

### Röntgenographic Pelvimetry.\*

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SINCE the beginning of my work in this field five years ago, when I briefly described a method of measuring the pelvis, several other factors pertaining to the use of X-rays in obstetrics have been elicited and are worthy of consideration.

#### *Ante-Natal Treatment.*

It is an acknowledged fact that the true conduct of labour commences with ante-natal treatment. During this period of supervision the chief duty of the doctor is to see that his patient is physically fit to deliver herself of a normal child. Munro Kerr and Holland, writing on Cæsarean section, showed by statistics that 80 per cent. of the operations performed in this country were for contracted pelvis, and that the mortality in those cases in which vaginal examination, or forceps delivery had been attempted before the operation was 27 per cent., compared with 1.6 per cent. in which pre-labour diagnosis had been made, and the operation performed without vaginal interference. Here, therefore, we have a maternal mortality of 25 per cent. which could have been greatly reduced if not altogether avoided if ante-natal supervision had been efficient. The X-rays, besides demonstrating pelvic deformities, the effect of old fractures or diseased joints, make it possible not only to see the existence and extent of the pelvic contraction, both of the inlet and outlet, but also to compare the abnormal with the normal pelvis, and measure the degree of contraction. Every woman should have her pelvis measured by the X-rays to see if she is fitted for child-bearing, and towards the end of her pregnancy, according to the degree of her contraction, if any abnormality is noted, another photograph should be taken to ascertain the presentation of the child, and its size relative to that of the pelvis, thereby giving a definite diagnosis, and enabling the case to be treated by a suitable method.

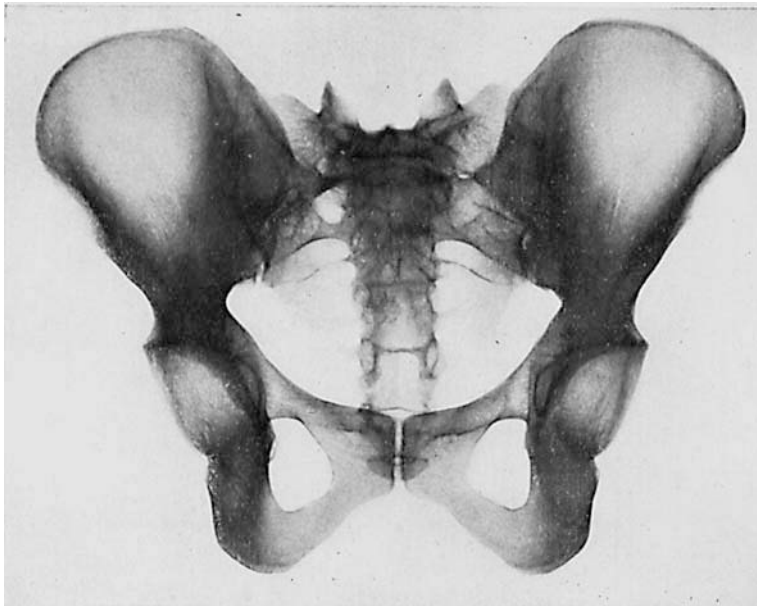
\*Read at the Annual Meeting of the British Medical Association, Portsmouth, July 1923.



**FIG. 1.—AN ABNORMAL PELVIS.**

**EXTERNAL.**—Showing considerable narrowing and apparent flattening of the iliac bones more marked on the right side. At the level of the antero-inferior spines the bones are distinctly narrower than normal.

**INTERNAL.**—On comparison with the “standard” the inlet was normal.



**FIG. 4.—NORMAL PELVIS.**

*Pelvimetry.*

The addition of Röntgenography to our obstetrical resources enables us not only to see the size and shape of the mother's pelvis, and of the foetal head, and the relations of the one to the other, but also to measure the pelvic diameters, both of the inlet and the outlet without vaginal examination.

Since the existence of contracted pelvis was first reported by Arantius various methods have been employed for measuring the extent of a pelvic deformity, if present.

*External pelvimetry* introduced by Baudeloque, while enabling us to measure directly the external pelvic diameters, and thence to draw certain conclusions as to the degree of contraction, is insufficient for estimating the size of the pelvic cavity. This cannot be done directly in the living woman, except during a laparotomy.

Every obstetrician has encountered cases which appeared on external examination to be normal, but when labour was advanced unlooked-for difficulties presented, when it was too late to do an abdominal operation.

In the same way one meets cases in which there is external pelvic deformity and in which one anticipates a difficult confinement, but in which, on the contrary, labour is quite unobstructed and the infant is of average size. This type of case is well shown in skiagram number 1, in which the abnormality is due to deformity of the iliac bones, the pelvic cavity being normal.

Fig. 1 represents the pelvis of a healthy primigravida seven and a half months pregnant. She consulted her own doctor as to his prognosis of a normal labour. He found, on external pelvimetry, that the distance between the anterior superior spines was only 8 in., and that between the iliac crests  $9\frac{1}{2}$  in. She was sent to me for X-ray pelvimetry.

*External.* On comparing her X-ray plate with the "standard" there is considerable narrowing and apparent flattening of the iliac bones, more marked on the right side. When worked out, the amount of contraction compares favourably with the doctor's direct measurements.

Between Iliac Crests.	Pelvis.	Skiagram.
Standard ... ..	28 cm.	32.5 cm.
Mrs. I. ... ..	23 cm.	26.8 cm.

At the level of the antero-inferior spines the bones are distinctly narrower than normal.

*Internal.* On comparison with the "standard" the inlet appears normal, and when worked out it is as follows :—

	Antero-posterior.		Transverse.	
	Pelvis.	Skiagram.	Pelvis.	Skiagram.
Standard ...	11.5 cm.	13.5 cm.	13.6 cm.	15.9 cm.
Mrs. I. ...	11.5 cm.	13.6 cm.	13.6 cm.	16.0 cm.

This case demonstrates clearly the advantages of this method of pelvimetry and the fallacy of depending on external measurement.

*Internal pelvimetry.* A method was devised by Skutsch which made it possible to estimate the size of the pelvic cavity indirectly and with fair accuracy, but the employment of his instrument necessitates an anæsthetic, if discomfort or actual pain to the patient is to be avoided.

The Röntgen rays, it was thought possible, might afford a valuable method of investigating the size and shape of the pelvis, but it was found that, while an excellent idea as to shape was obtained, that as to size was erroneous, owing to the fact that the sacrum and pubes lay at different levels from the sensitive plate, and consequently one portion of the pelvis was enlarged out of all proportion to the other. This defect made it impossible to utilize radiography for purposes of mensuration.

The employment of the following method will obviate this difficulty, and make it possible not only to see the existence and extent of the pelvic contraction, both of the inlet and the outlet, but also to compare the pelvis under examination with the normal pelvis, and to measure its diameters without causing any appreciable inconvenience to the patient.

#### *Position of Pelvis.*

Before discussing the technique of this method of pelvimetry a few anatomical facts on the position of the pelvis should be noted. In the erect posture the pelvis is placed obliquely with regard to the trunk of the body. The promontory of the sacrum, in well-formed females, is nearly four inches above the upper border of the symphysis pubis.

Fig. 2. The plane of the pelvic inlet, or true conjugate, forms an angle of about 65 degrees with the horizontal plane. Therefore with an antero-vertical plane it will form an angle of about 25 degrees. If the plane of the inlet is bisected by a line at right angles, one extremity will pass through the middle of the coccyx, and the other

through the umbilicus. The axis of the pelvic inlet is therefore directed downwards and backwards.

### VERTICAL SECTION OF PELVIS SHOWING AXIS OF INLET

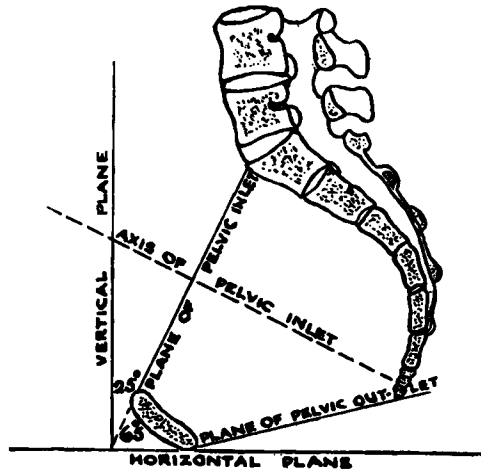


FIG. 2.

#### *Technique.*

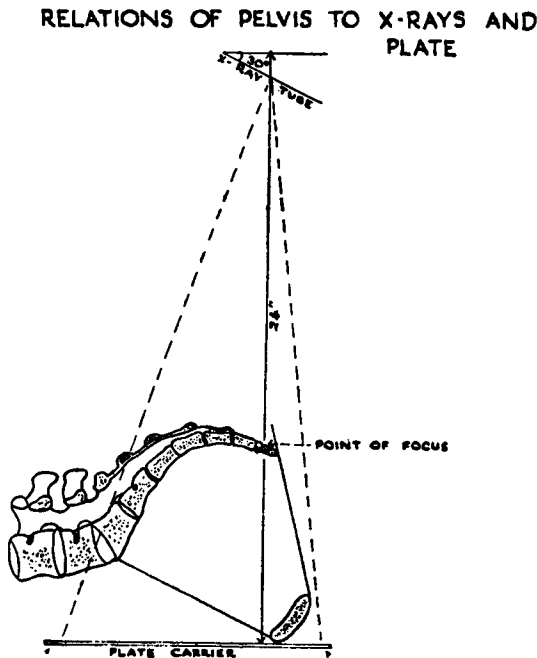
Fig. 3. The patient lies flat, face downwards, on the table, with her symphysis pubis touching the plate carrier. The X-ray tube is raised two feet above the plate and focussed on a point four inches below the mid-point of a line joining the posterior iliac spines; this point corresponds to about the middle of the coccyx. The tube is then tilted forward through an angle of 30 degrees, towards the patient's head, and it will then lie parallel with the plane of the pelvic inlet. The rays will thus be directed upwards and forwards in the axis of the true conjugate, and an excellent image of the pelvic cavity will be obtained on the plate.

In this technique there are three constant factors :—

1. The point of focus.
2. The X-ray tube at the same angle to and at the same distance from the sensitive plate.
3. The relation of the symphysis pubis to the sensitive plate.

Having these three fixed points, and using the shadow of the

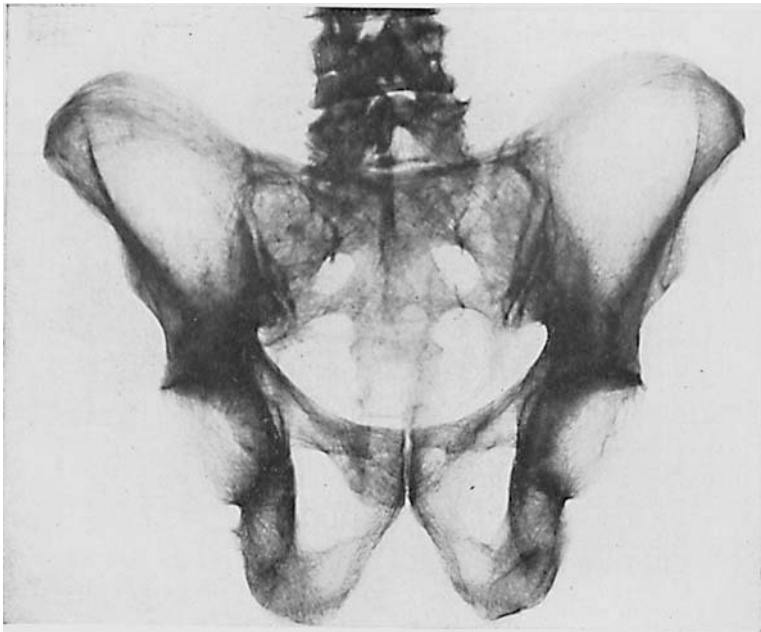
symphysis pubis as an axis, we can accurately measure any object within the "tube radius."



The possibilities of error in interpreting the size of the inlet, because of the varying degree of tilting of the different pelvises are negligible in this method of pelvimetry. In a contracted pelvis the angle which the plane of the pelvic inlet makes with the horizontal is greater than the normal, and the angle with the vertical will be correspondingly reduced. In a contracted pelvis, the promontory of the sacrum will be nearer the plate than the normal, and be more easily defined.

*Method of measuring.*

In a normal pelvis, which is designated the "standard pelvis" the various diameters, both external and internal, are accurately measured. When this pelvis is radiographed definite points can be marked on the plate; the distance between these points will bear a definite ratio to that between the corresponding points measured on the pelvis. This radiograph is taken as the "standard plate." By radiographing the patient in the same position as the "standard pelvis," an accurate comparison of the patient's plate with the "standard plate" will be obtained, and



**FIG. 5.—AN ABNORMAL PELVIS.**



**FIG. 6.—A NORMAL PELVIS.**

therefore of the patient's pelvis with the "standard" or normal pelvis; from it the internal measurements can be mathematically worked out; when compared with the direct measurements they are fairly accurate, as is shown by Figs. 4 and 5, there being an error of 2 mm. only. To work out mathematically the transverse diameter, for example, of the pelvic inlet, the length of the transverse diameter of the pelvic radiograph of the patient is multiplied by the transverse diameter of the standard pelvis, and divided by the transverse diameter of the standard plate. In the same way the antero-posterior diameter of the inlet, or the transverse diameter of the outlet can be worked out. I have not mentioned the oblique diameters, but if the true conjugate is diminished the oblique will also necessarily be reduced in proportion.

Fig. 4 is a skiagram of a normal pelvis, which is taken as the "standard plate"; the dimensions are:—

		Pelvis : Direct Measurements. Skiagram.			
Inlet :					
Antero-posterior	...	...	11.5 cm.	13.5 cm.	
Transverse	...	...	13.6 cm.	15.9 cm.	
Outlet :					
Transverse	...	...	11.0 cm.	12.0 cm.	

Fig. 5 shows an abnormal pelvis, the internal measurements of which show a very slight diminution when worked out by the above method with the direct measurements, there being only an error of 3 mm. in the antero-posterior diameter of the inlet, 2.1 mm. in the transverse diameter of the inlet. It also shows clearly the diminution in the outlet.

		Pelvis.		
		Direct Measurements.	Worked out.	Skiagram.
Inlet :				
Antero-posterior	...	10.5 cm.	10.2 cm.	12.0 cm.
Transverse	...	12.0 cm.	11.79 cm.	13.7 cm.
Outlet :				
Transverse	...	7.5 cm.	7.5 cm.	8.2 cm.

Fig. 6 represents the pelvis of a healthy woman, aged 25 years, who has had three normal labours, and whose external measure-



ments are normal. The internal measurements have worked out very satisfactorily when compared with the standard plate.

	Standard.		Mrs. "A."	
	Pelvis.	Skiagram.	Pelvis.	Skiagram.
<b>Inlet :</b>				
Antero-posterior...	11.5 cm.	13.5 cm.	11.5 cm.	13.5 cm.
Transverse... ..	13.6 cm.	15.9 cm.	13.6 cm.	16.0 cm.
<b>Outlet :</b>				
Transverse... ..	11 cm.	12.0 cm.	11 cm.	12.2 cm.

Fig. 7 is a skiagram of a woman with a flat pelvis. This patient's first child was eviscerated, and her second was delivered by Cæsarean section. The transverse diameter of the inlet is normal, but the antero-posterior is diminished over an inch. The transverse diameter of the outlet is 1 cm. larger than normal.

	Standard.		Mrs. "B."	
	Pelvis.	Skiagram.	Pelvis.	Skiagram.
<b>Inlet :</b>				
Antero-posterior...	11.5 cm.	13.5 cm.	8.5 cm.	10.0 cm.
Transverse... ..	13.6 cm.	15.9 cm.	13.6 cm.	16.0 cm.
<b>Outlet :</b>				
Transverse... ..	11.0 cm.	12.0 cm.	12.19 cm.	13.5 cm.

Fig. 8. A skiagram of a woman with a generally contracted pelvis. The transverse diameter of the inlet is diminished 1 cm., and the antero-posterior is diminished 3 cm., or over an inch.

	Standard.		Mrs. "M."	
	Pelvis.	Skiagram.	Pelvis.	Skiagram.
<b>Inlet :</b>				
Antero-posterior...	11.5 cm.	13.5 cm.	8.6 cm.	10.1 cm.
Transverse... ..	13.6 cm.	15.9 cm.	12.8 cm.	15.0 cm.

The measurements of the last two cases were verified at the time of operation.

### *Pregnancy.*

It is possible to obtain the X-ray shadow of the foetus *in utero*, and this is a great clinical and medico-legal advantage in cases in which there is doubt as to the presence of pregnancy or the existence of an abnormality. It is possible to recognize the foetus about the fourth month,—the use of the Potter-Bucky Diaphragm will enable us to recognize the presence of a pregnancy at even an earlier period.

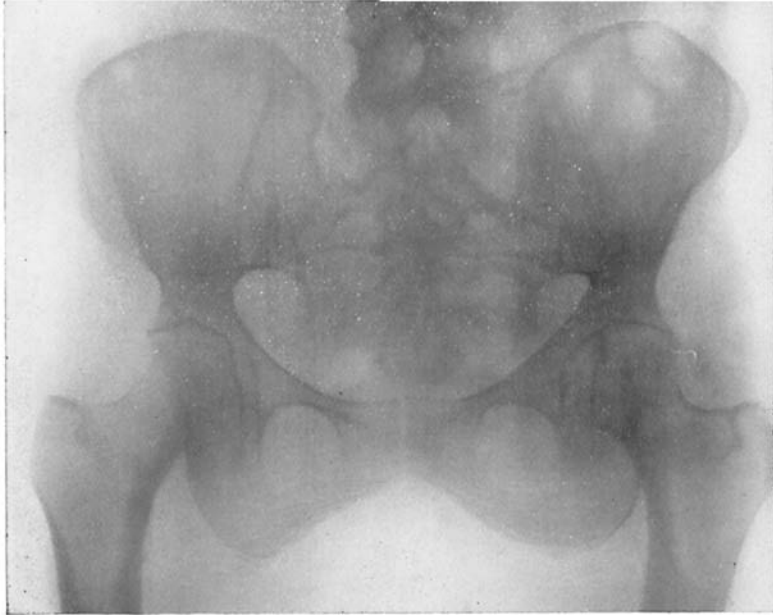


FIG. 7.—A FLAT PELVIS.



FIG. 8.—A GENERALLY CONTRACTED PELVIS.



**FIG. 9.—FETAL HEAD ABOUT TO ENGAGE THE PELVIS.**  
Photo taken five hours before the commencement of labour, which terminated normal.



**FIG. 10.—FETAL HEAD ATTEMPTING TO ENGAGE A CONTRACTED PELVIS.**  
Showing moulding of the skull bones and overlapping by the foetal skull of the pelvic inlet especially in the region of the symphysis pubis.

There are several factors which militate against the diagnosis of pregnancy in the early months,—the thickness of the maternal tissues, the hyper-congestion of the uterine wall, the amniotic fluid, and the slight density of the foetal bones.

I am doubtful whether one will be able to differentiate between an extra-uterine and an intra-uterine gestation, unless we combine some clinical method while the photograph is being taken, such as bimanual examination, when the shadow produced by the doctor's fingers would denote the position of the uterus. If, however, the gestation was in the pouch of Douglas the foetal shadow would overlap that of the doctor's fingers and make a differential diagnosis impossible.

*Relations of the presenting part to the pelvis.*

If the Röntgenograph is taken just before, or when labour commences, a very clear picture is produced of the foetal position, and the relations of the presenting part to the maternal pelvis. In vertex presentations, when the head is about to engage in the pelvis, an accurate comparison between the foetal skull and the pelvic inlet can be obtained, as is well illustrated by the following case (Skiagram No. 9). Mrs. S., aged 27, gave a history of a difficult instrumental delivery, the child living only an hour. Early in her second pregnancy she was sent to me. X-ray pelvimetry showed that her pelvis was normal. At the date of her confinement she was again X-rayed; this skiagram showed that there was no moulding of the foetal skull, and that the relations of the head to the pelvic inlet were satisfactory. The patient delivered herself nine hours later of a healthy child 7 lbs. in weight. Neither during the pregnancy or labour was a vaginal examination made.

If engagement of the foetal skull is difficult, during the efforts of labour moulding of the bones can be clearly seen and one can judge by the amount of overlapping if delivery is possible. If engagement is impossible there is distinctly seen overlapping of the pelvic inlet by the foetal skull, especially in the region of the symphysis pubis (Skiagram No. 10).

The recognition of this inability on the part of the foetus to navigate the passages successfully, would spare, by a timely Cæsarean section, many a mother a difficult labour with extensive damage, and considerably reduce infant mortality.

*Effects on the Mother and Fœtus.*

While it is recognized that large doses of the X-rays will produce an artificial menopause, the short exposure which is required for obstetrical diagnosis has no deleterious effect on the mother, and does not produce a temporary sterility.

In none of my cases, when the X-ray exposure has occurred during pregnancy, has intra-uterine death been produced, nor has any physical or mental maldevelopment shown in the new-born child.

*Conclusion.*

In conclusion, I would like to emphasize the following :—

1. The necessity of a “ standard ” plate for pelvic measurements.
2. The patient must be radiographed in the same position as the “ standard ” pelvis, having the same point of focus, the X-ray tube at the same angle to and the same distance from the sensitive plate.
3. The accuracy of diagnosis in showing to advantage the variety of pelvic contraction, and the ease with which the various pelvic diameters can be worked out.
4. The minimum amount of discomfort to the patient compared with other methods of pelvimetry.
5. By the collaboration of the Röntgenologist and the obstetrician there exists a valuable means of conserving maternal and foetal life.

To Dr. Beath, Röntgenologist to the Royal Victoria Hospital, Belfast, and to his assistant, Mr. Leeman, I express my gratitude for their assistance in taking the photographs for me.