% of the patients with this diagnosis were less than 5 feet tall, Brown (1953).

It will be recalled that a total of 47 such women in my whole series had a contracted antero-posterior of the pelvic brim. In Table 44 I show the pelvic brim antero-posterior of less than 10.2 cm. down to 9 cm. while I have taken the three groups of heights as previously described. The small women I have further sub-divided into 2-inch groups down to 4 feet 6 inches.

TABLE 44 on p. 82

TABLE 44

HEIGHT OF MOTHER AGAINST CONTRACTED PELVIC BRIM

	Under 4' 6"	4' 6"- 4' 7¾"	4' 8"- 4' 9¾"	4' 10"- 4' 11¾"	5' - 5' 3"	Over 5' 3"
c.m.						
10.0-10.1	1 C.S.	1 S.D.	-	1 S.D. 3 F.D. 3 C.S.	10 S.D. 3 F.D. 2 C.S.	2 F.D.
9.7-9.9	-	1 S.D.	2 C.S.	1 F.D. 1 C.S.	2 S.D. 1 F.D. 1 C.S.	-
9.4-9.6	-	-	2 S.D.	1 F.D.	1 S.D. 1 F.D.	1 S.D.
9.1-9.3	-	-	1 F.D.	1 S.D.	1 S.D.	-
8.8-9.0	-	-	1 S.D. 1 C.S.	-	-	1 F.D.
	21				22	4

As can be seen from this table less than half the women with a contracted pelvic brim were under 5 feet in height, the actual figure being 44.7%. This is a much lower figure than I found while investigating contracted pelves, but I think this can be explained by the fact that quite a few of these cases of contracted pelvis were discovered post-natally by X-ray pelvimetry, and as no difficulty was experienced would not have been classified as such without an X-ray diagnosis. Another important point is that here I am dealing only with primigravidae whose labour gave no previous clue to expected difficulty. As a matter of interest while there were not a few obstetrically difficult deliveries, in only one case was a contracted antero-posterior of the brim a direct cause of foetal death.

One other point of interest is that of the 47 women with a contracted antero-posterior of the brim, 27 had a brim area of 100 sq. cm. or less; of these two-thirds, or 17 out of 26 were under 5 feet in height. This would suggest that while a small woman may have a fairly adequate pelvic brim the fact remains that the chance of a contracted pelvic brim is 12.3% in the small woman against 5.4% in average women, and 1.5% in tall women/.

women.

The next point I investigated was the correlation between the pelvic outlet area and maternal height. I have taken the same standards for height as I did with the pelvic brim and for the outlet size I used the range of 105 sq. cm. and above to 70 sq. cm. In Table 45 I have charted my results.

Table 45 on p. 85.

The interesting points about this table are firstly the large number of small women in the spontaneous group who have quite a large pelvic outlet. The next point is that in the spontaneous group 10% of the small women had a contracted outlet area, (75 sq. cm. or less), while in the forceps group this was 15% and in the Caesarean section group nearly 30%.

In the women of average height it willbe seen that in the spontaneous group there were nearly as many with a contracted outlet area as in the small women but, of course, the incidence is much smaller - only 3.6%. In the forceps group there were actually more cases of contracted outlet area than in the small women, but again the actual incidence is smaller - only 6%. In the Caesarean section group of average height the incidence/

TABLE 45

PELVIC OUTLET AREA AGAINST MATERNAL HEIGHT

	Spontaneous (520)			Forceps (260)			Caesarean Section (50)		
	Small	Average	Tall	Small	Average	Tall	Small	Average	Tall
105+	14	46	54	3	8	21	3	1	5
100	13	47	26	1	8	12	-	5	-
95	13	53	21	2	11	18	2	-	1
90	20	45	17	5	35	19	1	4	2
85	22	26	15	10	30	8	-	7	-
80	29	23	11	8	32	14	4	5	1
75	10	3	3	4	4	1	-	3	- = 28
70	2	6	1	1	4	1	4	2	- = 21
Total	123	249	148	34	132	94	14	27	9 = 49

incidence of outlet contraction was 19%. In the tall women very few contracted pelvic outlets were seen, 6 out of 252 or 2.3%.

It will be recalled that there were a total of 171 women in the whole series whose height was under 5 feet. I calculated the average outlet area of these 171 small women and found it to be 88.1 sq. cm. As the average for the whole series was 91.74 sq. cm. (Table 17), it would seem that stature is not of much value in assessing the pelvic outlet.

To sum up maternal height - I think one might say that it has been rather a disappointment regarding an indication of pelvic size.

Out of 1000 booked women 200 will be under 5 feet in height, and of these 25 will have a contracted pelvic brim. Of the remaining women there will be a further 31 who have a contracted pelvic brim. Most of these women will be under 5' 3" in height, but a few will be over it - even over 5' 5".

Regarding the pelvic outlet, 23 of the small women will have a contracted pelvic outlet but only 8 of these will be the same ones who had a/

a contracted pelvic brim. In the tall and average women there will be a further 3¼ women with a contracted outlet area.

Therefore of our 200 small women 42, or 21% have a contracted pelvis and difficulty can be expected at delivery.

2. WEIGHT OF CHILD.

The next part of my investigation was the part played by the weight of the child in relation to the size of the pelvis and the method of delivery.

The first point I inquired into was the average weight of the baby in each of the three main types of delivery. In all three types of cases the child's weight varied from between 10 and 11 lbs. down to between 3 and 4 lbs. As there were few cases below 5 lbs. in weight, I took this as the lower level for my table and 10 lbs. as the upper level. In this table I show the weights in half-pound increments in percentages. Why I have chosen half-pound increments is because firstly the standard of prematurity or immaturity is 5½ lbs., and my first group is below this weight. The next group which I called small/

small weighed from 5½ lbs. to 6 lbs.15½ ozs., and the third group which I called average weighed from 7 lbs. to 8½ lbs. The last group I called the large babies whose weight was over 8½ lbs. at birth. I used this figure because in a previous paper (Sturrock and Brown, 1956) we found that above this level the size of the child had an important bearing on the duration of labour.

One last point was that for the first time plural pregnancy entered the picture. There were 6 twin pregnancies in my series, 2 spontaneous and 4 forceps deliveries. I considered the only feasible way to deal with the problem was to take the weight of the first child, notwithstanding the fact that in some cases it was the smaller of the two.

Table 46 shows the weights of the three types of delivery and Table 47 the averages of each group and Table 48 the average weight by type of delivery.

TABLE 46 on p. 89

TABLE 47 on p. 89.

TABLE 46.

WEIGHT OF CHILD by TYPE OF DELIVERY.

	Type of Delivery		
	Spontaneous	Forceps	Caesarean Section.
Over 10 lbs.	0.38	3.1	2.0
9½ - 10 lbs.	1.1	2.3	2.0
9 - 9½ lbs.	3.4	6.5	14.0
8½ - 9 lbs.	6.2	14.2	16.0
8 - 8½ lbs.	11.2	15.1	6.0
7½ - 8 lbs.	15.2	16.5	16.0
7 - 7½ lbs.	23.2	18.8	16.0
6½ - 7 lbs.	18.9	13.1	16.0
6 - 6½ lbs.	10.3	5.0	10.0
5½ - 6 lbs.	4.8	1.9	-
5 - 5½ lbs.	3.2	1.9	-
Under 5½lbs.	2.1	1.6	2.0

TABLE 47.

WEIGHT OF CHILD IN GROUPS by TYPE OF DELIVERY.

	Type of Delivery		
	Spontaneous	Forceps	Caesarean Section.
Large(Over 8½ lbs.)	11.1%	26.1%	34.0%
Average (7 lbs.1oz.-8½lbs)	49.6%	50.4%	38.0%
Small (5½ - 7 lbs)	34.0%	20.0%	26.0%
Premature (under 5½ lbs)	5.3%	3.5%	2.0%

TABLE 48/

TABLE 48.

AVERAGE WEIGHT OF CHILD.

Spontaneous Delivery	: 7 lbs. 4.12 ozs.
Forceps Delivery	: 7 lbs.12.5 ozs.
Caesarean Section	: 7 lbs.12.32 ozs.
Average Weight of Total	: 7 lbs. 7.24 ozs.

What can be learnt from the above tables ? The first point is that the forceps and Caesarean groups both contain a much greater percentage of large babies than the spontaneous group. This increased number of large babies is balanced by a lower number of small babies, while in the case of the forceps and spontaneous groups, the average sized babies are remarkably similar, being half the total in each case.

The average weights of the Caesarean group and forceps group are remarkably similar, being both over 8 ozs. heavier than the spontaneous deliveries. It seemed a necessary step in my investigations to find out the relationship of the size of the pelvic brim and the weight of the baby to the method of delivery. In view of the similarity of the average sized baby in all three types of delivery, and as obviously if there is brim disproportion, it is in the group of largest babies,

I/

I decided to confine this piece of the investigation to large babies only, i.e. over 8½ lbs.

In Table 49 I have tabulated this information for the area of the pelvic brim, taking the range of 130 sq. cm. and above down to 90 sq. cm. I have used the figures as they occurred in each group. As will be noticed, there were 68 in the forceps group out of a total of 260 forceps cases as against 58 in the spontnaeous group, although its total was double the forceps.

TABLE 49.

PELVIC BRIM AREA AGAINST LARGE CHILD (over 8½ lbs.)

	Spontaneous. (520).	Forceps. (260)	Caesarean Section. (50)
sq. cm. 130 & above	19	17	1
125	12	15	2
120	11	10	1
115	5	10	1
110	6	10	4
105	2	3	5
100	3	2	2
95	-	-	1
90	-	1	-
Total	58	68	17

As can be seen from this table the

Caesarean/

Caesarean group has by far the largest number of cases in the smaller pelvis. It will be remembered that 117 sq. cm. was the average brim area for my whole series, so it will be observed that 28% of the spontaneous, 38% of the forceps and 76% of the Caesarean section cases were in pelves less than this in area. This is in spite of these being the group of largest babies. One woman in the forceps group and three in the Caesarean group had a contracted brim antero-posterior, that is under 10.2 cm.

As a comparison to the above table, I thought it would be interesting to see whether the pelvic outlet had any relationship to the size of the child and method of delivery. I therefore took the outlet area in the range 105 sq. cm. or above down to 70 sq. cm., and have tabulated the results in this same group of large babies in Table 50.

Table 50 on p. 93.

In Table 17 I showed the average outlet area for my whole series was 92 sq. cm. Table 50 shows that 33% of the spontaneous deliveries are below this, while 72% of the forceps group are in a similar category. The Caesarean group is midway between at 53%. One interesting point is that/

TABLE 50.

PELVIC OUTLET AREA AGAINST LARGE CHILD (over 8½lbs)

	Spontaneous. (520)	Forceps. (260)	Caesarean Section. (50)
sq.cm. 105 or above	18	12	5
100	11	6	2
95	10	8	1
90	11	17	3
85	3	13	3
80	5	11	3
75	-	-	-
70	-	1	-
	58	68	17

that in only one case, a forceps, out of the 143 associated with large babies had a contracted outlet, 75 sq. cm. or less.

The importance of foetal size in labour has scant mention in the literature. Nathanson(1950) reviews 756 cases over 9 lbs. 15 ozs. in weight, collected over a period of 25 years. He states that 80% occurred in multiparae, but unfortumately he does not separate these from the primigravidae, or mention pelvic size. Presumably this is because the earlier cases occurred before X-ray pelvimetry was/

was feasible. In a previous commentary (Sturrock and Brown 1956), we emphasised the importance of a large child causing relative disproportion and prolonged labour. We found that 20% of our 1291 cases of prolonged labour, collected over a four year period, were associated with a large child. I will refer to this again when I discuss length of labour.

To sum up the investigation into foetal size, there does appear to be a definite relationship between the method of delivery, the size of the pelvis and the weight of the child. Out of a total of 143 women who delivered large babies only 9 had a small pelvic inlet (100 sq. cm. or less). The incidence of operative delivery increased below 117 sq. cm. especially in the Caesarean Section group.

Regarding the pelvic outlet area the incidence of operative vaginal delivery was greatest below 90 sq. cm., but the Caesarean group was fairly evenly spread throughout the outlet range.

PERINATAL MORTALITY.

Although the foetal and neo-natal death rate is not of statistical value it is, nevertheless, of great interest, in that small though the numbers/

numbers of cases in each group are, there are quite a few important points to be gleaned.

I have tabulated the 17 cases in which the child died before, during or after delivery by type of delivery. It will be noticed that there was no foetal loss in the Caesarean section group. The important information from our point of view is the size of the pelvis and I have taken the three main measurements, brim antero-posterior; inlet area and outlet area. Another most important point is just when the child died; in the case of stillborn babies I have made the difference between intra-uterine death (I.U.D.) in which the foetal heart failed before labour started, in some cases a few weeks, and intra-partum death (I.P.D.) in which the foetal heart was definitely heard in labour. In the case of intra-partum death it is important to differentiate between the total length of labour and that point in labour at which the foetal heart failed. Foetal weight, post-mortem result and maturity of the foetus have all been charted. In some cases the main reason for foetal loss is a maternal complication such as pre-eclampsia and this has also been noted. In Table 51 I have tabulated my results as described above and it will be noticed that I have placed the/

TABLE 51. on p. 96.

TABLE 51

FORCEPS DELIVERY

Case No.	Brim A.P.	Brim Area	Outlet Area	Foetal Result	Baby Weight	Maternal cause	Post-mortem Result	Gestation
	c.m.				lb. oz.			
1.	9.25	110	100	1 P.D. 12 hr.	7 13	Flat pelvis	Asphyxia	40 weeks
2.	12.5	125	80	N.N.D. 12 hr.	9 5	-	Ruptured liver	42 weeks
3.	10.3	115	90	1 P.D. 20 hr.	6 3	-	Pro-lapsed cord	43 weeks
4.	10.2	105	80	1 P.D. 24 hr.	8 14	-	Anoxia	43 weeks
5.	12.0	120	90	1 P.D. 16 hr.	7 0	Pre-eclampsia	Gross anaemia	41 weeks
6.	11.0	110	75	1 P.D. 36 hr.	6 10	-	Meningo-cele.	40 weeks
7.	10.75	115	90	N.N.D. 72 hr.	8 0	-	Hydro-cephalus	40 weeks

TABLE 51 - (Continued)

SPONTANEOUS DELIVERY

Case No.	Brim A.P.	Brim Area	Outlet Area	Foetal Result	Baby Weight	Maternal ? cause	Post-mortem Result	Gestation
	c.m.	c.m.			lb. oz.			
8.	9.0	90	85	1 U.D. 72 hr.	7 9	Flat pelvis	Anoxia. Macerated.	41 weeks.
9.	12.0	125	75	1 U.D. 168 hr.	7 1		Knot in cord Macerated	40 weeks
10.	10.2	100	80	N.N.D. 10/60	7 13	Pyelonephritis	Cord round neck	43 weeks
11.	11.5	115	95	1 P.D. 10 hr.	7 11		Anoxia	42 weeks
12.	12.0	135	105	1 U.D. 144 hr.	5 4	Pre-eclampsia	Cord round neck	40 weeks
13.	10.2	120	90	1 U.D. 96 hr.	4 10		Macerated	41 weeks
14.	10.5	110	105	1 U.D. 20 hr.	5 0	Pre-eclampsia	Macerated	41 weeks
15.	11.25	120	105	1 P.D. 5 hr.	4 12	Pre-eclampsia A.R.M.	Anoxia	40 weeks
16.	12.0	120	95	1 U.D. 96 hr.	3 4	Pre-eclampsia	Anoxia	36 weeks
17.	10.75	105	75	1 U.D. 48 hr.	4 10	Retro-placental haemorrhage	Macerated	34 weeks

the more important cases from our point of view at the top of the columns, forceps or spontaneous.

What can be learned from Table 51 ?

In the forceps delivery group there is one case, the first one, in which the contracted pelvic brim was definitely the cause of foetal loss. This was an unbooked case admitted in labour and while the pelvic measurements were not definitely known, the fact remains that foetal distress was evident and disproportion found in time to deliver the patient by Caesarean section. This is one case that was not properly managed, the attempt to obtain a vaginal delivery being pushed too far.

On the other hand the first case in the spontaneous group was not lost due to mismanagement, the foetal heart failed a few days after term for no very obvious reason. This is the type of case in which statistics tend to give a wrong impression because the patient has a contracted pelvis and she did deliver a dead child, but death was not due to the contracted pelvis. Both these cases presented a problem when they reported pregnant again because both obstetrician and patient are unwilling to risk a trial of labour and possible foetal death on a subsequent occasion, Caesarean/

Caesarean section is almost obligatory. To bring the record up to date on these two women, I have to report that I have performed a total of three Caesarean sections on them since the first babies were lost.

The next case of interest is the second forceps one in which a straight-forward forceps delivery resulted in neo-natal death a few hours later, due to a ruptured liver and massive intra-peritoneal haemorrhage. Was this rather large child, the biggest one lost in my series, too big for the smallish outlet, or was he held too tightly at birth ? Although I have since delivered this woman of a child nearly as large vaginally, I think the pelvis must be incriminated here also.

Cases 3, 9, 10 and 12all seem to have had trouble with the umbilical cord, but as this is so common, was it really the cause of death ? What about post-maturity ? As we can see from the table Cases 3, 4 10 and 11 were all over 42 weeks gestation and in which no other very definite cause for foetal loss was found, apart from alleged cord difficulty in Cases 3 and 10. I regret that I did not consider maturity in every case in my series because it was only when compiling/

compiling this table that I was forcibly struck with the frequency with which it occurred in cases where there was no other obvious cause for foetal death. For most of the time covered by my series the Unit in which I work took little notice of post-maturity and routine induction of labour was not practised. Therefore the women delivered by forceps, and most of the women delivered spontaneously and by Caesarean section were allowed to come into labour themselves. In some cases foetal distress was so acute and severe that the baby was dead before interference was possible - Cases 4 and 5. In a later part of my paper I will detail the reasons for operative intervention in which foetal distress figures not infrequently. I noticed while compiling tables of all stillbirths and neo-natal deaths in the cases delivered in our Unit over the last 3 years post-maturity is evident in one-third of the mature still-births. One last point about post-maturity while I am on the subject is that 19 of my 50 cases of Caesarean section, i.e. 38% were 42 weeks gestation or more.

Regarding the other cases of perinatal mortality, pre-eclampsia seemed to play a major role in many of the spontaneous deliveries and one of the forceps cases. The small size of some of these/

these babies does make one wonder on what grounds the X-ray pelvimetry was required. The 2 cases of congenital defect in the forceps deliveries group need no further comment.

One interesting point to note is that all the babies lost at forceps delivery died during or after labour, while seven of the ten spontaneous cases were dead when labour started.

How do the forceps results published here compare with other figures ? The uncorrected foetal mortality here is 2.7% which is considerably less than for the hospital as a whole in the year 1946 or even 1955, when the perinatal mortality was 5.8% and 4%. These figures contain both primigravidae and multiparae and it is not possible to correct them for primigravidae. I notice that in the latter year 12% of these forceps deliveries are in parous women, but foetal loss is not given. It has been my experience that a forceps delivery in a parous woman is not to be embarked on lightly as so often there is some major cause for requiring it, either malpresentation or disproportion because of a large child. Feeney (1954) has a foetal loss of 6.2% in the Coombe Hospital report, while Greenhill (1947) reported a perinatal mortality in forceps/

forceps deliveries of only 2.3%, which is only 0.4% better than my figures. As in America prophylactic forceps are used a great deal more often than in this country, his figures are naturally better than any in this country. The proof of this is in the same table which shows that the "natural cephalic" delivery was only 2½ times greater than the forceps, while in the Simpson Memorial Maternity Pavilion the forceps deliveries were under 14% of the total deliveries last year. In primigravidae I estimated the forceps rate to be 20%.

I mentioned earlier that there were no foetal deaths in the Caesarean group. While I am pleased that this occurred, the fact remains that there were 5 intra-partum deaths in my vaginal deliveries which should have been salvageable. Caesarean section is usually associated with a relatively high foetal mortality, due, in large measure to the big number of premature deliveries in pre-eclampsia and placenta praevia. In a 10-year review of foetal mortality in the Simpson Memorial Maternity Pavilion, Dunlop (1954) found that prematurity/

prematurity was the main cause of death in half the cases. The perinatal mortality was 11.1% and it is interesting to note that asphyxia was the main cause of still-birth. I am convinced that one of the main reasons for the improved results in my series is adequate resuscitation of the foetus. The days have gone when the asphyxiated baby was flogged unmercifully with lobeline, coramine, adrenaline, or even all three. Adequate clearing of the air passages, and, if necessary, gentle oxygenation are nearly always successful if the child is actually born with a heart beating. Admittedly all the babies in my series were mature by dates, although one baby in a tiny woman weighed under 4 lbs., but against this, all of them had been in labour - some of them over 70 hours.

DURATION/

DURATION OF LABOUR.

The duration of labour is one of the most important factors in modern obstetric practice. While labour should not be slavishly regulated by the clock, the fact remains that the wise obstetrician keeps an eye on the time labour has progressed, because it is a very simple matter to underestimate the severity of maternal and foetal distress in a protracted labour.

First of all I show the duration of labour in the three types of delivery. I have taken the duration of labour in 6 hour increments, and have placed the results in percentages for ease of comparison. Table 52 shows this in 6 hour increments up to 72 hours' duration.

TABLE 52/

TABLE 52.

DURATION OF LABOUR by TYPE OF DELIVERY.

Hours.	Spontaneous (520)		Forceps (260)		Caesarean Section. (50)	
0 - 5.55	7.7		1.9		4	
6 - 11.55	35.8		16.6		4	
12 - 18.55	25.8	91.9%	26.2	73.1%	6	38%
18 - 23.55	13.8		14.2		14	
24 - 29.55	8.8		14.2		10	
30 - 35.55	3.4		7.7		8	
36 - 41.55	1.7	5.9%	3.8	14.6%	12	28%
42 - 47.55	0.76		3.1		8	
48 - 53.55	0.9		3.1		12	
54 - 59.55	0.38		1.9		4	
60 - 65.55	0.38	2.1%	1.5	12.2%	4	34%
66 - 71.55	0.19		1.1		12	
72 & over	0.19		4.6		2	

This table shows that 43.5% of the spontaneous deliveries are born within 12 hours of labour commencing against 18.3% of the forceps deliveries, and 8% of the Caesarean sections.

At 18 hours duration the figure for the spontaneous/

spontaneous deliveries has risen to 69.3% as against 44.5% for the forceps and 14% for Caesarean section groups.

When 24 hours has been reached the figures are 83.1% for spontaneous, 58.7% for forceps and only 28% for the Caesarean section groups.

At 30 hours' duration, beyond which I consider labour to be prolonged, the figures are spontaneous 91.9%, forceps 72.9%, and Caesarean 38%.

This means that only 8% spontaneous deliveries had a prolonged labour as against 27% of the forceps, and 62% of the Caesarean section groups. It shall be emphasised here that this is not a thesis on prolonged labour, the high incidence in the Caesarean section group is quite often the main reason for the abdominal route. As is to be expected the Caesarean group has the largest average duration of labour but the difference between the spontaneous group and the forceps group is most striking, see Table 53.

TABLE 53 on p. 107.

TABLE 53.

AVERAGE DURATION OF LABOUR
IN DIFFERENT TYPES OF DELIVERY.

Spontaneous Delivery	- 15 hours 55 mins.
Forceps Delivery	- 27 hours 28 mins.
Caesarean Section	- 37 hours 53 mins.
Average of total	- 20 hours 40 mins.

The next piece of information I elicited was the duration of labour in the various sizes of pelvic brim. I thought that it would be of less value to insert the Caesarean section figures in the total because some of these cases had labour terminated after only a few hours. In Table 54 I show the results of all the women delivered vaginally, divided into periods as shown in Table 52, by the size of the pelvic brim. There were a total of 780 women in this series, and I have divided the brim area into 5 sq. cm. increments from 130 sq. cm. and above down to 90 sq. cm.

TABLE 54.

DURATION OF LABOUR by PELVIC BRIM AREA.
(Vaginal Deliveries - 780)

Hours.	130+	125	120	115	110	105	100	95	90	Total
Under 12	57	41	40	46	38	30	14	3	3	272
12 - 30	75	61	67	62	58	37	26	7	5	398
30 - 48	13	10	8	11	8	8	6	3	1	68
48 - 60	2	2	2	6	4	1	1	0	1	19
Over 60	4	4	6	3	2	2	0	1	1	23

This/

This table shows that there is a tendency for labour to be longer on the average in women with small pelvic brim areas, for instance only 12.5% of those with an area of 130 sq. cm. or more had labour lasting over 30 hours while 28% of the women with a pelvic brim area of under 100 sq. cm. had a prolonged labour. The numbers are small at the lower level of pelvic size but the trend can be seen. As already stated I did not include the women delivered by Caesarean section in the above table, but show the results separately in Table 55.

TABLE 55.

DURATION OF LABOUR by PELVIC BRIM AREA.
(Caesarean Section - 50)

Hours.	130+	125	120	115	110	105	100	95	90	Total
Under 12	-	-	-	-	1	2	-	1	-	4
12- 30	1	-	-	1	5	2	2	2	2	15
30 - 48	-	-	1	-	4	5	2	1	1	14
48 - 60	-	4	2	-	1	1	-	-	-	8
Over 60	1	2	2	1	1	-	2	-	-	9

This table shows that the tendency is for labour to be longer in the women with large pelvic brim areas. This can be explained by the fact that foetal distress occurred in some cases of small pelvic brim area after labour had been established a short while and Caesarean section was thought to/

to be the most likely method of obtaining a living child. Also, as I showed already in Table 32 quite a large number of the women with a small brim area have also a contracted antero-posterior of the pelvic brim and it was realised that a vaginal delivery was unlikely to succeed. The combination of foetal distress and contracted pelvis, of course, made Caesarean section more urgent than one or other alone. I will discuss in a later section of my paper the reasons for performing Caesarean section, but I should like to emphasise here that prolonged labour, by my definition, played a part in no less than 62% of my cases.

I mentioned, while discussing foetal size, that in a previous paper on prolonged labour a large baby, i.e. over 8½ lbs., was encountered in 20% of our series. I therefore thought it would be of importance to see how pelvic size enters the picture where labour is prolonged and the child large. In Table 56 I have plotted the area of the pelvic brim against labour lasting over 30 hours with a child over 8½ lbs. in weight. As the numbers are rather small, I have only used one table for all three types of delivery but have used abbreviations as previously for each method.

I/

I have taken the duration of labour over 30 hours and divided it into groups as in Tables 44 and 45.

TABLE 56 on p. 111.

From Table 56 it can be seen that a large pelvic brim gives the impression of having more cases of prolonged labour with large babies but a glance at Table 49 will show that 37 babies were born to women with a pelvic brim area of 130 sq.cm. or over and 19 were born to these with an area of 105 sq. cm. or less. Therefore the incidence of prolonged labour was 19% in the large pelves and 37% in the smaller.

Another interesting point is that 29 women in Table 56 were associated with prolonged labour, out of a total in my whole series of 143 whose babies weighed over 8½ lbs. This is 20.3% which is a very similar figure to that which we found in our previous paper on prolonged labour - 18.2% with large babies.

What of the pelvic outlet, does it have any influence on the duration of labour ? In the next part of my paper I have studied the part played by the area of the pelvic outlet in these women delivered vaginally. There are again 780 such/

TABLE 56

DURATION OF LABOUR IN LARGE BABIES BY SIZE OF PELVIC BRIM AREA

Hours	130+	125	120	115	110	105	100	95	90	Total
30-48	1 S.D. 2 F.D.	1 F.D.	-	-	1 F.D.	2 F.D.	-	-	-	7
48-60	1 S.D. 1 F.D.	1 F.D. 2 C.S.	1 C.S.	1 F.D.	1 F.D. 1 C.S.	- 1 C.S.	-	-	-	10
Over 60	2 F.D.		2 F.D.	2 F.D. 1 C.S.	1 C.S.	1 F.D. 1 C.S.	1 C.S.	-	1 F.D.	12
Total	7	4	3	4	4	5	1	-	1	29

such women of whom two-thirds had a spontaneous delivery. I have used the same increments for the duration of labour in Table 54, but for the outlet area have taken 105 sq.cm. and above as the largest figure and lowered it by 5 sq. cm. to a level of 70 sq. cm. The results can be seen in Table 57.

TABLE 57.

DURATION OF LABOUR by OUTLET AREA.

(Vaginal Deliveries - 780).

Hours.	105+	100	95	90	85	80	75	70	Total
Under 12	63	37	46	53	34	26	8	5	272
12 - 30	69	58	60	61	59	71	11	9	398
30 - 48	11	4	7	12	10	18	5	1	68
48 - 60	1	4	2	7	4	1	-	-	19
Over 60	2	4	4	3	4	6	-	-	23

This Table does show a tendency for the lower size of pelvic outlet to have a more prolonged labour, but the numbers are small. The pelvic area of 105 sq.cm. and above shows only 14 out of 146 cases of prolonged labour, i.e. 9.6% as against 19% in those women with a pelvic outlet area of 80 sq. cm. and below. It is interesting to note that below 80 sq.cm., no case with labour lasting over 48 hours was delivered vaginally.

What about the outlet area in those women delivered/

delivered by Caesarean section ? In Table 58 I show the results using the same figures as above.

TABLE 58.

DURATION OF LABOUR by OUTLET AREA.

(Caesarean Sections - 50).

Hours.	105+	100	95	90	85	80	75	70	Total.
Under 12	1	-	-	-	-	2	-	1	4
12 - 30	4	-	1	3	2	1	1	3	15
30 - 48	-	1	2	2	1	4	2	2	14
48 - 60	2	3	-	1	2	-	-	-	8
Over 60	2	1	-	1	2	2	1	-	9

From this table it can be seen that the cases of prolonged labour are spread throughout the whole range of pelvic outlets. Contracted outlet, below 80 sq. cm., does not occur with any greater frequency in cases of prolonged labour than the largest outlet area in my series, where delivery is by Caesarean section.

What is the importance of prolonged labour in modern hospital obstetric practice ? In a previous paper, Sturrock and Brown (1956), we showed that the incidence of prolonged labour was 12.2% in 1940 and 1941, while it fell to 8.7% in 1948 and 1949. In 1955 the incidence of prolonged labour/

labour fell to 6.1% in the Simpson Maternity Pavilion, Edinburgh. In the present paper the incidence of prolonged labour was 17% but, of course, this is not a consecutive series and the incidence of prolonged labour is greater, both because of the high incidence of interference, and secondly, because my series consists entirely of primigravidae.

In our paper we pointed out that the risk of maternal death is increased in prolonged labour and while the death rate from prolonged labour fell markedly between 1940 and 1949 the risk was always present. This was brought sharply to our notice when the only true obstetric death in the hospital last year was in a case of prolonged labour delivered by Caesarean section for disordered uterine action and foetal distress. I am glad to say that there were no maternal deaths in my series at all, no matter how long labour lasted.

We also pointed out that the perinatal mortality was high in 1940 and 1941 being 12.2%, while it fell to 9.5% in 1948 and 1949. In 1955 the foetal loss fell to less than half of this, 4.9%. In my paper there were 3 babies lost where labour was prolonged, but this incidence of 2.1% does not really give a true picture, 2 of these babies/

babies being congenitally deformed and the last one was an intra-partum death at 24 hours. (Case No. 4). However it is necessary to include all three in a series of prolonged labour to be able to compare them with other series.

I have made it plain that as far as I am concerned labour is prolonged after 30 hours' duration, and this is the standard I have adopted throughout my paper. In Britain many hospital reports and also various authors such as Macrae (1944) consider that 48 hours should be the time beyond which labour is prolonged. We already have given our reasons for choosing 30 hours, but while compiling the present thesis, I have made a division at 48 hours so that it is possible to see the incidence using this as a standard. Tables 54 & 55 show that in 61 cases labour is prolonged beyond 48 hours' duration, that is 7.3% of cases.

At the other end of the scale one finds the American obstetricians tending to shorten the level of prolonged labour, and no less an authority than Greenhill (1954) states that he considers 18 hours to be the duration of normal labour. This to my mind is far too short a time to allow, as at that level less than half the forceps deliveries would be included and under 70% of the spontaneous deliveries.

To/

To sum up the duration of labour, the first point is that Caesarean section still plays a major role in these cases in whom labour is prolonged. In my series the incidence of Caesarean section is only 6% of all the cases, but when labour is prolonged over 30 hours 22% of these cases are delivered abdominally.

There is a tendency for labour to be longer when the pelvic brim area and outlet area are small. The combination of a large baby with a small pelvic brim also tends to prolong labour.

The Caesarean figures tend to give a confusing picture because if a known contracted pelvis is present in a labouring woman, there is a tendency to shorten the duration of labour should vaginal delivery appear improbable.

MATERNAL AGE :

The part played by the age of the mother in both the method of delivery and duration of labour was next investigated. Maternal age was first of all investigated in each of the three types of delivery to find out the average age and I have divided it into 5 year increments. The youngest woman was 14 and the oldest 44, but as numbers were small at each end of the scale, I have taken under/

under 20 and over 40 as the lower and upper end of the age groups. In Table 59 I show the results in percentages for ease of comparison and in Table 60 the average age in each type of delivery.

TABLE 59.

MATERNAL AGE IN 5 YEAR PERIODS.

Years.	Type of Delivery. Spontaneous.	Forceps.	Caesarean Section.
Under 20	9.7%	6.5%	-
20 - 24	48.7%	32.7%	26.0%
25 - 29	30.6%	32.0%	32.0%
30 - 34	8.6%	18.0%	18.0%
35 - 39	2.6%	17.7%	18.0%
40 & over	0.38%	3.1%	6.0%

TABLE 60.

AVERAGE AGE by TYPE OF DELIVERY.

Spontaneous Delivery	: 24.4 years.
Forceps Delivery	: 27.1 "
Caesarean section	: 29.3 "
Average of all deliveries	: 25.5 years.

The most striking fact in Table 59 is the similarity of age groups, especially in the middle range of Caesarean section and forceps delivery. Elderly/

Elderly primigravidae were relatively uncommon in my series if one takes 40 years as the standard, but nowadays there is a tendency to lower the age at which women are considered elderly primigravidae to 35 and this is the standard I have used. At 35 years of age it can be seen that spontaneous delivery occurred in only 3% of cases, while operative delivery occurred in over 20% of cases. There did not seem to be a marked tendency to cut short the duration of labour in these elderly primigravidae, but, of course, there were the women in whom vaginal delivery was considered likely to occur. Baird (1956) found that in a large series of primigravidae 94% had a spontaneous delivery while in their teens, but this fell to 63% over the age of 35. His series was, of course a consecutive one and is not comparable to mine; but as can be seen in Table 59, the incidence of operative delivery is much higher in elderly primigravidae.

I thought that it would be of interest to compare the duration of labour with the age of the mother. I have kept this first table for vaginal deliveries only, as many of the Caesarean section cases had labour considerably shortened, notwithstanding the fact that the duration of labour was on the average longer than in vaginal delivery.

This/

This tendency was more marked in the elderly primigravidae as will be shown later. In Table 61 I have tabulated maternal age in 5 hour periods against the duration of labour. I divided the duration of labour in a similar manner to that in Table 54.

TABLE 61.

DURATION OF LABOUR by AGE GROUPS OF MOTHER.
(Vaginal Delivery - 780)

	Under 12 hours.	12-30	30-48	48-60	60+	% Labour Prolonged.
Under 20	29	33	5	3	1	12.5%
20 - 24	117	177	31	3	6	11.9%
25 - 29	76	121	29	5	10	18.2%
30 - 34	31	45	7	5	4	17.4%
35 - 39	12	15	2	2	3	20.6%
40 & over	4	4	1	-	1	20.0%
Total	267	395	75	18	25	
			128 = 16.4%			

As can be seen from this table labour does tend to be prolonged in a not inconsiderable proportion of cases. The average for all the 780 vaginal deliveries was 16.4%. In the right hand column of Table 61 I show the ratio of cases in whom labour was prolonged. It is rather interesting to note that while the ratio of prolonged/

prolonged labour does rise appreciably as age rises, it is by no means a regular curve. Baird (1956), using 24 hours as the upper limit of normal labour rather than 30 hours as I have done, found 10.6% of primigravidae under 20 years of age and 25.5% over 35 years of age had a prolonged labour. He did, however, include Caesarean sections in his paper, which appreciably shortened labour in the older age groups.

As far as the Caesarean sections were concerned the duration of labour extended from 4 hours to 74 hours, the reason for interference in the short labours was generally foetal distress. There were a total of 12 cases in elderly primigravidae of whom 7 had a prolonged labour, i.e. 58.3%. The figure for prolonged labour in women under 35 years of age was 63.1% which figure can probably be explained by the tendency to perform Caesarean section more readily in the older woman.

So far, when considering the effect of maternal age on the outcome of delivery, with the method of delivery and the duration of labour, I have not mentioned the pelvis at all. The reason for this is that the pelvic size and shape are static, at least in this country where osteomalacia is rare. I thought, however, that it would/

would be of interest to compare the outcome of labour in a series of cases with known pelvic abnormality. I showed earlier in Table 1 that there were 47 cases of contracted antero-posterior of the pelvic brim. To these I have added a further 6 cases in which the transverse of the brim was contracted, the resulting brim area being under 100 sq. cm. I have plotted the age of these 53 patients against the method of delivery in Table 62.

TABLE 62.

METHOD OF DELIVERY by AGE.
(Contracted Pelvic Brim).

	Spontaneous Delivery.	Forceps Delivery.	Caesarean Section.
Under 20	4	1	-
20 - 24	9	7	3
25 - 29	5	5	5
30 - 34	3	4	2
35 - 39	2	1	1
Over 40	-	-	1
	23	18	12

The numbers of those patients over 35 years of age are small but the Caesarean section rate is 40%, while below this age it is only 20%, which does/

does show the tendency for older age groups to require increased operative interference.

Another point seen in this table is that up to the age group 20-24, spontaneous deliveries equalled both forceps and Caesarean sections but above this operative delivery of one kind or another was twice as common as spontaneous delivery.

6. REASONS FOR OPERATIVE DELIVERY.

A. FORCEPS DELIVERY.

In the introduction to my thesis I stated the 5 major indications for forceps delivery which I have used in my series. I have purposely made this as small as possible as nothing detracts from a paper like this than a large number of minor indications. For instance, one hospital report I read, elderly primigravidae and tuberculosis were two of the stated indications. I think that in primigravidae the five indications cover most possibilities that may occur. I have, of course, excluded breech presentation and therefore forceps to the aftercoming head from my series.

I will briefly describe what I include in each type of forceps delivery, with the reminder that I have only allowed one indication for each delivery. If there is a malposition of the head I have taken this as the major indication, even if there should be some other indication as well. An example of this is when there is a second stage delay, and vaginal examination reveals a deep transverse arrest of the head. In my view the cause of the delay is the malposition of the head and I classify it as such.

(i) Maternal/

(i) Maternal distress : under this heading I include all cases in which the mother shows either mental or physical distress. Mental distress is difficult to assess on paper, but it includes all women who lose control of themselves and those who give up trying to assist in obtaining a spontaneous delivery during the second stage of labour. Physical distress contains quite a few different complications. First of all there is a woman in the second stage for some time in whom the pulse rises sharply sometimes to 120 per minute or more. These patients often suffer acute pain in spite of analgesics and, if not delivered fairly soon, reach a stage of dehydration and exhaustion. In the same category are women with known cardiac disease, chest disease, renal disease and severe pre-eclampsia. One should, of course, deliver these women before exhaustion is reached. I have also included in this category eclampsia and epilepsy. In all these deliveries the vertex presented in an antero-posterior position. I did not specifically divide the delivery into low forceps, mid-forceps, or high forceps, but there were none of the latter in my series. My reason for not specifically dividing the cases by the height of vertex in the pelvis is partly because I am slightly bewildered by/

by the different definition of mid-forceps in the literature, and partly because it is often extremely difficult to state exactly the type of delivery done if there is either a large caput or much head moulding. At the other end of the scale a really low forceps delivery can usually be avoided by making an adequate episiotomy under local analgesia.

(ii) Second Stage delivery : these patients might be said to have some degree of inertia because the cervix has been fully dilated for some time, generally about 2 hours, but delivery is not forthcoming. Again for a case to be classified as such the vertex must be presenting in the antero-posterior with the cervix fully dilated. How long should one wait in this type of case before applying the forceps ? Obviously one does want to deliver the patient before the mother becomes exhausted and the foetus distressed, in spite of the opposite statement in some excellent text books of obstetrics, Munro Kerr, (1949). It has been my procedure to deliver the patient after the second stage has lasted two hours, if all the other factors for forceps delivery are satisfied.

(iii) Foetal distress.- the usual signs of foetal distress/

distress were acceptable, the most important of which are undue slowness of the foetal heart and the passage of fresh meconium. As stated earlier, this series was based on cases delivered before there were routine inductions for post-maturity performed in the unit. This meant that frequently meconium was found to be present when the amniotic sac broke. Sometimes old meconium was present with the foetal heart rate unaffected, but if fresh and the foetal heart rate slowed, action was usually taken to expedite delivery.

Once again, however, before classifying a case as such the vertex had to be anterior.

(iv) Deep Transverse arrest - by this I mean that the head is arrested in the transverse diameter of the pelvis before the forceps are applied. The argument is often advanced that the head may not be actually arrested, but merely placed in the transverse at the time vaginal examination is made. Depending on the diagnostic skill of the accoucheur it may be possible to decide on the position of the head on two or more occasions, but it is not common practice to examine vaginally the normal booked primigravida till there is an obvious hold-up in the progress of labour. In view of this I have classified as deep transverse arrest of the head

all/

all cases in which it is found to be in the transverse diameter on vaginal examination under anaesthesia prior to applying the blades of the forceps. Some of these patients were delivered by Kiellands forceps, but in most cases manual rotation and forceps delivery was undertaken. In British text-books this type of arrest is usually classified as a mal-rotation of an occipito-posterior position, although there is considerable evidence that in many of these cases the head engages in the transverse and descends in the transverse where arrest occurs. To my mind, this is the most serious type of obstruction encountered in modern daily practice, not because it cannot usually be adequately dealt with, but because it is often difficult to recognise even under anaesthesia. If unrecognised a misapplication of forceps is made and either foetal damage or a failed forceps may result. Even if recognised manual rotation may prove extremely difficult or even impossible. The often advised method of pushing the head up and rotating it above the pelvic brim may be extremely hazardous as if the brim is flat, the head may fail to engage again, or the disimpaction of the foetal head may result in prolapse of the umbilical cord. In these cases the/

the Kielland's forceps are most useful, but while I find they are extremely satisfactory as regards the foetus, they do tend to lacerate the vagina. Because of these various difficulties I have investigated various extra factors in the case of deep transverse arrest.

(v) Persistent occipito-posterior - This, of course, means that the vertex is arrested posteriorly, either right, left or directly posterior. It must be emphasised that these cases represent only that percentage of occipito-posterior position that do not rotate to anterior or transverse, and these are not delivered spontaneous face to pubes. The danger of these cases, although not so great as in the case of deep transverse arrest, are nevertheless greater than if the occiput is anterior. Some authorities advise delivery with the face to pubes in these cases, but the fact remains that this is not always possible, manual or forceps rotation is required, and may result in similar difficulties as I mentioned in the last paragraph.

The first investigation I made was the part played by the shape of the pelvis in causing the different types of forceps delivery. In Table 63 I show the results in 260 forceps cases.

TABLE 63.

REASON FOR APPLICATION OF FORCEPS BY SHAPE OF PELVIS.

	Gynae-coid.	Android	Anthro-poid	Platy-pelloid.	Total
Maternal distress	16	1	1	3	21
Second stage delay	70	5	8	8	91
Foetal distress	26	4	1	5	36
Deep transverse arrest	47	11	2	22	82
Persistent occipito-posterior	18	3	9	-	30
Total	177=68%	24=9.2%	21=8%	38=14.6%	

As can be seen from this table second stage delay is the commonest reason for applying forceps, closely followed by deep transverse arrest of the head. Less than half as frequent as the latter is foetal distress, followed by persistent occipito-posterior and least frequently of all comes maternal distress. Therefore a malposition of the head accounts for 43% of all forceps deliveries but deep transverse arrest is almost three times as frequently found as a persistent occipito-posterior position.

It/

It will be recalled that in Table 22 I showed that a gynaecoid pelvis was more than twice as frequently found as the other three types together. As can be seen in Table 63 the main point of interest is the frequency with which platypelloid and android pelves occur in cases of deep transverse arrest of the head, in 40% of the cases. The frequency of persistent occipito-posterior in anthropoid pelves is to be expected and it is in this type of case that forceps delivery without rotation is wise.

The next point I investigated was the part played by the pelvic outlet of the pelvis in causing the different reasons for forceps delivery. In Table 64 I have shown the outlet area against the reasons for forceps delivery. I have taken the outlet area as previously from 105 sq.cm. and above down to 70 sq. cm.

TABLE 64 on p. 131.

This table shows that 2nd stage delay has the greater number of patients with a contracted outlet area if one takes those below 80 sq. cm. On the other hand one notices that there are a larger number of cases in the middle range of pelvic/

TABLE 64.

REASONS FOR APPLICATION OF FORCEPS

by OUTLET AREA OF PELVIS.

Outlet area.	Maternal Distress	2nd Stage Delay.	Foetal Distress.	D.T.A.	P.O.P.
sq.cm. 105+	5	13	4	6	4
100	1	11	2	4	3
95	3	10	6	9	3
90	4	20	10	19	6
85	3	11	9	20	5
80	3	18	4	21	8
75	2	4	-	3	-
70	-	4	1	-	1
Total	21	91	36	82	30

size, in cases of deep transverse arrest of the head than in 2nd stage delay. Actually the average area in deep transverse arrest is 87.7 sq. cm. as against 90.6 sq. cm. in 2nd stage delay. These figures show that there is no relationship between the reason forapplication of forceps and the size of the pelvis.

(vi) Deep Transverse Arrest of the Head.

I mentioned earlier that this particular complication gave riseto difficulty in delivery mainly/

mainly because of the difficulty in recognising the malposition of the head. What are the reasons for deep transverse arrest of the foetal head ? Moir (1956) states that the causes are as shown below - often in combination.

(a) The sacral curve is flattened.

(b) The sacral tip projects far forwards.

(c) The side walls of the pelvis converge causing the ischial spines to encroach on the available space in the mid-pelvis.

Let us examine these three causes individually.

(a) In Table 26 I showed that there were 32 women with flat sacrae in the forceps group. Of these 32, 14 were in cases of deep transverse arrest, which meant that 17% of this malposition of the foetal head was associated with a flat sacrum against 12% in the forceps group taken as a whole. As 12% of spontaneous deliveries had a flat sacrum it would not seem of much significance.

(b) If the sacral tip projects forward the antero-posterior of the pelvic outlet must be decreased in size. Table 11 showed that the average antero-posterior of the pelvic outlet was 11.32 cm. for forceps deliveries which was only slightly/

slightly less than the average of all the pelves in my series. I calculated the average for the 82 cases of deep transverse arrest in my series and it resulted in a figure of 10.97 cm., a difference of just over one-third of a centimeter.

(c) The ischial bispinous was shown in Table 14 to average 10.13 in all forceps deliveries, while in deep transverse arrest the figure was 10.27 cm. a figure almost identical with the average for my whole series.

In Table 31 I showed that funnelling of the pelvis was fairly frequently found in forceps deliveries, a total of 54 cases had an outlet area at least 35 sq.cm. smaller than the brim area. Of these 54 cases, 13 were associated with deep transverse arrest, which is less than one would expect as this is only 24% asagainst 20.8% in all forceps deliveries.

I have often thought that deep transverse arrest of the head was in great measure due to rigid soft parts. One reason for this is that this complication is so rarely found in parous women. As a matter of interest I followed up a series of forceps deliveries performed for deep transverse arrest at the first delivery. Of the 53 women who had this complication, only 3 had a forceps/

forceps delivery at the second delivery, but only 1 was for deep transverse arrest. What of the other 50 women ? No less than 49 had a spontaneous delivery, more than half the babies being larger in this pregnancy than in the first. The last case was delivered by Caesarean section because of previous foetal loss at delivery, this being a case of contracted pelvic brim.

To summarise the aetiology of deep transverse arrest, pelvic brim shape appears to play a more important part than either the shape of the sacrum or of the size of the pelvic outlet, but the soft tissues seem to be important.

(vii) Persistent Occipito-Posterior Position of Vertex - This complication was found to be present in only 30 of the forceps cases, nearly one-third as common as deep transverse arrest of the head. Manual rotation of the head was performed in 21 cases while 9 were delivered face to pubes either after failure to rotate, or as an elective procedure. It struck me that those cases delivered face to pubes appeared to have a much smaller pelvic outlet than those delivered by forceps following manual rotation. The outlet areas/

areas were respectively 82.5 sq. cm. and 90.75 sq. cm., the latter figure being about the average for forceps deliveries, while the former is a much smaller area than was found in any of the three main types of delivery. This would suggest that while rotation is generally desirable in occipito-posterior position of the vertex, if difficulty is encountered, delivery face to pubes is generally possible.

B. CAESAREAN SECTION.

(i) Disproportion: As I mentioned in the introduction to my thesis it is difficult to place the indications for Caesarean section in hard and fast groups, because so often there is a combination of causes. As has already been mentioned, there were 11 cases of this type of delivery with a contracted antero-posterior of the pelvic brim and a further 3 cases had a contracted transverse of the brim. There were, apart from these cases, a further 6 cases with a separate contracted outlet - therefore the pelvis was contracted in 20 out of 50, or 40% of the cases requiring Caesarean section. One further case with small measurements and a big baby also was classed/

classed as disproportion.

(ii) Disordered Uterine Action:

As already mentioned disordered uterine action was frequently combined with disproportion but I feel that the latter should be given priority. In using this term in my paper, I include only those cases with a normal pelvis and in whom labour was strongly established for some hours. I found that in 2 cases classified as disordered uterine action labour lasted under 30 hours, but in both of them interference was undertaken because of acute maternal distress in the presence of complete lack of progress for some hours. As a matter of interest the average duration of labour in this whole group was 51 hours. There were a total of 24 such cases and while it is perhaps of little value to divide these into different categories, it is of interest from the point of view of treatment during labour. I have always felt that Jeffcoate's (1949) classification is the most practical, and by his standard 12 of these cases had a hypotonic uterus, while 11 had a hypertonic lower uterine segment. The last case showed a constriction ring formation.

(iii) Elderly/

(iii) Elderly Primigravidae :

Although elderly primigravidae were found to occur in 24% of the Caesarean group, as shown in Table 59, it would appear that in only one case was maternal age the main indication for Caesarean section. This woman had been married for many years and after 27 hours of poor labour Caesarean section was employed.

(iv) Foetal Distress : was described under forceps delivery. In cases of Caesarean section I only have used this as a major reason when the pelvis is normal and labour established. In 3 such cases in my series foetal distress made abdominal delivery necessary. I have previously mentioned the connection between the post-maturity and foetal distress and this was most evident in these women delivered by Caesarean section. No less than 38% of these patients were at 42 weeks gestation or more, and of these one-third showed some degree of foetal distress even though this was not the major lesion present.

(v) Malpresentation of head - this was found in only 1 case with a normal pelvis, a brow presentation. A further malpresentation - this time a face was found in one of the cases of contracted pelvis./

pelvis.

As stated already it is difficult to adequately describe the reasons for Caesarean section in five such categories as are shown above. One other factor was commonly found in this group of women, an occipito-posterior position of the vertex. A total of 17 women were found to have this malpresentation at operation. This means that just over one-third of the Caesarean section group had this associated cause for the operation. As a matter of fact, 8 of these 17 women had a contracted pelvis, 6 brim and 2 outlet, which may have been the cause of the occipito-posterior position. One must, of course, remember that these patients were, with few exceptions, not at a point in labour at which spontaneous rotation of the head might have been expected to occur. This is 3 times more than the usually quoted incidence of occipito-posterior position of 11% (Dawson 1940).

In Table 66 I have summarised the reasons for Caesarean section where I have not only shown the major indications but also the minor ones, because while I am most interested in the pelvis, other investigators might consider foetal distress more important.

TABLE 67/

TABLE 67

MAJOR AND MINOR INDICATIONS FOR CAESAREAN SECTION

Major Indications		Minor Indications				
		Dispro-portion	D.U.A.	Foetal Distress	Elderly Prim.	Malpres-entation	P.O.P.
Dispro-portion	21	-	8	7	5	1	8
Disordered ut. action	24	8	-	2	5	-	9
Foetal distress	3	7	2	-	2	-	-
Elderly prim.	1	5	5	2	-	-	-
Malpres-entation	1	1	-	-	-	-	-

This table shows that while the major indications can be largely confined to the two complications, disproportion and disordered uterine action, there are quite a few minor indications which may influence one's judgement and not press a trial of labour too far in the hope of obtaining a vaginal delivery.

It seemed of interest to see how many cases with contracted pelvis and disproportion had a prolonged labour. This can be seen to be 38% which figure suggests that if labour is prolonged, intra-partum radiological pelvimetry is well worth considering. As I mentioned earlier there were 14 cases of contracted pelvic brim and 6 of contracted outlet, but of greater importance is the fact that 4 of the cases of contracted pelvic brim also had a contracted outlet although I have given priority to the brim. This means that to be strictly accurate there were 10 cases of outlet contraction to 14 of brim contraction - a surprisingly high proportion. In the remaining 780 cases delivered vaginally a combined inlet and outlet contraction was only seen on 5 occasions.

In only 2 cases of the 50 delivered by Caesarean section was the cervix fully dilated at the time of operation. One was a malpresentation

of/

of head with a contracted pelvis and the other the one case of disproportion with a small but not contracted pelvis.

DISCUSSION.

Since starting to collect the material from which I have written this thesis the whole concept of ante-natal radiology has undergone a dramatic change. This has most probably started as a result of the radiation hazards caused by the dropping of atomic bombs on Japan towards the end of the 1939-1945 war. Since then bigger and better nuclear explosions have resulted in radio-active material being released into the atmosphere. Any X-ray examination, even a "pediscope" taken when fitting a pair of shoes, results in a certain quantity of gamma rays being absorbed by the tissues, and as X-ray examination for diagnostic purposes is many times stronger, interest has been shown in the radiation dose received by various tissues, especially the foetal gonads. Osborn and Smith (1956) studied this problem and found that both straight X-rays of the abdomen and X-ray pelvimetry in pregnancy, resulted in a genetically significant dose of radiation.

This paper, while of importance, is more theoretical than real at the moment, because it may take more than one generation to see if there has been any effect on the genes as a result of heavy dosage on the foetal gonads. A subsequent paper/

paper by Stewart et al (1956), stated that leukaemia was nearly twice as commonly found in children whose mothers had had X-rays taken of the abdomen during pregnancy, than in controls. The numbers so far are small, 85 of leukaemia against 45 controls, but while other surveys are being made to confirm or refute these findings, the fact remains that those of us who have made full use of X-rays during pregnancy have had to reconsider their use.

By this I mean not only the limitation of X-rays and pelvimetry, but whether it is possible to cut down on the number of films taken and especially the type of film which results in a large dose of radiation to the foetus. While this is not altogether an obstetrical problem, the fact remains that it is the obstetrician who orders the films to be taken, and he may be used to a certain set of films from which he expects to assess various aspects of shape and size of the pelvis.

In the first part of my thesis I described the four films that were the standard pelvimetry employed when I first started to collect this series. I also mentioned that a modified antero-posterior film was used in the latter part of my series. The question that must be answered is whether/

whether from the information I have collected, any of the radiological finding could be omitted.

Obviously the film that results in the greatest dose to the foetus and especially its gonads if a vertex presentation, is the one of the true brim. This film is the only one which enables the shape of the pelvic brim to be seen. The ischial bispinous is also measured from this film, but it is quite possible to measure the bi-spinous from a modified picture. Is the shape of the pelvic brim so important obstetrically ? It is possible by using the pelvic index to classify the pelvic brim shape of anthropoid and platy-pelloid. The remainder must be either gynaecoid or android, and as I showed in Table 22, 11.4% of these were android. In table 24 and 25 I compared the size of the pelvic brim area and outlet area in the four different types of pelvis. In Table 26 I showed the relation of flat sacrae to the shape and in Table 63 the reason for application of forceps in the four types of pelvis. In these 4 tables the information received was of interest but I do not think of sufficient importance to retain this particular X-ray film of the pelvic brim.

I mentioned that recently this film had been/

been largely superseded by a modified antero-posterior of the pelvic brim from which the only measurement made was the ischial bispinous. This is technically a difficult measurement to obtain accurately, and one might question the value of the ischial bispinous - after all they can be palpated vaginally and a rough estimate obtained of their distance apart. I have always believed, and hope I have expressed it clearly in my paper, that the area of the pelvic outlet is more important than either the sagittal or coronal measurement alone. I showed in table 37 how commonly a contracted bi-spinous measurement was associated with a contracted outlet area and also how commonly Caesarean section was associated with a small transverse outlet measurement. I therefore am of the opinion that the ischial bispinous measurement is one of the essential measurements required.

It has been the practice of our radiological department to obtain the transverse of the pelvic brim by the parallax method. This involves a double exposure and while the dose of gamma rays is small, one does wonder if it is absolutely necessary. Another point that seems worth considering is whether the previous film mentioned, the modified pelvic brim, could not be combined with this one, because they are very similar and it/

it would seem possible to measure both the transverse of brim and ischial bispinous on one film. Snow (1952) describes a method of doing this using only 1 exposure.

The most important film of all is the true lateral and if one were confined to one film this would be the one of choice. From this film the antero-posterior of inlet and outlet can be measured, the shape of the sacrum and the sacro-sciatic notch seen as well as the degree of engagement of the foetal head. From the antero-posterior of the brim, and the transverse obtained in the last mentioned film, one can calculate the area of the pelvic brim and the outlet area from the two lower measurements. I have shown that the area measurements of the brim is of value in the comparative tables but that one must keep a careful note of the antero-posterior of the brim; also because in many cases of rickety flat pelvis the transverse of the brim was very large, and in spite of a contracted anteo-posterior the brim area was large. I calculated that of the 47 cases of contracted pelvic brim 25 were rickety flat and 22 simple flat. The importance of the area measurement is seen mostly in those cases with an adequate antero-posterior but a contracted transverse/

transverse measurement. There were 11 such cases of generally contracted pelvis in my series of which nearly one-third required Caesarean section.

As regards the outlet area I showed in Table 16 that 20% of these cases with a contracted pelvic outlet (below 80 sq. cm.), required Caesarean section and I indicated that if there was contraction at both brim and outlet the chances of Caesarean section rose to nearly 50%. This would suggest that these measurements are worth taking.

The only remaining pelvic measurement that is left to discuss is the sub-pubic angle. This is taken by placing the X-ray tube above the patient's spine and both the maternal and foetal gonads must get a full radiation dose.

In Table 38 I showed that there was a definite relationship between the ischial bispinous and the sub-pubic angle, after all they are both a transverse measurement of the pelvis. In Table 39 I showed that a small sub-pubic angle was very rarely associated with a contracted antero-posterior of the outlet. I would submit that if one feels a narrow sub-pubic angle on vaginal examination, the essential measurement to obtain is the outlet area, because if there is no contraction here vaginal delivery is likely. I consider that the/

the film taken to obtain a film of the sub-pubic angle is not sufficiently important to submit both mother and child to such a large dose of gamma rays.

This means that it should be possible to limit the films to a modified brim and a true lateral. If one is only taking pelvimetry X-rays it should be possible to screen off the maternal and foetal gonads. At some recent Caesarean sections I located the ovaries while the foetus was still in utero, and I found that they were very close to the cornua of the uterus. On taking a bony level, the crest of the ilium, I found the ovaries were just above this level.

The next question is which patients should have antenatal pelvimetry performed, if any.

I showed that small women had on the whole a smaller pelvis than taller women, in Table 43, but on the other hand Table 42 showed that there was as much chance of these small women having a spontaneous delivery as the tall women. In Table 44 I showed that there were only 44.7% of women with a contracted pelvic brim antero-posterior who were under 5 feet in height. These figures would suggest that routine X-ray pelvimetry of/

of small women is unnecessary- it should only be done if there is some associated reason. It would seem to me there is still a big place for a thorough clinical examination of the pelvis in the primigravida at the thirty-sixth week. Abdominal examination should be made to assess the lie, presentation, position and degree of engagement of the head. Afterwards a vaginal examination to assess the state of both the pelvis and soft parts should be made. If the head is not engaged an attempt should be made to make it do so, using one of the accepted manoeuvres, such as Munro Kerr's modification of Muller's method. If the head cannot be made to engage, or alternatively if the promontory of the sacrum is reached more easily than is the obstetrician's usual finding, then X-ray pelvimetry would appear justified. What about contraction lower down than the brim ? If the obstetrician feels that there is narrowing of the lower pelvis I think X-ray pelvimetry is justified because failure to recognise contraction in the lower pelvis, which may possibly be associated with it in the upper pelvis, may result in insuperable dystocia and foetal loss. The later risk of childhood death from leukaemia would appear/

appear less of a risk. Another occasion on which I consider pelvimetry obligatory, although possibly outside the scope of this paper, is a breech presentation in both a primigravid and parous woman. The published figures of breech loss vary but are often as high as 10%, the parous being just as bad or often worse than the primigravidae, Cutts and Abbas (1950). Intra-partum pelvimetry would appear to have a place in disordered uterine action. I showed that 40% of women requiring Caesarean section for disproportion had a prolonged labour, table 67, and it would appear justified to see the true size of the pelvis in these women. It might have enabled us to shorten the labour by performing earlier Caesarean section.

Finally, should one have a difficult vaginal delivery, or have to deliver a primigravida by Caesarean section for disordered uterine action, it seems to me a wise precaution to have this patient X-rayed post-natally. Not only is this a useful piece of information to the obstetrician, but the information is invaluable when the patient returns for her next confinement. It also means that pelvimetry is performed in the absence of a foetus and the risks to embryonic tissue is avoided.

As/

As this paper is confined to primigravidae it is perhaps outwith its scope to mention parous women, but I do feel that any case of previous difficult delivery, or unexplained stillbirth does merit careful pelvic study including pelvimetry.

As I have already mentioned Osborn and Smith (1956) found that the radiation dose from straight X-rays was nearly as heavy as at pelvimetry. Here once again there are probably a great many unnecessary radiological examinations, often I am sure because of failure to examine the patient properly. One example of this is of a breech presentation being suspected because a head cannot be felt at the pelvic brim. In many cases the head is so deeply engaged that it cannot be palpated abdominally - this fact could have been learnt in a few seconds if the obstetrician had performed a vaginal or even a rectal examination. I would submit that if a breech presentation is diagnosed pelvimetry is all that is required, because the breech, or,if one is wrong, the vertex, will be seen in the lateral X-ray film. What one is trying to avoid is a double radiological assessment, one to diagnose the presentation and then on top of this full pelvimetry which/

which means probably a total of 6 X-ray films.

X-rays to diagnose foetal abnormality in the presence of hydramnios are probably justified because so often the pregnancy is doomed to failure the presence of anencephaly being confirmed. What about multiple pregnancy ? To be of any help here the diagnosis should be made by the 28th week of gestation so that the patient can be given rest in bed at home or even in hospital. Also if twins are expected the mother naturally wants to know so that she can prepare a second layette and obtain a double pram. Nothing gives a patient less confidence in her accoucheur than a failure to diagnose a multiple pregnancy, or worse still to tell her she has twins and only one baby appear. However while allowing for radiological examination of suspected multiple pregnancy, this should involve very few cases per annum if clinical acumen is used first. Various other reasons must be permitted for radiological examination such as malpresentation, transverse lie and other suspected foetal deformities in the absence of hydramnios, but there are 2 reasons often given for carrying out radiological study that can, I feel, be dispensed with. The first of these is assessment of maturity and the second suspected foetal/

foetal death. The first of these is so inaccurate that it is no real help in diagnosis or prognosis, while the second only appears after the foetus has been dead a few days. Repeated auscultation of the foetal heart is a much more reliable guide to the state of the foetus.

The last point I wish to mention about radiological diagnosis in pregnancy is in the suspected case of placenta praevia. This has been found to be a great help in differentiating between those women who have either a major degree of placenta praevia, a minor degree,or none at all. If of the latter 2 groups, it is generally possible to let the patient home and attend the ante-natal clinic; while if the former, hospitalisation is obligatory. As nowadays one sees many cases of very slight bleeding at any time after the 28th week of gestation, and as most of them have not a major degree of placenta praevia, the saving in beds by radiological screening of these cases has been considerable. However, it is often the custom to take at least 4 films to locate the placenta accurately so that the dose of radiation must be considerable. It would indeed be a great pity to dispense with this valuable diagnostic procedure/

procedure but I think it should be possible to cut down the number of films to two, a standing lateral and an antero-posterior. By this means the presenting parts should be encouraged to impinge upon the pelvic brim if it is possible for them to do so. If not, it should be feasible to see if the placenta praevia is anterior or posterior; and also whether of major or minor degree.

I must confess that I would view with dismay any attempt to prohibit the use of X-rays in the pregnant woman on the evidence at present available. The reasons for performing straight X-rays mentioned are not comprehensive, but even in a busy ante-natal clinic should only amount to a few exposures a week. The big advantage of radiological pelvimetry is that the measurements are available for the whole obstetric life of that particular patient. Should there have been difficulty at the first delivery, it is of much importance to know the exact size of the pelvis, and attempt to prevent a recurrence of the same trouble in another labour.

What/

What lessons can be learnt from the information I have collected, and to what use can it be put in the future management of our cases ?

In Table I I showed the incidence of contracted pelvic brim antero-posterior in the 3 types of delivery under discussion. From this table I would suggest that not only those with a contracted pelvic inlet, i.e. under 10.2 cm., but those whose pelvic inlet is 10.5 cm. or less should have a hospital delivery. This will permit 38% of the Caesarean section patients being delivered in hospital as booked cases.

Table 2 showed the very small incidence of contracted transverse of the pelvic brim in all types of delivery. I would suggest that any case with a transverse measurement of 11.5 cm. or less should have a very closely supervised trial of labour. In combination with this transverse measurement one can combine the inlet area of the pelvic brim. A glance at table 3 shows that 46% of the women requiring Caesarean sections have an area of 105 sq. cm. or less. The number of spontaneous and forceps deliveries are both in the region of 20% with this size of brim area, so I would advise hospital delivery of those whose pelvic/

pelvic brim area is 105 sq. cm. and below.

As regards the pelvic outlet, I have shown that the area measurement is the important one, and while I have taken as a criterion of contracted outlet a figure of 75 sq. cm. or less, an inspection of Table 16 shows that if one takes 80 sq.cm. and below as a standard of hospital delivery, 38% of Caesarean sections and 26% of forceps deliveries will be included.

Briefly I mention pelvic architecture to point out that apart from platypelloid pelves in which over one-third are contracted, gynaecoid pelves are 7 times as commonly found as any other one type, see Table 22. I would therefore suggest that the shape of the pelvic brim, provided it is of adequate size is not of enough importance to merit the special brim film. Similarly while the shape of the sacrum does not entail taking a special film its incidence is so similar in all three types of delivery, that providing the pelvic brim and outlet are adequate, the shape of the sacrum is not important.

In the next part of my thesis I correlated various pelvic measurements; I showed, in Table 33, that of the 47 cases of contracted pelvic brim antero-posterior Caesarean section was required/

required in 11, i.e. 23.4%. I did mention, however, that in the few cases where the outlet also was contracted a Caesarean section was required in half the cases. This suggests that a trial of labour is usually possible in most cases of contracted pelvic brim, but if the outlet also is contracted, elective Caesarean section is probably the better treatment.

Focussing attention on the pelvic outlet, I showed that the outlet area was more important than the antero-posterior or transverse measurement alone. I demonstrated that many cases with one small measurement were amply compensated in the other, having an adequate outlet area.

I showed the relationship of the sub-pubic angle to the ischial bispinous, and also to the antero- posterior of the outlet. This proved that only very rarely was a small sub-pubic angle associated with a contracted antero-posterior of the outlet, only 5 cases out of the 830. I have therefore no hesitation in once more confirming the fact that the sub-pubic angle can be dispensed with as a radiological measurement, but if found to be narrow on clinical examination, pelvimetry as described earlier in the discussion is advised.

While considering contracted pelvis it would be/

be of interest to know how my figures compare with a year's total in the the Maternity hospital. In 1956 there were a total of 57 cases of contracted pelves in primigravidae, using the same standard as I have done for inlet and outlet. These had to be pruned considerably, elective sections and breech presentations being removed to make the conditions comparable to my series. This left a total of 44 cases, 14 spontaneous deliveries, 15 forceps deliveries and 15 Caesarean sections. Of these 44 cases, 27 were brim contraction and 17 outlet contraction as against 47 and 43 in my series. I have only counted each case once, so that if both pelvic brim and outlet are contracted I have given the brim priority. This means that my figures are approximately equal to twice the total number of cases to be expected in the Simpson Maternity Pavilion in a year. As nearly 2000 primigravidae are delivered in a year my figures cover a total number of nearly 4,000 primigravidae. The reason why more contracted outlets are seen in my series is in large measure due to the fact that many such cases were only definitely diagnosed by pelvimetry, often post-natal.

The/

The next part of my thesis was devoted to the correlation between maternal height and pelvic size. Although I showed quite definitely that a woman of small stature had a smaller pelvic brim area and generally a smaller outlet area, the fact remains that these small women had a greater chance of spontaneous delivery than either of the two taller groups. The incidence of Caesarean section was slightly higher in small women than in those of average height, while the incidence of forceps delivery was least in the small women.

I showed in table 44 the relationship of maternal height to contracted pelvic brim antero-posterior. Less than half of these cases were under 5' in height, while table 45 showed that the incidence of contracted pelvic outlet area was even less commonly seen in these small women. It has been our practice to book all primigravid women under 5' in height, but the figures throw doubt on the necessity for this. Admittedly 21% of these small women have the likelihood of either contracted brim or outlet against 9% of the women of average height, but the fact remains that nearly two-thirds of these women had a vaginal delivery/

delivery. In this town where 86% of deliveries are in hospital the booking position is fairly straightforward, but in other areas where hospital beds are at a premium, it does seem rather wasteful to book so many patients who are likely to have an adequate pelvis and easy vaginal delivery.

I next considered the part played by the weight of the child and showed how frequently a baby weighing over 8½ lbs. required operative delivery, either abdominal or vaginal. The size of the child is, of course, one of the factors that cannot be taken into consideration at booking, but if the baby appears large it would appear well worth while considering pelvimetry.

Perinatal mortality was discussed, and the cases in which contracted pelvis was found detailed. A contracted pelvic brim appeared to be the cause of death in one case and the outlet in another. Apart from this, cord complications, postmaturity and pre-eclampsia appeared to be a frequent cause of perinatal loss in women with normal pelves.

The duration of labour in the 3 types of delivery was considered, and the significance of pelvic brim and outlet size discussed. A small pelvic brim area was shown to be associated with an increased incidence of prolonged labour. A small/

small pelvic outlet area also is associated with a tendency for labour to be prolonged.

Maternal age was considered and the rising ratio of prolonged labour as age increases shown. The fact that 80% of the women over 35 years of age required operative delivery, either abdominal or vaginal, would seem to indicate that hospital delivery is obligatory in the elderly primigravida.

In the next part of my thesis I showed the reasons for operative delivery. I showed the part played by pelvic brim shape in the aetiology of forceps delivery, and also the part played by the size of the pelvic outlet. It would appear that neither of these bears any relationship to the reason for application of the blades. In view of this it would appear impossible to prognose which patients will require forceps delivery. I already have mentioned the necessity of delivering all women in hospital with an outlet area of 80 sq.cm. or less, but this will only include 26% of forceps deliveries.

The reasons for Caesarean section are finally discussed, and the large number of cases of disproportion emphasised. In any case of prolonged labour intra-partum radiology would appear to be desirable.

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