A RADIOGRAPHIC COMPARISON OF THE MALE AND FEMALE PELVIS

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INTRODUCTION

To anatomists it has long been well known that in any collection of female pelves there are specimens in which the sex characters are so indeterminate that they may be said to resemble or even to be indistinguishable from the pelvis in the male or to be "android" in type. Two American observers, Caldwell & Moloy (1933, 8) have in recent years devoted much time to the study of the varying form of the female pelvis and its classification from the morphological point of view. Their publications have aroused considerable interest amongst obstetricians in this country, partly because of the alleged high incidence amongst females of this tendency to the male type, but mainly because of their claim to have demonstrated the importance of pelvic shape as classified by them not only in determining the type of foetal presentation but also the mechanism of labour. From the shape of the pelvic inlet judged merely by subjective impressions they have classified the female pelvis on a morphological basis into four standard or "parent" types, the "gynecoid" in which the shape of the inlet is "round" or broadly oval with the long axis transverse, the "anthropoid" in which it is oval with the long axis antero-posterior, the "android" in which it is heart-shaped, and the "platypelloid" in which it is flattened antero-posteriorly. They also classified and named intermediate or borderline forms so that in all, including an asymmetrical group, twelve categories were described. The percentage frequency of occurrence of their standard types (including the borderline forms in the nearest related standard type) amongst 147 pelves of white women in the fine collection of sexed pelves at Western Reserve University, Cleveland, U.S.A., was stated by them (1938) to be as follows: anthropoid 22·5, platypelloid 2·6, gynecoid 41·4, android 32·5. In their view about a third of the female pelves in this group thus appeared to have definite male characters and less than half were characteristically female in type. To facilitate their study of the female pelvis in the living subject they have devised a special method of taking radiographs and a special instrument known as the "precision stereoscope" as an aid to their interpretation.

In a radiological study of 215 consecutive primigravidae these authors (1934) found that, excluding intermediate forms, only 40 % were "true gynecoid" in type whereas as large a proportion as 12 % belonged to each of the

types "true anthropoid" and "true android". In view of the alleged importance of the occurrence of male tendencies in the female pelvis in influencing the course of labour it seems essential to determine the characters which are of most importance in differentiating the female from the male type of pelvis as they are shown in radiographs. A number of authors, notably Derry (1923)[1] and Strauss (1927–8), have made important contributions to the study of the characters of the female pelvis in dried skeletal material but it will be readily apparent that such detailed investigations of the characters of some of its constituent bones (the iliac) as they made are not possible in pelvic radiographs. Caldwell & Moloy (1933) in their study of the occurrence of the male or "android" type of pelvis in females have devoted most attention to the study of the pelvic inlet. From inspection, and in quite an arbitrary manner, they classify those in which it is blunt heart-shaped as "android" and those in which it is more typically female as "gynecoid". They also took measurements of some of the important diameters of the pelvis, but so far they have not published any of these. There seems now to be very general agreement for the view that classifications based on subjective impressions are not reliable. Based on personal judgments, they are too prone to be biased from one cause or another, and grading of the same characters into the same groups by different individuals, who are presumably using the same criteria, may show remarkable divergencies. When characters are measurable and expressible in numbers, the knowledge regarding them provided by this method of treatment of the data is likely to be of a much more satisfactory nature.

MATERIAL FOR PRESENT INQUIRY

In an investigation on the bony pelvis and its influence on labour, embracing a radiological and clinical study of a consecutive series of 500 women which was recently completed at the Obstetric Unit of University College Hospital and the Institute of Anatomy, University College, radiographs of the antero-posterior and lateral views of all the pelves were taken by a standardized method. From these radiographs, by appropriate adjustments for distortion, the actual dimensions of many characters of the pelvis were easily obtained. For the series of women the average values and variabilities of these characters and of certain ratios or indices derived from them were then calculated. As the best method of determining the characters in which the female pelvis differed most from the male or "android" type, as seen in radiographs from the anterior and lateral aspects, seemed to be to institute a comparison between the average values of these characters in a series of female pelves with the corresponding characters in a fairly adequate sample of typical males pelves, radiographs of the antero-posterior and lateral views of the pelvis were taken in an unselected series of fifty young adult men by exactly the same methods

[1] An attempt might have been made to calculate indices for the ilium approximately corresponding to those used by Derry and named by him the *chilotic* and the *chorematic* had it been possible to locate the pubo-iliac point with any degree of exactitude.

as were adopted for the women. For these men the average values and variabilities of the characters under review in the women were then estimated. They are shown in comparison with the corresponding values for the women in Table I. The points from which the measurements were taken are shown in the diagrammatic outlines given in Figs. 1 and 2, which are tracings taken from photographs of the actual radiographs of the antero-posterior and lateral views of a female pelvis from the series.

TABLE I. *Showing a comparison of the mean values and variabilities of many of the principal characters shown radiographically in series of female and male pelves.*

		Females No. of observations: 375–509			Males No. of observations: 50–52		
Pelvic characters	Symbols	Means and S.E.	S.D.	Co. V. %	Means and S.E.	S.D.	Co. V. %
Obstetric true conjugate diameter	A_1B	118·3±0·44	10·0	8·5	115·1±1·30	9·4	8·2
Anatomical true conjugate diameter	AB	122·4±0·44	10·0	8·5	119·6±1·28	9·2	7·7
Greatest transverse diameter at brim	HJ	130·6±0·31	7·0	5·4	120·8±0·82	5·9	4·9
Pelvic brim index:							
(1) with obstetric conjugate	$100\,A_1B/HJ$	90·8±0·36	8·2	9·1	95·3±1·10	7·9	8·3
(2) with anatomical conjugate	$100\,AB/HJ$	93·9±0·37	8·3	8·9	99·2±1·07	7·7	7·8
Approximate area of pelvic inlet:							
(1) with obstetric conjugate	$\pi HJ \times A_1B/4$	121·6±0·58	13·2	10·8	109·5±1·69	12·2	11·1
(2) with anatomical conjugate	$\pi HJ \times AB/4$	126·8±0·66	12·8	10·1	113·4±1·72	12·4	10·9
Antero-posterior diameter at pelvic outlet	A_2C	119·7±0·44	8·6	7·2	119·4±1·21	8·6	7·2
Transverse diameter at outlet (inter-spinous	ab	99·5±0·37	7·1	7·1	82·9±0·85	6·2	7·4
Intertuberal breadth	EF	109·0±0·32	7·0	6·4	92·9±0·89	6·4	6·9
Approximate area of pelvic outlet	$\pi ab \times A_2C/4$	93·7±0·54	10·4	11·1	78·0±1·25	8·8	11·3
Subpubic angle	$\angle R_1A_2R_2$	93·5±0·34	7·4	7·8	75°8±0·81	5·8	7·6
Sacro-sciatic notch index	$100\,VW/K'L$	52·4±0·37	7·6	14·5	61·8±1·08	7·8	12·6
Index of pelvic funnelling	$100\,(HJ–EF)/QR$	21·2±0·28	6·2	29·0	24·4±0·89	6·4	26·1
Index of sacral curvature	$100\,EF/BC$	18·3±0·28	6·2	33·9	21·9±1·03	7·4	33·7
Sacral index	$100\,XY/BC$	108·9±0·43	9·6	8·8	109·8±1·52	10·8	9·9
Sacral inclination to pelvic brim	$\angle ABC$	76°4±0·29	6·4	8·3	74°4±0·79	5·6	7·6
Sacral inclination to pelvic brim	$\angle ABF$	92°6±0·38	8·5	9·1	93°5±1·08	7·7	8·2
Inclination of pelvic brim to horizontal plane	$90°–\angle DAB$	57°7±0·28	6·1	10·6	57°2±0·78	5·6	9·9
Posterior sagittal segment ratio at inlet	$100\,BZ/AB$	48·7±0·34	7·1	14·5	46·6±0·99	7·0	15·0
Ilio-innominate ratio	$100\,MO/MX$	65·7±0·20	4·5	6·9	66·7±0·53	3·8	5·7
Posterior sagittal segment ratio at outlet	$100\,K'C/A_2C$	33·0±0·23	4·8	14·5	25·7±0·67	4·8	18·6

Units of measurement. The means and standard deviations of the linear measurements are in mm., of the areas in sq. cm., of the angles in degrees and of the ratios or indices in percentages.

METHODS OF MEASUREMENT OF PELVIC CHARACTERS

Before comparing the mean values and variabilities in the male and female series it may be advisable to refer briefly to some of the characters and the method of measuring them which was used. Their exact nature will be made more apparent from the lettering of the figures and the symbols used to denote

them in Table I. There are two true conjugate diameters on the list, the anatomical true conjugate and the obstetric true conjugate. These are measured on the lateral radiograph from the sacral promontory to the posterior margin of the upper end of the symphysis pubis and to the summit of the eminence on the posterior surface of the symphysis pubis a little below its upper end respectively. The anatomical conjugate is on the average 3 or 4 mm. longer than the obstetric. The greatest transverse diameter at the brim is found by trial on the antero-posterior radiograph. Two values of the pelvic brim index (100 × conjugate diameter/greatest transverse diameter at brim) have been calculated, one using the obstetric, the other the anatomical conjugate. At the outlet of the bony pelvis, the measurement in the antero-posterior direction is taken on the lateral radiograph from the lower border of the symphysis pubis

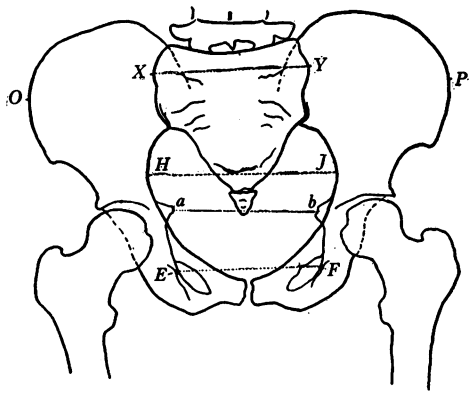

Fig. 1. Outline tracing of radiograph of the antero-posterior view of the pelvis showing the principal measurements taken.

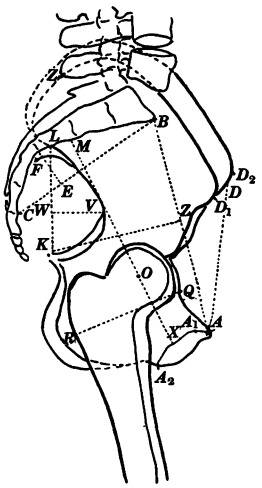

Fig. 2. Outline tracing of radiograph of the lateral view of the pelvis showing the principal measurements taken.

to the lower end of the sacrum at the sacro-coccygeal junction; in the transverse direction two measurements are taken from the antero-posterior radiograph, the interspinous diameter or the distance between the extremities of the ischial spines and the intertuberal breadth which is the distance between the inner margins of the ischial tuberosities. The approximate areas of the pelvic inlet and outlet have been calculated from the antero-posterior and transverse diameters on the assumption that the openings are approximately elliptical in shape and that the major ($2a$) and minor ($2b$) axes of the ellipse can be represented by these diameters. The formula πab then gives the area. Comparison of the actual measurement of the inlet areas in a number of radiographs by the planimeter with the corresponding areas obtained by using the diameters as the elliptical axes in which the agreement is usually fairly close seems to give adequate support for the validity of the assumption. The width of the

subpubic angle in the individual pelves was obtained from the ratio of two chords, half the intertuberal breath and the height of the pubic arch. The former was measured on the antero-posterior radiograph as already described, the latter measured on the lateral radiograph is the distance from the lower margin of the symphysis pubis to the lower border of the ischial tuberosity. Both having been adjusted by the use of correcting factors for distortion, the ratio gives the cotangent of half the subpubic angle. From a table the values of the corresponding angles can easily be obtained.

The sacral index is 100 × straight sacral breadth/straight sacral length, the components being obtained from measurements on the two radiographs adjusted for distortion. The index of sacral curvature is 100 times the ratio of the subtense from the deepest point of the concavity of the sacrum to the straight sacral length over the straight sacral length. The inclination of the sacrum is measured by two angles, *ABC* and *ABF*, on the lateral radiograph. These are the respective angles which the true conjugate diameter, *AB*, makes at the sacral promontory with (*a*) the straight sacral length, *BC*, and (*b*) the chord from the sacral promontory to the deepest point of the sacral curve, *BF*.

The descriptive terms "narrow", "wide", "gynecoid", etc. being considered very unsatisfactory for a classification of the sacro-sciatic notch, an attempt was made to obtain a numerical index of its form in the following way. On the shadow of the notch nearest the film on the lateral radiograph a chord was drawn from the base of the ischial spine to the point where the lower margin of the ilium bounding the notch behind met the sacrum, and on this chord a perpendicular was dropped from the deepest point of the concavity of the notch. The ratio of 100 times this subtense to the chord on which it stands is the sacro-sciatic notch index: its size bears an inverse relation to that of the notch, or in other words, the higher the index the narrower the notch. The index shows a considerable range of variation in both the male and female series and, though it cannot be claimed to be an accurate criterion, it does bring out differences in the form of the notch in each sex group. The amount of convergence in the side walls of the pelvis or pelvic funnelling was measured by an index which took the form: 100 (greatest transverse diameter at the brim—intertuberal breadth)/depth of the pelvis from the ilio pectineal eminence to the lower border of the ischial tuberosity on the side adjacent to the film. As it has been stated that one of the features in which the female pelvis differs from the male is in the extent of iliac bone that intervenes between the acetabulum and the auricular surface for articulation with the sacrum, the female with the wider sacro-sciatic notch being relatively the larger in this respect, the difference between male and female almost suggesting that the female type could be produced from the male by the insertion of a short segment of bone at the summit of the sacro-sciatic notch, an attempt was made to measure this character by a ratio which was devised and will be referred to as the ilio-innominate ratio. It was obtained in the following way. On each lateral radiograph the centre of the acetabular cavity on the side of the pelvis

adjacent to the film was clearly marked and through this point, *O*, a straight line was drawn passing backwards just above the summit of the sacro-sciatic notch till it met the sacrum at *M* and forwards till it met the shadow of the pubic ramus at *X*. $100\,MO/MX$ is the criterion used. Another ratio on the list which is referred to as the posterior sagittal segment ratio at the pelvic inlet should be a guide to variations in the same feature of the pelvis. Caldwell, Moloy & D'Esopo (1934) state that, when the pelvic brim is held in the horizontal plane, in all their pelvic forms the widest transverse diameter at the brim lies in the same coronal or frontal plane as the ischial spines. At the point of intersection of the true conjugate and transverse diameters of the pelvic brim the former is divided into a posterior and an anterior sagittal segment. On the assumption that the relationship described by Caldwell & Moloy held fairly approximately in our series of women and men, on each lateral radiograph a perpendicular was dropped from the mid-point between the ischial spines to the true conjugate diameter. The segment of the true conjugate diameter behind the point of intersection was taken as a percentage of its total length to give the index. This ratio like the ilio-innominate ratio should indicate variations in the "depth" or relative extent of the posterior sagittal segment of the pelvic inlet. The posterior sagittal segment ratio at the pelvic outlet is a similar ratio obtained from the pubo-sacral or antero-posterior diameter at the outlet on the lateral radiograph by dropping a perpendicular on it from a point midway between the bases of the ischial spines.

The inclination of the pelvic brim to the horizontal plane was measured in the following way. On each lateral radiograph, by a special goniometer with long arms, the angle which the anatomical true conjugate continued to a point on the front of the symphysis pubis made with the line passing from the latter point to the mid-point of a line connecting the tips of the anterior superior iliac spines, was measured and recorded. In the living subject in the erect position the three points, the front of the symphysis pubis and the tips of the two anterior superior iliac spines, are said to lie approximately in the same perpendicular coronal plane, the spino-symphysial plane. In the individual members of our series of men and women when standing erect the deviation of the spino-symphysial plane from the vertical was measured by a simple instrument which was devised for the purpose. This consisted of a wooden framework of three adjustable arms supporting small vertical plates to be applied to the iliac spines and front of the symphysis respectively and carrying on a projecting rod, at the point of intersection and at right angles to the arms, a detachable goniometer from the graduated scale on which the amount of deviation of the plane from the vertical was easily read and recorded. In 473 women the range of variation from the vertical was from plus 10° to minus 10°, but 36 % were exactly vertical and the average deviation from the perpendicular was only 1°. In fifty-two men the range of deviation was the same as in the women; in 70 % the plane was exactly perpendicular and the average deviation was less than 0·5°. For the individual pelves the angles, if any, giving

the deviation in a plus or minus direction of the spino-symphysial plane from the vertical were added to or deducted from the angle shown in the lateral X-ray giving the inclination of the true conjugate to the spino-symphysial line. The resulting angles were the angles of inclination of the true conjugate (or approximately the pelvic brim) to the vertical plane. The complement of each angle, or the difference from 90°, gave the inclination of the pelvic brim to the horizontal plane.

COMPARISON OF CHARACTERS IN MALE AND FEMALE PELVES

Size and proportions of pelvic inlet

As is shown in Table I the characters amongst those analysed which appear to be most important in differentiating the male and female pelvis are the size and proportions of the pelvic inlet, the size and proportions of the pelvic outlet, the size of the sacro-sciatic notch and the size of the subpubic angle. Of less importance are the amount of convergence of the side walls of the pelvis and the degree of sacral curvature. Both the diameters at the pelvic brim, the true conjugate and the greatest transverse, are on the average significantly less in the male than in the female pelvic series, but whereas the true conjugate is only some 3 mm. less, the transverse diameters show a difference of 10 mm. or three times as much. Associated with the smaller diameters the mean area of the pelvic inlet in the males is considerably less than that in the females. The difference is as much as 12 or 13 sq. cm. As the greatest transverse diameter at the brim in the male pelvis is relatively more diminished than the true conjugate in comparison with the corresponding diameters of the female pelvis, the ratio of the true conjugate diameter to the transverse diameter or the pelvic brim index is greater in the former. The difference is about 5 units using either conjugate diameter. While the pelvic brim index undoubtedly indicates the general shape of the pelvic inlet, viz. as to whether it tends to be circular or is oval with the major axis in the sagittal or transverse directions and the degree of flattening in these planes, it does not, as pointed out by Caldwell & Moloy, differentiate the wedge-shaped or "android" type of inlet. In the series of pelves examined the shape of the inlet is undoubtedly more nearly circular on the average amongst the males than the females, though the typical female pelvic inlet is often somewhat loosely referred to as "round" in form. A similar difference in the pelvic index of men and women to that shown has been described for other racial types, including the Australian, Negro, Andamanese etc. (see Deniker, 1900). It must be pointed out that these average measurements of the diameters at the inlet derived from radiographs of the living are not in very close agreement with the corresponding average diameters recorded in anatomical text books which have probably been estimated in the majority of cases from dried pelves. Thus Bryce in Quain's *Anatomy* (1915) quotes the average transverse diameter and conjugate diameter at the pelvic brim in full-sized females as being 133 and 134 mm.

respectively, which give a pelvic brim index of 86 approximately. In full-sized males the corresponding diameters are said to be 127 and 102 mm., giving an index of 80 approximately. These values would suggest that the male pelvis is relatively more elongated in the transverse direction or flatter than the female, a view which is completely at variance with the relationship found in the series of Londoners and in many other racial types. There is strong reason for the belief that the average dimensions now recorded and accepted for the diameters of the pelvis, more especially the true conjugate, are not truly representative of those that are found in the pelves of English men and women of the present day and are in need of careful revision. As radiographs showing the view of the pelvic inlet parallel to the film were not taken, we are not in the most favourable position to comment on Caldwell & Moloy's observations or to institute a direct comparison between their results and ours. Even from the radiographs showing the antero-posterior views of the pelvic inlet it is possible to select some that appear to be of "android" type, viz. those showing a definite tendency to be blunt heart-shaped with the greatest transverse diameter at the brim located relatively far back near the base of the triangle. The frequency of occurrence of this type of inlet in our series of female pelves cannot be compared with that found in Caldwell & Moloy's series because the criteria on which classification of types is based, being merely personal impressions and incapable of standardization, are not the same. It may be of interest to mention, however, that in the series of about 500 female pelves forty or 8 % seemed to have a definite android appearance. In a further thirty or 6 % the android tendency was less clearly and sometimes rather doubtfully indicated. Thus in our view the total incidence of the android type in the series would not be higher than 14 %, i.e. less than half the incidence found by Caldwell & Moloy. In the android group of forty pelves the mean size of the sacro-sciatic notch was rather smaller than in the whole series but the size of the subpubic angle did not differ. These two characters, as has been mentioned, are amongst those of greatest value in distinguishing the female from the male type of pelvis. It is worthy of note that in the male series of fifty pelves there are some which show a typically gynaecoid form of inlet.

Size and proportions of pelvic outlet

While the mean antero-posterior diameter at the pelvic outlet, measured from the lower border of the symphysis pubis to the lower end of the sacrum at the sacro-coccygeal junction, is the same in the female and male series of pelves the transverse diameters in this region, both interspinous and intertuberal, are much smaller on the average in the male, the mean sexual difference being as much as 16 mm. (Table I). As a consequence of the relatively great narrowing of the elliptical outlet in the male, its area, as estimated from the pubo-sacral and interspinous diameters, is much less in the latter than in the female, the mean difference being about 16 sq. cm. The average values given for the antero-posterior or conjugate diameter at the outlet of the female

and male pelves given in Table I, 119–120 mm., differ greatly from the similarly designated diameter for adult pelves quoted by Bryce in Quain's *Anatomy*, 108 mm. for the female and 85 mm. for the male. The average values given for the intertuberal breadth in Table I, 109 mm. for the female and 93 mm. for the male, also differ greatly, especially the former, from the corresponding averages quoted in Quain for the transverse diameter at the pelvic outlet, viz. 141 and 88 mm. The measurements may not have been taken from exactly the same anatomical points but it is impossible to give any reasonable explanation for differences of the magnitude observed. As with the diameters at the pelvic inlet the values for the mean dimensions of the pelvic outlet which have been more or less generally accepted by anatomists hitherto appear to be in much need of verification if not revision.

Subpubic angle

The mean values given for the size of the subpubic angle in the male and female series of pelves are not comparable with the corresponding values published by other observers as they have not been estimated in exactly the same way. As measured by the method used, however, the angle clearly indicates the definite sexual difference in the size of this character, its mean value being about 18°.

The sacro-sciatic notch index

In the female series the average value of this index is 52, in the male 62 approximately (Table I). As the larger the index the smaller the notch, the latter is clearly of a narrower and deeper form on the average in the male. The numerical method adopted of estimating the size of the notch is much more reliable and informative than the use of descriptive terms such as narrow, U-shaped, wide, gynaecoid, etc., based on personal impressions.

Other pelvic characters

The amount of convergence in the side walls of the pelvis in passing from the inlet to the outlet and the degree of curvature of the sacrum are on the average significantly greater in the male than in the female pelvis. As well as being flatter than in the male the female sacrum is usually said to be relatively broader in proportion to its length. This relationship is not shown in the series of pelves under review, the sacral index is of the same order in both sexes. While the mean sacral index for the group of males in Table I, 110, is approximately the same as that usually quoted for the male sex, 112 (see Quain), the mean value for the female, 109, is as much as 7 units less than the mean sacral index (116) given for the female in Quain. It is thus only in the females of our series that the proportion of breadth to length of the sacrum seems to deviate from that found on the average and recorded for specimens from Europeans. As the sacrum is relatively longer the index tends towards the value found for the more primitive racial type, the negress.

The angle of inclination of the pelvic brim to the horizontal is usually stated to be slightly greater in the female than in the male; the same sexual relationship is said to hold for the sacro-pelvic angle (*ABF*) which the pelvic brim makes with the front of the upper part of the sacrum. In Table I the mean values given for these two angles do not differ in the two sexes. The angle which the pelvic brim (true conjugate) makes at the promontory with the straight sacral length ($< ABC$) is on the average 2° greater in the female than in the male. The difference, though relatively small, is statistically significant and is probably mainly dependent on the greater longitudinal curvature of the male sacrum.

The ilio-innominate ratio, which it was hoped would bring out the relatively greater extent of the part of the os ilium between the sacrum and acetabulum in the female pelvis than in the male, does not differ in the two sexes (as can be seen from Table I). The posterior sagittal segment ratio at the inlet which might be expected to give some indication of any difference in relative growth in the same region of the ilium is higher by 2 units in the female than in the male. The difference is significant statistically but seems to be of too small an order to be of much practical importance in differentiating the male from the female pelvis. The posterior sagittal segment ratio at the pelvic outlet is distinctly greater in the female than in the male (Table I). The sexual difference is probably largely dependent on the greater inclination of the sacrum to the pelvic brim and the greater flattening of the sacrum in the female.

TABLE II. *Showing the correlation coefficients between a selection of pairs of pelvic characters*

Variables		r
Pelvic brim index and sacro-sciatic notch index	(424)	$0{\cdot}132 \pm 0{\cdot}048$
Pelvic brim index and size of subpubic angle	(469)	$0{\cdot}005 \pm 0{\cdot}046$
Subpubic angle and sacro-sciatic notch index	(422)	$0{\cdot}142 \pm 0{\cdot}048$
Subpubic angle and area of pelvic inlet	(360)	$0{\cdot}018 \pm 0{\cdot}053$
Subpubic angle and area of pelvic outlet	(360)	$0{\cdot}122 \pm 0{\cdot}052$
Area of pelvic inlet and area of pelvic outlet	(375)	$0{\cdot}504 \pm 0{\cdot}039$

DISCUSSION

The pelvic characters amongst those shown and measurable in the antero-posterior and lateral radiographs which seem to be of most value in differentiating the male from the female pelvis, and which might be expected by analogy to distinguish the android type from the more typical form of female pelvis, have been described. They are the size and proportions of the pelvic inlet and outlet, the size of the subpubic angle and the size of the sacro-sciatic notch. If films of the pelves showing the outline of the inlet parallel to the horizontal plane had been available it would have been possible, by the use of chords and the arcs obtained by dividing its contour into segments, to devise some numerical expression describing its form in detail which would have been much more precise and informative than the use of purely descriptive

terms, android, gynecoid, etc. There appears to be a surprisingly small degree of association between the different pelvic characters, or for a pelvis which is "more female" in type in one character to show the same tendency in another. In the female series of nearly 500 the relationships between numerous pairs of pelvic characters were estimated by the method of correlation. A small selection of the coefficients of correlation which were calculated are shown in Table II. There is a moderate degree of correlation between the areas of the pelvic inlet and outlet ($r=0{\cdot}5$). A slight but statistically significant tendency is present for the sacro-sciatic notch to narrow as the pelvic brim becomes relatively elongated transversely ($r=-0{\cdot}132$), for the notch to increase with increase of the subpubic angle ($r=-0{\cdot}142$) and for the subpubic angle to increase with increase in area of the pelvic outlet ($r=0{\cdot}122$), but as the coefficients are all less than 0·15 in value the degree of association indicated cannot be considered of much practical importance. There is no correlation whatever between the shape of the pelvic brim and the size of the subpubic angle nor between the area of the pelvic inlet and the size of the subpubic angle.

As may be seen in Table I there is a fairly close agreement between the variabilities of the corresponding characters in the male and female series of pelves. The variation shown in most of them is considerable, the coefficient of variation being often nearly 10 %. In the area of the female pelvic inlet this variability corresponds to a range of from 87 to 165 sq. cm. In the ranges of the frequency distributions of the several pelvic characters which differ significantly in their mean values in male and female series of pelves there is a very considerable overlap and there are relatively few values of any one character in the one sex that may not be found at least occasionally in the other. Strauss (1927–8) found a considerable range of dispersion and sexual overlapping in all the characters of the ilium which he examined. He came to the conclusion that "sexing unknown pelvic material borders upon guesswork". While many anatomists will perhaps support his inference that individual characters, because "they vary so greatly and exhibit such marked sexual overlapping, are of limited value in sexing the pelvis" most will maintain there is sufficient evidence to warrant the view that from a consideration of a combination of characters it is possible to be fairly confident of distinguishing the sex in all except a small proportion of pelves.

SUMMARY AND CONCLUSIONS

A detailed comparison has been made between the means and variabilities of a large series of characters which have been measured in antero-posterior and lateral pelvic radiographs of unselected groups of men and women with the object of determining which of these characters are of most importance in distinguishing the male pelvis or the so-called "android" type of female pelvis from the more typical form of female pelvis. There seems to be sufficient evidence to warrant the following conclusions.

1. Of the characters brought under review, those that seem to be of most importance in distinguishing the male from the female pelvis, and by analogy the "android" type from the more typical form of the female pelvis, are the size and proportions of the pelvic inlet and outlet, the size of the sacro-sciatic notch and the size of the subpubic angle.

2. Of less importance but still of value are the degree of convergence of the side walls of the pelvis or pelvic funnelling and the degree of curvature of the sacrum.

3. The variabilities shown by corresponding characters in the two sexes are usually in close agreement and are fairly high, being often about 10 %.

4. The two characters measurable in the radiograph, the ilio-innominate index and the posterior sagittal segment ratio at the inlet, which might be expected to bring out in the female the relatively greater extent of iliac bone between the acetabulum and the auricular surface for articulation with the sacrum, do not differ very appreciably on the average in the two sexes.

5. With one or two exceptions, e.g. the areas of the pelvic inlet and outlet, the correlation between any pair of pelvic characters is usually of a small order and of no practical importance.

6. The characters thus seem to vary in size or form more or less independently of one another. This relative lack of association is found even between such definite sexual characters as the subpubic angle and the sacro-sciatic notch.

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