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Anatomy

ANATOMICAL AND CLINICAL PERSPECTIVES OF THE HUMAN PELVIS WITH COMPARATIVE ANALYSIS OF MALE AND FEMALE PELVIC STRUCTURES

Dr T Jagadeesh	2nd Year PG Scholar, Department of Rachana Shareera SDM College of Ayurveda and Hospital. Hassan.
Dr Simi C P	Associate Professor, Department of Rachana Shareera SDM College of Ayurveda and Hospital. Hassan.
Dr Prasanna S	Professor and HOD, Department of Rachana Shareera SDM College of Ayurveda and Hospital. Hassan.
Dr Gopika Rajeevan	2nd Year PG Scholar, Department of Rachana Shareera SDM College of Ayurveda and Hospital. Hassan.
Dr Santhosh Patil H K	2nd Year PG Scholar, Department of Rachana Shareera SDM College of Ayurveda and Hospital. Hassan.
Dr J Sai Sucharitha	2nd Year PG Scholar, Department of Rachana Shareera SDM College of Ayurveda and Hospital. Hassan.

ABSTRACT The pelvis is a lower division of the abdominal cavity. The pelvis is formed by articulation of two hip bones, sacrum and coccyx. These bones are joined by Two synovial Sacroiliac joints and two fibrocartilaginous joints (by upper margin of pubic symphysis, on either side by anterior border of ala of sacrum, arcuate line, pectineal line (pecten pubis) and pubic crest and posteriorly by the sacral promontory. 3 from a clinical perspective understanding the pelvic anatomy is essential in various fields including obstetrics, orthopedics, urology, and radiology. This article also explores the anatomical features of the male and female pelvis, highlighting the key difference in shape, size and structural orientation. Integrating anatomical knowledge with clinical relevance, this review emphasizes the importance of the pelvis in both health and disease, providing a comprehensive understanding for students and health care professionals.

KEYWORDS :

INTRODUCTION

Pelvis, in human anatomy basin shaped complex of bones that connects the trunk and the legs, supports and balances the trunk, and contains and supports the intestines, the urinary bladder, and the internal sex organ, the pelvis contains of paired hipbones (innominate bones)[4] connected in the front by pubic symphysis and behind by the sacrum. Each hipbone is made up of three bones – the blade or plate shaped ilium[5], above and to either side, which account for the width of the hips, the ischium, behind and below, on which the weight falls in sitting, and the pubis in front. All three unite in early adulthood at a triangular suture in the acetabulum, the cup shaped socket that forms the hip joint with the head of the femur (thigh bone)[6]. the ring made by the pelvis functions as the birth canal in females. The pelvis serves as a critical role in providing attachments for muscle that balance and support the trunk and moves the legs, the hip and trunk. In the human infant the pelvis is narrow and non-supportive. As the child begins walking, the pelvis broadens and tilts, the sacrum descends deeper into its articulation with the ilium, and the lumbar region of the lower back develops.[7] Thus a comprehensive understanding of the anatomical features and clinical relevance of both male and female pelvises is essential for medical professionals this article aim to explore the structural differences, functional significance and clinical importance of the human pelvis, high lightening its vital role in health and disease.

Greater Pelvis (False Pelvis) or Obstetrics Pelvis:[8]

It is part of the pelvis above the pelvic brim and is formed by iliac fossae. The greater pelvis forms a part of posterior abdominal wall, and contains caecum, appendix, sigmoid colon and coils of terminal ileum.

Lesser Pelvis (True Pelvis):[9]

It is a part of the pelvis below the pelvic brim and above the pelvic outlet. Clinically, the term pelvis is usually applied to the lesser pelvis is enclosed by sacrum and lower parts of the two hipbones (below the pelvic inlet). The short anteroinferior wall of the lesser pelvis is formed by the pubic symphysis, whereas its long posterosuperior wall is formed by the sacrum and coccyx. On each side, the pelvis wall is formed by ischiopubic ramus and lower part of the ilium. The true pelvis contains small intestines, rectum, urinary bladder and reproductive organs.

Pelvic Inlet (Also Called As Pelvic Brim):[10]

The brim of the pelvis is formed by, Anteriorly by upper margin of the pubic symphysis, Posteriorly by sacral promontory.

On either side by Linea terminalis which includes anterior margin of ala of sacrum, arcuate line, iliopubic eminence, pectin pubis/pectineal line, and pubic crest.

Pelvic Outlet:[11]

The pelvic outlet (also called inferior pelvic aperture is bounded)

1) Anteriorly by the lower margin of the pubic symphysis.
2) Posteriorly by coccyx.
3) On each side by ischiopubic ramus, ischial tuberosity, and Sacro tuberous ligament.

Forensic View of Pelvis:[13]

Hip Bone

SI NO	FEATURES	MALE	FEMALE
1	General appearance	Heavy, rough with prominent sites of muscular attachments.	Light, comparatively smooth
2	Pre-auricular sulcus (attachment of anterior Sacro iliac ligament lying just lateral to Sacro iliac joint)	Infrequently, when present it is narrow and shallow	Frequently present, broad and deep
3	Greater sciatic notch (Harison's and Hrdlicka felt that the greater sciatic notch is was one of the best determinations of sex, the latter claiming a 75% success rate using these criteria alone).	Narrow and deep	Broad and shallow
4	Obturator foramen	Large and oval	Small and triangular
5	Ileo – pectineal line	Well-marked and rough	Rounded and smooth
6	Ischial tuberosity	Inverted	Everted
7	acetabulum	Larger being 52mm in diameter on the average	Smaller being 46mm in diameter on the average

(The pubis length being measured from planes of symphysis to the reference point in the acetabulum and the ischial length being from the same point to the most distal edge of the ischium. The reference point is the site of the fusion of the three elements of the immature innominate bone usually marked by notch in the acetabular surface of the acetabulum)

Sacrum[14]

SI NO	Features	Male	Female
1	General appearance	Larger, heavier, rough and narrow.	Smaller, lighter, smoother and broader.
2	Breadth of the body of the 1st sacral vertebra	More than breadth of one side ala	Less than breadth of one side ala
3	Inner curvature	Uniformly curved anteriorly	Abruptly curved at the last two segments
4	Sacro – iliac articulation	Extends up to 3rd segment	extend up to 2 1/2 to 3rd segment
5	Carpo-basal index	More than 42	Less than 42

Difference Between Male and Female Pelvis:[12]

The difference between male and female pelvis are principally associated with the following two features:

1) Heavier built and stronger muscle in the male account for stronger bones and well-defined muscle markings in the male pelvis.
2) To provide passage to the baby during parturition, the pelvic cavity is comparatively wider and shallower in the female.

SI NO	Features	Male	female
1	False pelvis	Narrow and deep	Wide and shallow
2	Pelvic inlet	Heart shaped	Transversely oval
3	Pelvic canal/cavity	Long segment of the short cone	Short segment of a long cone
4	Pelvic outlet	Comparatively small	Comparatively large
5	First piece of sacrum	Superior surface of the body occupies nearly half the width of base of sacrum	Superior surface of the body occupies about one third the width of base of sacrum
6	Sacrum	Long, narrow, with smoothly curved pelvic surfaces.	Short, wide, flat, with abruptly curved pelvic surfaces
7	Sacroiliac articular facet (auricular surface)	Extends down up to the lower border of 3rd piece of sacrum	Extends down only up to the upper border of 3rd piece of sacrum
8	Subpubic angle (angle between inferior pubic rami)	Narrow: <90 degree (angle between the middle and index fingers approximately 70 degree)	Wide: 90-100 degree or more (angle between the thumb and the index finger)
9	Ischio-public index	73-94	91-115

Estimation of Age in Pelvis:[15]

The changes occurring on the articular surface of the symphysis pubis are considered a reliable index of aging male skeletons. In female skeletons, parturition has modifying effects on these changes. When the changes in the symphysis pubis are correlated with other skeletal criteria, Krogman ventures an accuracy of plus or minus 2 years. The changes may be summarized as:

Below 20 years, the symphyseal surface has an even appearance with a layer of compact bone over its surface. Between 20-30 years, it looks markedly ridges and irregular – "the ridges" or "billowing" run transversely and irregularly across the articular surface. Between 25-35 years, the "billowing" gradually disappears and the articular surface in macerated bone presents granular appearance with its well defined anterior and posterior margins. Between 35-45 years, the articular surface looks smooth and oval with raised upper and lower extremities. Between 45-50 years, narrow beaded rims develop in and around the margins of the articular surface, showing some erosion. Over 50 years, the symphyseal surface presents varying degree of erosion with breaking down of the ventral margins. All these changes as to the age limits are rough approximates and as stressed earlier, should be considered in conjunction with other skeletal changes.

Clinical Significance of Pelvis:[16]

Gynecological Aspects of Pelvis:

The standard position of the uterus is anteverted and anteflexed. Abnormal positioning of the uterus is associated with pathology. Retroversion, for example, is a cause of dyspareunia. Additionally, retroversion of a gravid uterus is associated with higher rates of spontaneous abortion.

The muscles of the pelvic floor are susceptible to injury during vaginal deliveries. The most injured muscles are the pubococcygeus and puborectalis muscle due to their proximity to the vagina.

Understanding the lymphatic drainage of the female reproductive tract is essential for assessing the spread of gynaecological malignancies. In general, most pelvic reproductive organs drain into the internal and external iliac lymph nodes. However, the ovaries are an important exception, as their lymphatic drainage follows the ovarian vessels and reaches the para-aortic (lumbar) lymph nodes.

Orthopaedic View of Pelvis:

Pelvic joints are susceptible to a wide range of pathological conditions, including arthritis, trauma, fractures, dislocations, malignancies, inflammatory disorders, and pregnancy-related changes. One of the most common clinical complaints is pelvic joint pain. For example, the lumbosacral joint is particularly vulnerable to injury due to intervertebral disc herniation at the L5–S1 level, trauma, fractures, or degenerative changes. Pain in this region often arises from the surrounding ligaments, which can transmit nociceptive signals when affected by structural alterations or abnormal biomechanics.

Similarly, the pubic symphysis may become a source of pain due to instability, misalignment, or ligamentous laxity, especially during pregnancy. This pain is often associated with irritation of nearby nerves, including the pudendal, genitofemoral, iliohypogastric, and ilioinguinal nerves. The sacrococcygeal joint is another significant contributor to lower back pain, accounting for a considerable proportion of cases. Pain in this region is typically mediated through nociceptive fibres from spinal segments L4–L5 and S1–S3.

The pelvis contains a dense network of major nerves, and any compression or irritation of these structures can lead to significant articular or referred pain. Diagnostic imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI) may not always detect the underlying causes of pelvic pain. Although positron emission tomography (PET) scans may be suggested in certain cases, their use is limited due to cost and accessibility.

As a result, the diagnosis of many pelvic joint disorders often depends on excluding other conditions and relying on careful clinical evaluation. Management strategies typically include rest, nonsteroidal anti-inflammatory drugs (NSAIDs), physiotherapy, application of heat or cold, and, in some cases, surgical intervention or nerve blocks. Despite these approaches, treatment outcomes can vary, and some patients may continue to experience persistent symptoms.

Figure – 1:

Fig – 1.1(Narrow, Male Pelvis Having Angle <90^0)

Fig – 1.2(Wide, Female Pelvis Having Angle 90^{0})

Figure – 2:

Fig – 2.1 Male (Pelvic Inlet Having Heart Shaped)

Fig – 2.2 Female (Pelvic Inlet Having Oval Shaped)

Figure – 3:

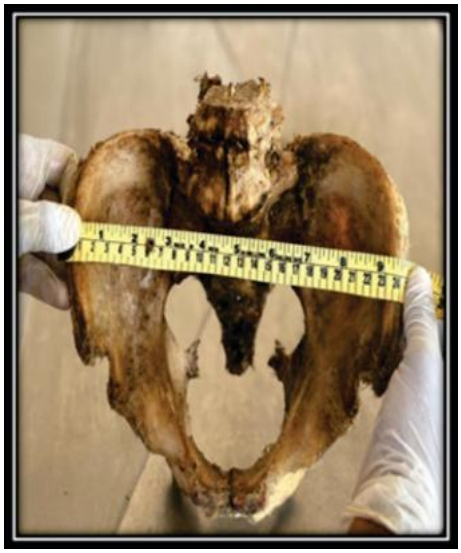

Fig 3.1 – (Width, Long, the Male Pelvis – 9 CM)

Fig – 3.2(Width, Short, the Female Pelvis – 9.5CM)

Figure – 4

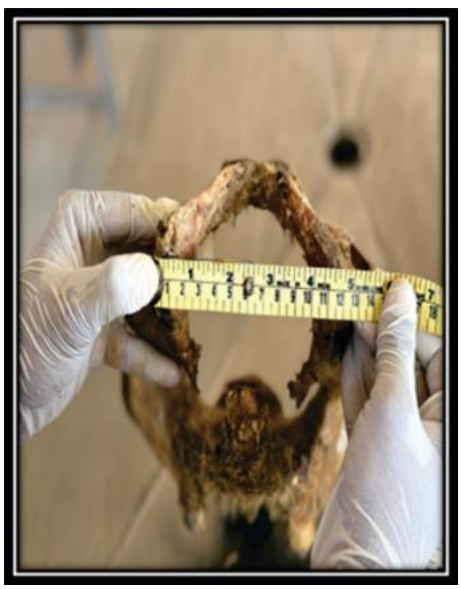

Fig 4.1 - (Width of the Angle in Male– 4.5CM)

Fig 4.2 - (Width of the Angle in Female– 6CM)

Figure – 5: (Pelvic Outlet Width is Short in Male and Long in Female)

Fig 5.1 – (Width of the Pelvic Outlet Short - 3CM)

Fig – 5.2 - (Width of the Pelvic Outlet Long – 4CM)

Figure – 6:

Fig 6.1 – Sacrum is Long, Narrow in Male

Fig – 6.2 Sacrum is Short, Wide in Female

Figure – 7:

Fig 7.1 - Green Portion Shows the False Pelvis

Fig 7.2 - Red Portion Shows the True Pelvis

Fig 7.3 – Yellow Portion Shows the Pelvic Inlet of Brim of Male Pelvis.

Fig 7.4 – Red Portion Shows the Pelvic Inlet or Brim of Female Pelvis.

Fig 7.5 – Yellow Portion Shows the Pelvic Outlet of Male Pelvis.

Fig 7.6 – Red Portion Shows the Pelvic Outlet of Female Pelvis.

Figure – 8:

Fig 8.1 – Male, Acetabulum Measures 52mm

Fig 8.2 – Female, Acetabulum Measures 40mm

Figure – 9:

Fig 9.1 – Obturator Foramen of Male Pelvis Large and Oval

Fig 9.2 -obturator Foramen of Female Pelvis Small and Triangular

DISCUSSION

The present study provides a comprehensive anatomical and clinical evaluation of the human pelvis, with a focused comparative analysis between male and female pelvic structures. The findings highlight distinct morphological, functional, and clinical differences that are crucial in medical practice, forensic identification, and obstetrics.

One of the key observations in this study is the dimensional variation between male and female pelvis, which aligns with established anatomical principles. The pelvic inlet in males was observed to be heart-shaped, whereas in females it was transversely oval, facilitating childbirth. Similarly, the pelvic outlet measurements recorded in this study (approximately 3 cm in males and 4 cm in females) emphasize the relatively larger outlet in females, supporting its obstetric function. The subpubic angle, measured as narrow (<90°) in males and wider (≥90°) in females, further reinforces sexual dimorphism. These measurements collectively demonstrate that the female pelvis is structurally adapted to allow fetal passage, being wider, shallower, and more spacious compared to the male pelvis.

The acetabular diameter differences (average 52 mm in males and smaller in females) and variations in ischial and pubic indices observed in this study are consistent with the literature and serve as reliable markers in both anatomical and forensic evaluations. Additionally, the recorded differences in sacral morphology long, narrow sacrum in males versus short, broad sacrum in females contribute significantly to the variation in pelvic cavity dimensions.

From a forensic perspective, the pelvis remains one of the most reliable bones for sex determination. Features such as the greater sciatic notch, preauricular sulcus, obturator foramen, and ischial tuberosity orientation showed clear sexual dimorphism in this study. The broader and shallower greater sciatic notch and the frequent presence of a well-defined preauricular sulcus in females were particularly useful indicators. The findings support previous studies that report up to 75% accuracy using pelvic features alone for sex determination. Moreover, the assessment of pubic symphyseal surface changes provides valuable information for age estimation, although it should always be correlated with other skeletal parameters for accuracy.

The use of colour-coded pelvic representations in this study (green for false pelvis, red for true pelvis, and differentiated markings for pelvic inlet and outlet) significantly enhances anatomical understanding. These visual distinctions help in clearly identifying spatial orientation and boundaries of pelvic regions, which is particularly beneficial for students and clinicians. The differentiation between false (greater) pelvis and true (lesser) pelvis is clinically important, as the true pelvis contains vital pelvic organs and plays a direct role in obstetrics.

Clinically, the pelvis has wide-ranging importance across multiple disciplines. In gynaecology, the orientation and dimensions of the pelvis influence uterine positioning, pregnancy outcomes, and complications such as retroversion and pelvic floor injuries. The study also highlights the vulnerability of pelvic floor muscles, particularly the pubococcygeus and puborectalis, during childbirth.

From an orthopaedic perspective, the pelvis is a common site for pain and pathology. Conditions such as lumbosacral disc herniation (L5–S1), sacroiliac joint dysfunction, and pubic symphysis instability are frequently encountered. The dense neural network within the pelvis, including the pudendal and genitofemoral nerves, explains the complex and often referred nature of pelvic pain. The discussion also underscores the limitations of imaging modalities such as CT and MRI in diagnosing certain pelvic conditions, emphasizing the importance of clinical examination.

Furthermore, the lymphatic drainage patterns of pelvic organs, especially the unique drainage of the ovaries to para-aortic lymph nodes, have significant implications in the spread of malignancies and their management.

Overall, this study reinforces that the pelvis is not merely a structural entity but a dynamic anatomical region with critical functional, clinical, and forensic significance. The integration of morphometric data, forensic indicators, and clinical correlations, along with innovative visual representation, enhances the understanding of pelvic anatomy. These insights are particularly valuable for anatomists, clinicians, forensic experts, and students, contributing to improved diagnostic accuracy and clinical outcomes.

CONCLUSION

The present study highlights the structural, functional, and clinical significance of the human pelvis with a clear comparative understanding of male and female pelvic anatomy. The observed differences in shape, size, and orientation particularly in the pelvic inlet, outlet, subpubic angle, and sacral morphology demonstrate marked sexual dimorphism, reflecting the adaptation of the female pelvis for childbirth and the comparatively robust nature of the male pelvis.

The morphometric measurements recorded in this study, including variations in pelvic diameters and acetabular dimensions, provide practical value in anatomical assessment and reinforce their relevance in clinical and forensic settings. The forensic evaluation of pelvic features such as the greater sciatic notch, obturator foramen, and preauricular sulcus confirms the pelvis as a reliable indicator for sex determination, while changes in the pubic symphysis offer supportive evidence for age estimation.

The use of colour-coded representations of the pelvis enhances clarity in identifying the boundaries of the false and true pelvis, as well as the pelvic inlet and outlet, thereby improving anatomical understanding and teaching effectiveness.

Clinically, the pelvis plays a crucial role in multiple disciplines, including obstetrics, gynaecology, orthopaedics, and radiology. Knowledge of pelvic anatomy is essential for understanding childbirth mechanisms, diagnosing pelvic pathologies, managing musculoskeletal disorders, and evaluating the spread of malignancies.

In conclusion, the pelvis serves as a vital anatomical and functional unit, and a thorough understanding of its variations and clinical implications is indispensable for medical students, clinicians, and forensic experts. This study integrates anatomical details with clinical and forensic relevance, contributing to a more comprehensive and applied understanding of the human pelvis.

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