

Sex determination by Radiology

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Article outline

Head to Tail study of Human Anatomy through Radiology and Determination of Sex.

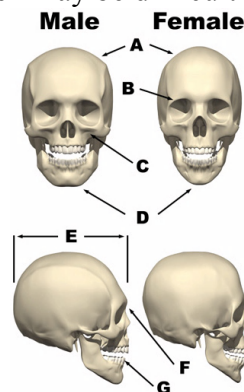


Male Skeleton

Female Skeleton

Skull

Until the age of puberty there is little difference between the skull of the female and that of the male. The skull of an adult female is, as a rule, lighter and smaller, and its cranial capacity about 10 per cent., less, than that of the male. Its walls are thinner and its muscular ridges less strongly marked; the glabella, superciliary arches, and mastoid processes are less prominent, and the corresponding air sinuses are small or rudimentary. The upper margin of the orbit is sharp, the forehead vertical, the frontal and parietal eminences prominent, and the vault somewhat flattened. The contour of the face is more rounded; the facial bones are smoother, and the maxillæ and mandible and their contained teeth smaller. From what has been said it will be seen that more of the infantile characteristics are retained in the skull of the adult female than in that of the adult male. A well-marked male or female skull can easily be recognized as such, but in some cases the respective characteristics are so indistinct that the determination of the sex may be difficult or impossible.



A- Vertex
B- Temple
C- Zygoma

D- Mandible
E- Fronto- occipital
length

F- Supraorbital
protuberance
G- Teeth

The horizontal circumference of the cranium is measured in a plane passing through the glabella (Turner) or the ophryon (Flower) in front, and the occipital point behind; it averages about 50 cm. in the female and 52.5 cm. in the male.

Frontal Bone

Superciliary arches are prominent medially, and are joined to one another by a smooth elevation named the glabella. They are larger in the male than in the female.

Temporal Bone

The size and form of mastoid process vary somewhat- it is larger in the male than in the female.

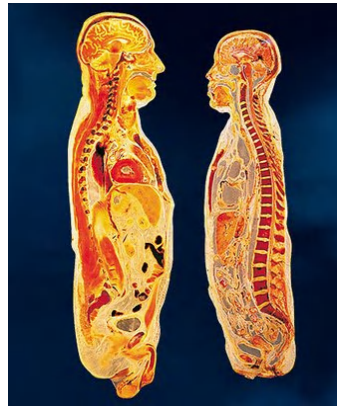
Vertebral Column

The vertebral column is situated in the median line, as the posterior part of the trunk; its average length in the male is about 71 cm. Of this length the cervical part measures 12.5 cm, the thoracic about 28 cm, the lumbar 18 cm, and the sacrum and coccyx 12.5 cm. The female column is about 61 cm. in length.

The lumbar curve is more marked in the female than in the male; it begins at the middle of the last thoracic vertebra, and ends at the sacrovertebral angle. It is convex anteriorly, the convexity of the lower three vertebræ being much greater than that of the upper two.

Sacral and Coccygeal Vertebræ

In the female the sacrum is shorter and wider than in the male; the lower half forms a greater angle with the upper; the upper half is nearly straight, the lower half presenting the greatest amount of curvature. The bone is also directed more obliquely backward; this increases the size of the pelvic cavity and renders the sacrovertebral angle more prominent. In the male the curvature is more evenly distributed over the whole length of the bone, and is altogether greater than in the female.



Male

Female

Thorax

The thorax of the female differs from that of the male as follows:

Its capacity is less.

The sternum is shorter.

The upper margin of the sternum is on a level with the lower part of the body of the third thoracic vertebra, whereas in the male it is on a level with the lower part of the body of the second.

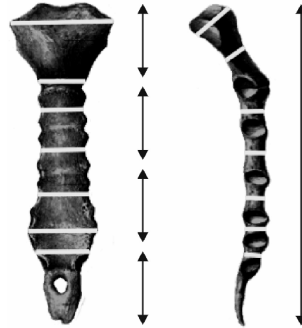
The upper ribs are more movable, and so allow a greater enlargement of the upper part of the thorax.

Clavicle

In the female, the clavicle is generally shorter, thinner, less curved, and smoother than in the male. In those persons who perform considerable manual labor it becomes thicker and more curved, and its ridges for muscular attachment are prominently marked.

Sternum

Its average length in the adult is about 17 cm. and is rather greater in the male than in the female.



Breadth, length, thickness of the sternum segments and total length of the sternum.

MANUBRIUM INDEX, BODY OF THE STERNUM INDEX AND STERNUM ANGLE

	Female (X±SD, cm)	Male (X±SD, cm)	t	p
IM	1.18±0.16	1.24±0.17	1.21	0.23
IC	0.29±0.07	0.29±0.06	-0.28	0.78
Sternum angle	165.30±7.19	166.35±7.38	0.37	0.71

IM – manubrium index (manubrium width / manubrium length), IC – body of the sternum index (sternum body width / sternum body length)

STANDARD FEMALE AND MALE STERNUM

Manubrium	Female (X±SD)	Male (X±SD)	p
Max. Breadth (cm)	6.06±0.81	6.82±0.80	<0.05
Min. Breadth (cm)	3.13±0.33	3.68±0.55	<0.05
Average breadth (cm)	4.59±0.50	5.25±0.68	<0.05
Length (cm)	5.24±0.45	5.52±0.36	<0.05
Average thickness (cm)	1.12±0.09	1.26±0.19	<0.05
Area (cm ²)	24.13±3.71	28.98±3.48	<0.05
Volume (cm ³)	27.49±5.53	37.33±6.30	<0.05

Body

Average breadth (cm)	2.71±0.31	3.07±0.43	<0.05
Length (cm)	9.42±1.40	10.97±1.44	<0.05
Average thickness (cm)	0.92±0.12	1.00±0.11	<0.05
Area (cm ²)	26.14±4.79	34.80±5.50	<0.05
Volume (cm ³)	24.35±5	94 35.08±6.81	<0.05

Sternum

Total length (cm)	18.29±1.74	20.86±1.46	<0.05
Area (cm ²)	50.26±7.45	63.86±7.68	<0.05
Volume (cm ³)	51.84±10.57	72.42±11.54	<0.05

Humerus

Male humerus has Supero-laterally projected greater tubercle while in female it is laterally swollen. Male has well developed crest of greater tubercle. Male has sharply pointed crest of lesser tubercle and deep narrow as well as long intertubercular sulcus.

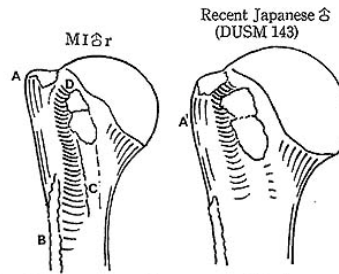
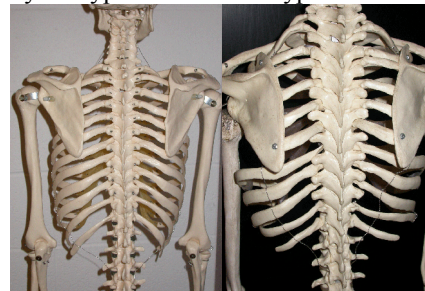


Fig. 4.16. Characters seen on the upper part of the humerus.
Anterior view of the right side. A: supero-laterally projected greater tubercle, A': laterally swollen greater tubercle, B: well-developed crest of greater tubercle, C: sharply pointed crest of lesser tubercle, D: deep, narrow and long intertubercular sulcus.

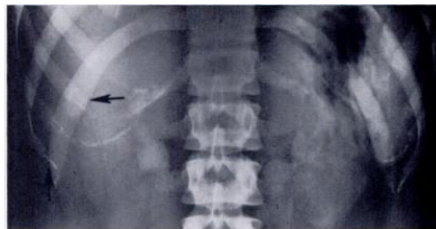
Ribs

Sexual differences are demonstrated by the way adult costal cartilages calcify. In type 1, male pattern, the upper and lower borders of the cartilage calcify in continuity with the end of the ribs; later, the calcification extends into the central area. The female pattern is seen in types 2, 3, and 4. Type 2 is a solid tongue of calcification extending from the rib into the central portion of the adjacent cartilage, and may reach to the sternum. In type 3, two parallel lines of calcification extend from the center of the rib into the adjacent cartilage (this may be associated with oophorectomy and hysterectomy some years prior to filming). Type 4 consists of rounded solitary or coalescent calcific loci in the central portion of the costal cartilage (seen in women over 55 years of age). The estimated degree of certainty for type 1 is 95% and type 2 is 93%.

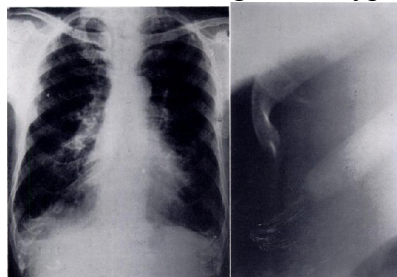


Male Ribs

Female Ribs



View of lower ventral ribs showing mixed types of calcification.



A- Chest PA view showing calcification of costal cartilages in Male

B- Chest PA view showing calcification of floating ribs in Female

Pelvis

Hip Bone

Preauricular sulcus is more commonly present and better marked in the female than in the

male.

The anterior inferior spine (said to occur more frequently in the male than in the female), the tuberosity of the ischium, the pubic symphysis (more frequent in the female than in the male). The pubic symphysis (more frequent in the female than in the male), and one or more for the Y-shaped piece at the bottom of the acetabulum.

The female pelvis differs from male pelvis as under-

The bones are more delicate – thin and light.

The pelvis is less massive.

The pelvis is more shallow.

The ilia are less sloped.

The anterior iliac spines are more widely separated – thus the greater prominence of the hips laterally.

The superior aperture of the lesser pelvis (pelvic inlet) is larger, more nearly circular and has greater obliquity.

The cavity of the pelvis is shallower and wider.

Sacrum is shorter, wider and the upper part is less curved, so the sacral promontory is less imposing into the pelvic cavity.

The obturator foramina are triangular – oval in shape and smaller in size than the male circular foramina.

The inferior aperture of the lesser pelvis (pelvic outlet) is larger and the coccyx is more moveable.

The sciatic notches are wider and shallower.

The spines of the ischia project less inward – hence not protruding as much into the pelvic cavity.

The acetabula are smaller and look more distinctly forward.

The superior pubic ramus is longer than the width of the acetabulum.

Ischial tuberosities and the acetabula are more wider apart.

The pubic symphysis is less deep.

The muscle attachments are more poorly marked.

The pubic arch is wider and more rounded than in the male where it is an angle rather than an arch. (~ 90° c.f ~ 60°).

The pelvis is divided by an oblique line passing through the prominence of the sacrum, the arcuate and pectineal lines, and the upper margin of the pubic symphysis, into the greater and lesser pelvis.

Greater pelvis

The greater pelvis is:

Superior to the pelvic inlet.

Bounded by the abdominal wall anteriorly, the iliac fossae posterolaterally and the L5 and S1 vertebrae posteriorly.

The location of some of the abdominal viscera like the sigmoid colon and ileum.

It supports the intestines and transmits some of their weight to the anterior wall of the abdomen.

Lesser pelvis

The lesser pelvis is:

Between the pelvic inlet and outlet.

Known as the true pelvic cavity.

Bounded by the pelvic surfaces of the hip bones, sacrum and coccyx.

Limited inferiorly by the musculofascial pelvic diaphragm.

The location of the pelvic viscera – the urinary bladder and reproductive organs such as the uterus and ovaries.

Of major obstetrical and gynaecological significance.

Pelvic inlet

The size and shape of the pelvic inlet is important because it is through this opening that the fetal head enters the lesser pelvis during labour. The size of the lesser pelvis is particularly important in obstetrics because it is the bony pelvic canal through which the fetus passes during vaginal birth. To determine the capacity of the female pelvis for childbearing, the diameters of the lesser pelvis are noted radiologically or during a pelvic examination.

The pelvic inlet is variable in contour. The shape can be affected by sexual, racial and nutritional differences in the population. It is heart shaped in males and some females; although in most females the opening is larger and is more rounded or oval in contour. The periphery of the pelvic inlet is formed by the pelvic brim which is indicated by the linea terminalis. This is an oblique ridge on the internal surface of the ilium (also known as the arcuate line) and is continued onto the superior pubic ramus as the pectineal line. The inlet is completed anteriorly by the pubic crests and posteriorly by the anterior margin of the base of the sacrum and the sacrovertebral angle (sacral promontory).

The inlet has three principal diameters which can be measured:

The anteroposterior. Extends from the sacral promontory to the pubic symphysis and is measured on average about 110 mm in the female.

The transverse diameter. Extends across the width from the midpoint of the pelvic brim on one side to the other on the opposite side. About 135mm on average in females.

Oblique diameter. From the iliopectineal eminence on one side to the sacroiliac articulation on the opposite. Average measurement is 125mm in female.

Pelvic outlet

The pelvic outlet has a more irregular contour. It is bounded posteriorly by the point of the coccyx, and laterally by the ischial tuberosities. These eminences are separated by three notches: one in front, the pubic arch, formed by the convergence of the inferior rami of the ischium and pubis on either side. The other notches, one on either side, are formed by the sacrum and coccyx behind, the ischium in front, and the ilium above; they are called the sciatic notches; in the natural state they are converted into foramina by the sacrotuberous and sacrospinous ligaments. When the ligaments are *in situ*, the inferior aperture of the pelvis is lozenge-shaped or diamond shaped, bounded, in front, by the pubic arcuate ligament and the inferior rami of the pubes and ischia; laterally, by the ischial tuberosities; and behind, by the sacrotuberous ligaments and the tip of the coccyx.

There are two diameters of the pelvic outlet:

Anteroposterior diameter. Extends from the tip of the coccyx to the lower part of the pubic symphysis. In the female average diameter is 90 – 115mm. It varies with the length of the coccyx, and is capable of increase or diminution, on account of the mobility of the coccyx.

Transverse diameter. Measured between the posterior parts of the ischial tuberosities about 115 mm in the female.

Types of pelvis

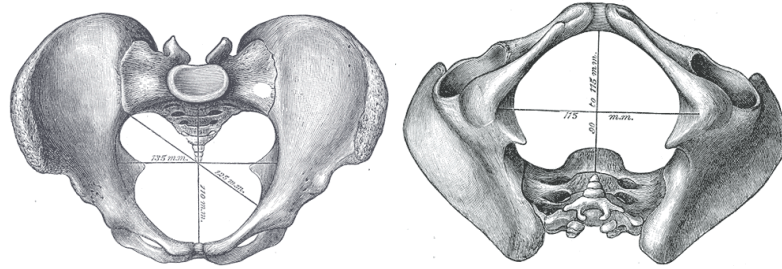
There are four main types of pelvis, the prevalence dependent on sex and race. For example the relative frequencies in white females is:

Gynaecoid – round with enlarged transverse diameter – normal female type – 41.4%

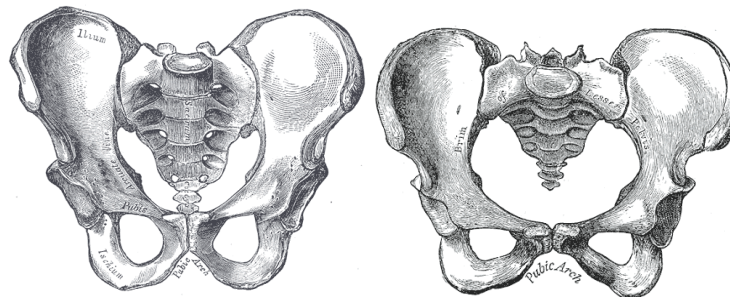
Android – heart shaped – in a woman may present hazards to normal delivery of a baby – 32.5%

Anthropoid – long AP diameter – 23.5%

Platypelloid – long transverse diameter – 2.6%



A- Diameters of superior aperture of lesser pelvis (female)
B- Diameters of inferior aperture of lesser pelvis (female)



A- Male pelvis

B- Female pelvis

The characteristic differences between the male and female pelvis are distinctly indicated as early as the fourth month of fetal life.

Articulations of the Pelvis

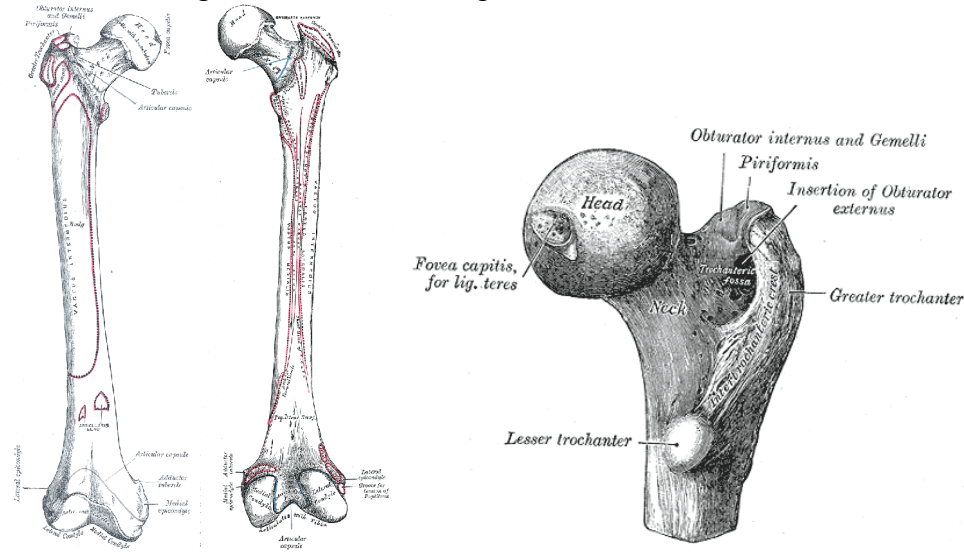
In the adult male, all the pieces of coccyx become ossified together at a comparatively early period; but in the female, this does not commonly occur until a later period of life. Interpubic fibrocartilaginous lamina connects the opposed surfaces of the pubic bones. Each of these surfaces is covered by a thin layer of hyaline cartilage firmly joined to the bone by a series of nipple-like processes which accurately fit into corresponding depressions on the osseous surfaces. These opposed cartilaginous surfaces are connected together by an intermediate lamina of fibrocartilage which varies in thickness in different subjects. It often contains a cavity in its interior, probably formed by the softening and absorption of the fibrocartilage, since it rarely appears before the tenth year of life and is not lined by synovial membrane. This cavity is larger in the female than in the male, but it is very doubtful whether it enlarges, as was formerly supposed, during pregnancy.

Femur

The femur the longest and strongest bone in the skeleton is almost perfectly cylindrical in the greater part of its extent. In the erect posture it is not vertical, being separated above from its fellow by a considerable interval, which corresponds to the breadth of the pelvis, but inclining gradually downward and medialward, so as to approach its fellow toward its lower part, for the purpose of bringing the knee-joint near the line of gravity of the body. The degree of this inclination varies in different persons, and is greater in the female than in the male, on account of the greater breadth of the pelvis.

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Upper extremity of right femur viewed from behind and above.

Tibia

In the male, its direction is vertical and parallel with the bone of the opposite side; but in the female it has a slightly oblique direction downward and lateralward, to compensate for the greater obliquity of the femur.

Skeletal Differences According to Sex

Bone	Area or Feature	Female	Male
Skull	Forehead	Eminences	Sloping
	Supraorbital ridges	Not prominent	Prominent
	Frontal sinuses	Small	Large
	Mastoid processes	Small	Large
	Muscular ridge on occiput	Small	Large
	Chin	Rounded with point at midline	Square
	Teeth	Small	Square
Sternum	Body: manubrium ratio	Body short	Body long
Ribs	Cartilage calcification	Central (may be triangular, linear, or beadlike)	Peripheral (upper and lower border)
Pelvis	Entire	Not massive, gracile, smooth	Massive, rugged, marked muscular ridges
	Symphysis	Rectangular	Triangular
	Subpubic angle	Obtuse (U-shaped)	Acute (V-shaped)
	Pelvic bone	Long	Short
	Sciatic notch	Wide and shallow	Narrow and deep
	Preauricular sulcus	May be present	Usually absent
	Inferior ramus	Recurved	Thick
	Obturator foramen	Small triangular	Large, usually ovoid
	Pelvic inlet	Circular. elliptic	Heart-shaped
Femoral head	Diameter	Under 43 mm	Over 44 mm

Larynx

laryngeal prominence (pomum Adami). This prominence is most distinct at its upper part, and is larger in the male than in the female.

The rima glottidis is the narrowest part of the cavity of the larynx, and its level corresponds with the bases of the arytenoid cartilages. Its length, in the male, is about 23 mm.; in the female from 17 to 18 mm.

Trachea and Bronchi

The trachea is nearly but not quite cylindrical, being flattened posteriorly; it measures about 11 cm. in length; its diameter, from side to side, is from 2 to 2.5 cm., being always greater in the male than in the female.

Diaphragm

the absolute range of movement of diaphragm between deep inspiration and deep expiration averages in the male and female 30 mm. on the right side and 28 mm. on the left; in quiet respiration the average movement is 12.5 mm. on the right side and 12 mm. on the left.

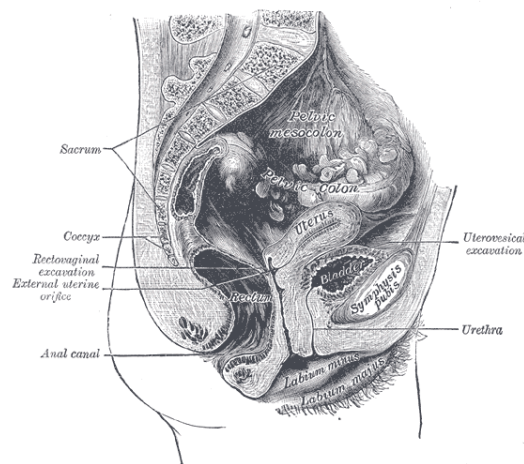
Abdomen

The abdomen proper differs from the other great cavities of the body in being bounded for the most part by muscles and fasciæ, so that it can vary in capacity and shape according to the condition of the viscera which it contains; but, in addition to this, the abdomen varies in form and extent with age and sex. In the adult male, with moderate distension of the viscera, it is oval in shape, but at the same time flattened from before backward. In the adult female, with a fully developed pelvis, it is ovoid with the narrower pole upward, and in young children it is also ovoid but with the narrower pole downward.

Urinary Organs

This condition is known as movable kidney, and is more common in the female than in the male.

The Female Bladder The female bladder is said by some to be more capacious than that of the male.



Bibliography

1- Gray's Anatomy-

- Myology, The Muscles of the Thorax, paragraph 31
- Osteology, The Femur, paragraph 1, 4
- Osteology, The Frontal Bone, paragraph 2
- Osteology, The Hip Bone, paragraph 5, 20, 22
- Osteology, The Interior of the Skull, paragraph 21, 48
- Osteology, The Pelvis, paragraph 13
- Osteology, The Sacral and Coccygeal Vertebrae, paragraph 12
- Osteology, The Temporal Bone, paragraph 7
- Osteology, The Thorax, paragraph 4
- Osteology, The Tibia, paragraph 1
- Osteology, The Vertebral Column as a Whole, paragraph 1, 2
- Splanchnology, The Abdomen, paragraph 2
- Splanchnology, The Larynx, paragraph 2, 50
- Splanchnology, The Trachea and Bronchi, paragraph 1
- Splanchnology, The Urinary Bladder, paragraph 6
- Splanchnology, The Urinary Organs, paragraph 35
- Syndesmology, Articulations of the Pelvis, paragraph 18, 25

3- Grainger and Allison's Diagnostic Radiology, 3rd Edition, Vol. 2, Pages 1571

4- Van Voorthuisen's Text Book of Radiology, Pages 121- 122

5- Modi's Text Book of Medical Jurisprudence and Toxicology, pages 20- 38

6- Current Publisher's Notes on Clinical Jurisprudence and Toxicology, Pages 12-28

7- Journal of Anatomy Society of India 51(2) 162-167 (2002), Pages 162- 167

8- Coll. Antropol. 30 (2006) 1: 43-47 Original scientific paper

9- Shiv Navani, Jagdis R. Shah and Paul S. Levi- 1970, pages 771-772

10- J. Anat. (1990), Pages 172, 221- 226