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2nd Edition

Textbook of OBSTETRICS







OBSTETRICS

Sudha Salhan

Foreword
Anusuya Dass

JAYPEE

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3 The Bony Pelvis

Anil Kumar Jain, Sudha Salhan

INTRODUCTION

The process of normal labor depends on a safe journey of the fetus through the maternal pelvis. No two pelvis are exactly the same and slight variation of pelvic structure does not hamper normal delivery. At the most, the variation may delay process of labor, but marked deformity may render vaginal delivery impossible.

ANATOMY (FIGS 3.1 AND 3.2)

The maternal pelvis is made up of four bones—two innominate bones one on each side and sacrum with coccyx posteriorly. Each innominate bone is composed of the ilium, ischium and pubis. These bones are articulated together by four joints—the symphysis pubis joint anteriorly, two sacroiliac joints posterolaterally and one sacrococcygeal joint posteriorly. The symphysis pubis is a secondary fibrocartilaginous joint without a capsule or a synovial cavity. The articular surfaces of the two pubic bones are covered with a hyaline cartilage. On the other hand, the sacroiliac joint between ilium and sacrum is a synovial joint with a capsule and synovial cavity. Due to softening of ligaments during pregnancy, probably under the effect of the hormone relaxin, some gliding movements are possible at the symphysis pubis and the sacroiliac joints. These joints may become hypermobile, thus causing enlargement of the pelvic cavity during labor. Even the coccyx is pushed back at the sacrococcygeal joint by the descending fetal head during labor. The pelvis is divided into two parts—***upper false pelvis*** and ***lower true pelvis:*** The junction of these two is called the ***pelvic*** or ***inlet brim***.

Pelvic Inlet (or Brim) (Fig. 3.1)

Pelvic inlet continuous from sacral promontory and extending along the ilium on each side in a circular fashion, is a ridge called the ***brim***. This is the entry way of the fetus from the false pelvis to the true pelvis. The bony

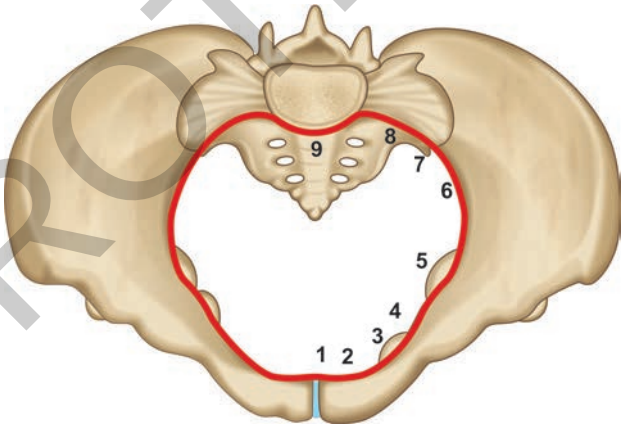


Fig. 3.1: Pelvic inlet with its bony landmarks
Keys: **1**—Center of upper border of symphysis pubis; **2**—Pubic crest; **3**—Pubic tubercle; **4**—Pectineal line; **5**—Iliopectineal eminence; **6**—Ilial portion of Iliopectineal line; **7**—Sacroiliac joint; **8**—Anterior border of ala of sacrum; **9**—Center of sacral promontory

landmarks on the brim anteroposteriorly on either side are the center of the upper border of the symphysis pubis, pubic crest, pubic tubercle, pectineal line, iliopectineal eminence, ilial portion of the iliopectineal line, sacroiliac joint, anterior border of the ala of sacrum and center of sacral promontory. It is heart shaped with the promontory of the sacrum forming a slight projection into it posteriorly.

False Pelvis (Figs 3.2 and 3.3)

It mainly consists of two iliac bones with two iliac crests (one on each side) forming the superior limit. The false pelvis does not have any bony boundary anteriorly, being bounded by the anterior abdominal wall. Posteriorly, it is bounded by the lumbar vertebrae and laterally by iliac fossae. The false pelvis has no obstetrical importance except to support the gravid uterus. In the past, it was thought to indicate the shape and size of the true pelvis, which is not true.

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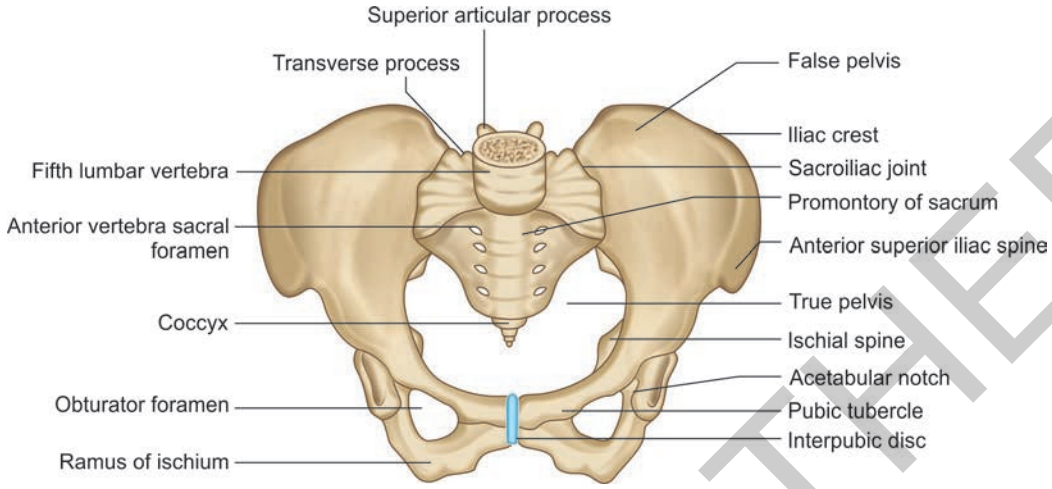


Fig. 3.2: Normal female pelvis with false and true pelvis

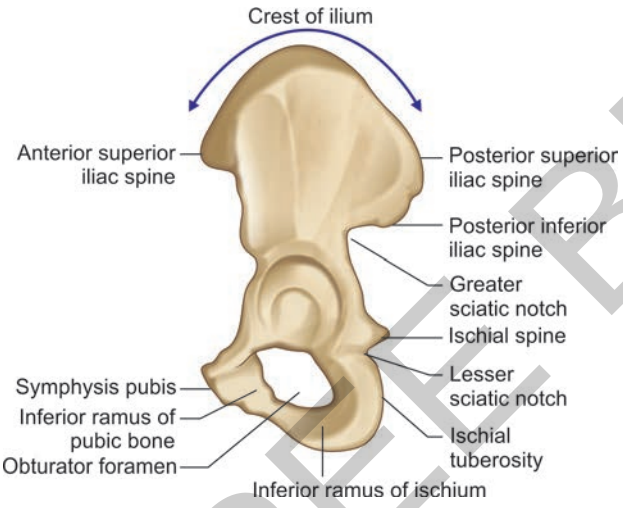


Fig. 3.3: Innominate bone showing important landmarks

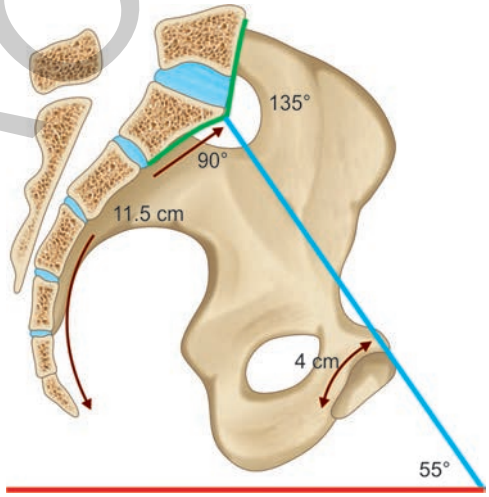


Fig. 3.4: Angle of inclination

True Pelvis

This part of the pelvis forms a bony canal through which the fetus must pass during labor, hence it is of great significance. The true pelvis is shallow anteriorly, formed by the symphysis pubis (4–5 cm) and deep posteriorly, formed by the sacrum and coccyx (10 cm). It is divided into three parts—***inlet, cavity*** and ***outlet***.

Inlet

The inlet is narrowest anteroposteriorly and widest from side to side, i.e. in the transverse diameter. Therefore, the fetal head enters the pelvic inlet with its longest diameter (anteroposterior) in the widest part of the pelvis (transverse diameter).

Plane

It is an imaginary flat surface bounded by the bony landmarks of the inlet or brim and is often called the ***superior strait***. This plane is not horizontal but tilted forward when a woman is standing and forms an angle of around 55° with the horizontal. This is called the ***angle of inclination***. Radiologically, this angle can be measured by measuring the angle between the front of L_5 and the plane of inlet and subtracting this angle from 180° (Fig. 3.4).

Obstetrical Significance

When the angle of inclination is increased as in sacralization of L_5, is called ***high inclination***. Due to change of uterine axis, as compared with the axis of inlet, engagement of

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fetal head is delayed and occipitoposterior positions are more common. Labor is prolonged as altered structure of pelvis delays the descent of the head and a flat sacrum hinders internal rotation of the fetal head. On the other hand, lumbarization of S_1 (first sacral piece) decreases angle of inclination and this is called ***low inclination***. This favors early engagement and easy delivery.

Axis of Inlet

It is a line drawn from center of the inlet, perpendicular to the plane of the inlet. Its direction is downwards and backwards (Fig. 3.5). The axis passes through the umbilicus to the coccyx. The uterine axis generally coincides with the axis of the inlet and the fetus is easily pushed into the brim with uterine contractions.

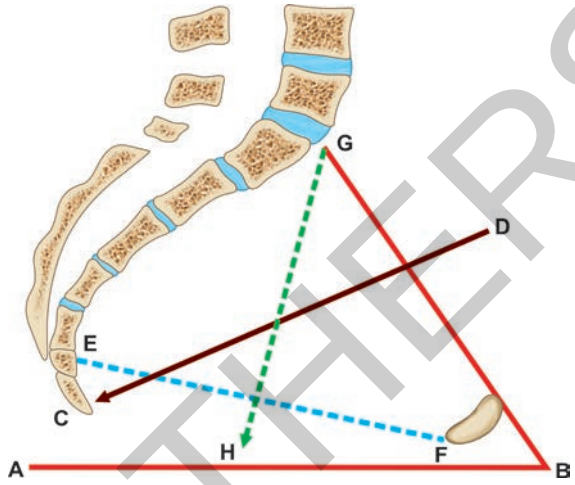


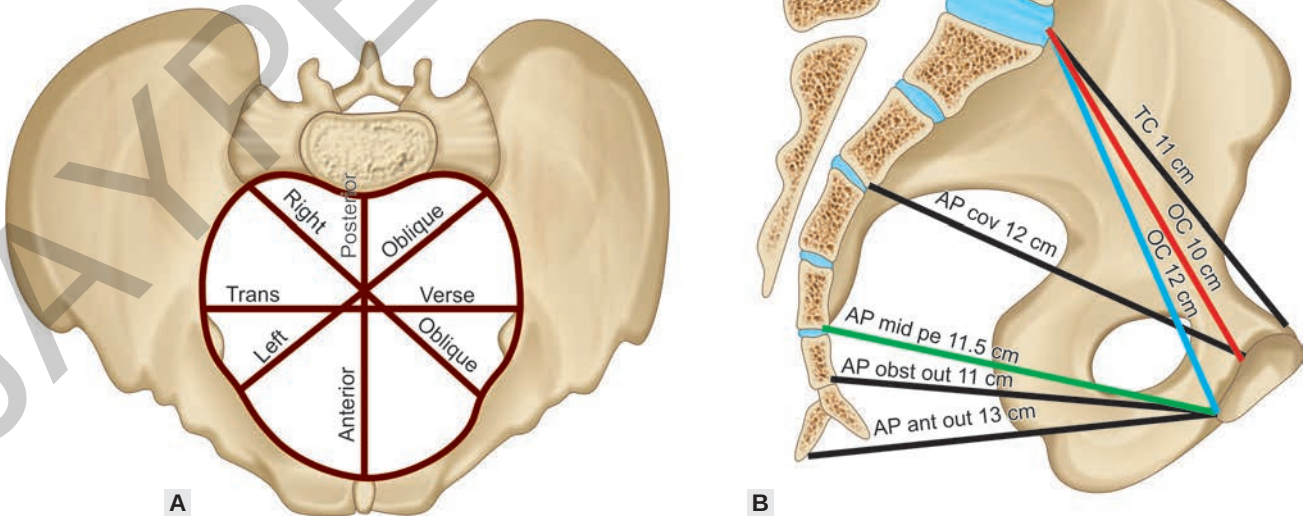
Fig. 3.5: The planes and axes of pelvis
Keys: AB—Horizontal line; **GB**—Plane of inlet; **FE**—Plane of obstetrical outlet; **DC**—Axis of inlet; **GH**—Axis of obstetrical outlet

Diameters of Pelvic Inlet (Figs 3.5 and 3.6)

From front to back, there are three diameters worth mentioning:

1. ***Anteroposterior diameter (Figs 3.6A and B) also known as the true conjugate, anatomical conjugate*** or ***conjugate vera) (11 cm):*** It is the distance between the inner margin of the middle of upper border of the symphysis pubis to the midpoint of the sacral promontory. Its direct measurement can only be made by X-ray pelvimetry. By subtracting around 1.25 cm from this we can obtain the obstetric conjugate.

- ***Obstetrical conjugate (10 cm):*** It is the distance between the midpoint of the sacral promontory to the prominent bony projection in the midline on the inner surface of symphysis pubis. It is the shortest anteroposterior diameter of the brim and cannot be measured clinically but can be estimated by deducting 1.5–2.0 cm from the diagonal conjugate depending on the height, thickness and inclination



Figs 3.6A and B: A. Diameters of pelvic inlet; **B.** Anteroposterior (AP) diameters of pelvis
Keys: OC—Obstetric conjugate; **TC**—True conjugate

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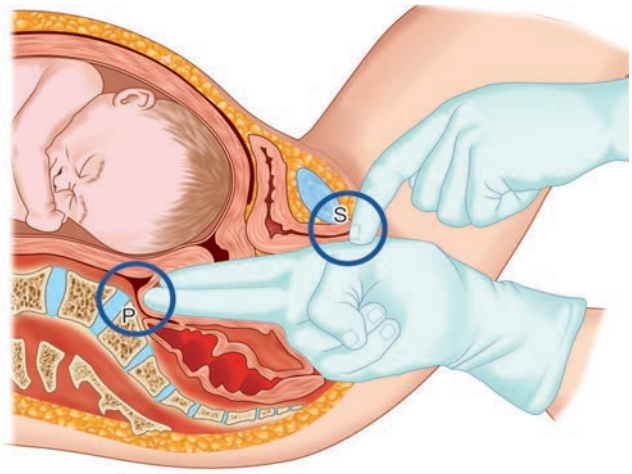


Fig. 3.7: Vaginal examination to determine diagonal conjugate
Keys: **S**—Symphysis pubis; **P**—Sacral promontory

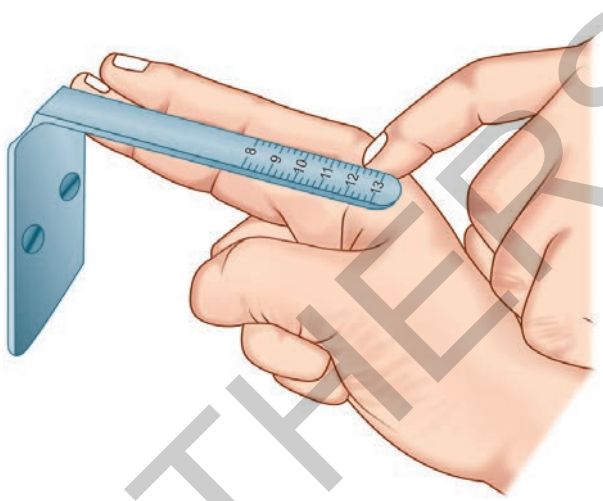


Fig. 3.8: Metal scale mounted on the wall for measuring diagonal conjugate after vaginal examination

of the symphysis pubis. Obstetric conjugate can be measured by ultrasound examination.

- ***Diagonal conjugate:*** It is the distance between the lower borders of the symphysis pubis to the midpoint on the sacral promontory. It measures 12 cm. It is the diameter, which can be measured clinically during pelvic assessment in late pregnancy or in labor.
  How should the diagonal conjugate be measured?
  The patient is placed in the dorsal position. Two fingers are introduced into the vagina taking aseptic precautions. The fingers are to follow the anterior sacral curvature. In a normal pelvis, it is not easy to feel the sacral promontory or at best it can be felt with difficulty. However, in order to reach the promontory, the elbow and the wrist are to be depressed sufficiently while the fingers are mobilized in the upward direction. The point at which the bone recedes from the fingers is the ***sacral promontory***. The fingers are then mobilized under the symphysis pubis and a marking is placed over the gloved index finger by the index finger of the left hand (Fig. 3.7).
  The internal fingers are removed and the distance between the marking and the tip of the middle finger gives the measurement of the diagonal conjugate (Fig. 3.8). Practically, if the middle finger fails to reach the promontory, generally termed as ***promontory not tipped,*** it is likely that the conjugate is adequate for an average-sized head to pass through.

2. ***Transverse diameter (Fig. 3.5):*** It is the distance between the two farthest points on the pelvic brim over the iliopectineal lines. It measures 13 cm.
   The diameter usually lies slightly closer to the sacral promontory and divides the brim into an anterior and a posterior segment. The head negotiates the brim through a diameter, called ***available*** or ***obstetrical transverse***. This is described as a diameter which bisects the anteroposterior diameter in the midpoint. Thus, the obstetrical transverse is either equal or less than the anatomical transverse.
3. ***Oblique diameter (12 cm):*** It extends from one sacroiliac joint to the opposite iliopubic eminence. There are two oblique diameters, right and left named according to the sacroiliac joint from which they start, e.g. the right oblique diameter extends from the right sacroiliac joint to the left iliopectineal eminence. This is the diameter in which the presenting part engages (Fig. 3.6).

Cavity

Definition: It is a space (not a plane like the brim) bounded above by the brim and below by the plane of least pelvic dimensions.

- ***Plane of least pelvic dimensions (or narrow pelvic plane):*** It is like the plane of the inlet and this flat surface also has bony landmarks. It extends from the lower border of the symphysis pubis to tip of ischial spines laterally and the tip of the fifth sacral vertebra posteriorly. As the name indicates, it is the narrowest plane of the pelvis, roughly corresponding to the origin of the levator ani muscles.
- ***Plane of cavity:*** Since the cavity is not a flat surface but a space extending from S_1 to S_5 sacral vertebrae posteriorly and symphysis pubis anteriorly, its plane is considered somewhere in the middle of this space.

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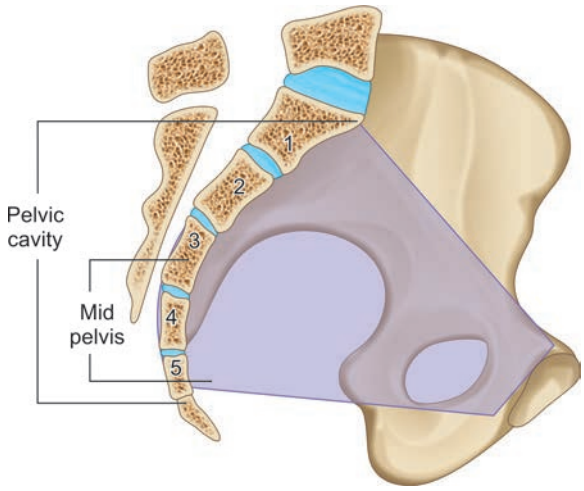


Fig. 3.9: Pelvic cavity and mid pelvis at the junction of S_4 and S_5 or tip of sacrum

The plane of the cavity extends from the midpoint of the posterior surface of the symphysis pubis to the junction of the second and third sacral vertebra (Fig. 3.9). As it is the roomiest plane of the pelvis, it is also called ***plane of greatest pelvic dimensions***.

- ***Shape of cavity:*** It is almost round in shape.
- ***Axis of cavity:*** It is a mid perpendicular line drawn to the plane of the cavity. Its direction is almost downwards.
- ***Diameters***
  - ***Anteroposterior diameter (12 cm):*** It is the distance between the midpoint on the posterior surface of the symphyis pubis to the junction of the second and third sacral vertebrae.
  - ***Transverse diameter (12 cm):*** It is the distance between two farthest points laterally. As there are no bony landmarks and points lie on the soft tissues covering the sacrosciatic notches and obturator foramina, this diameter cannot be exactly measured and is roughly 12 cm.

Mid Pelvis

It is a space bounded above by the plane of the greatest pelvic dimensions and below by a plane called the ***mid pelvic plane***. It roughly corresponds to the lower half space of the cavity of pelvis.

Mid pelvic plane: Bounded anteriorly by the lower margin of symphysis pubis, this plane extends through the ischial spine to the junction of S_4 and S_5 sacral pieces or the tip of fifth sacral piece according to the structure of the sacrum. Therefore, if it meets at the tip of the S_5 sacral piece, the plane becomes the same as that of the plane of least pelvic dimensions; otherwise it forms a wedge posteriorly (Fig. 3.9).

Diameter of mid pelvis: Anteroposterior diameter (11.5 cm). It is measured from the lower border of the symphysis pubis to the junction of S_4 and S_5 or the tip of S_5 (11 cm), whichever is applicable.

Bispinous or transverse diameter (10.5 cm): It is the distance between two ischial spines.

Obstetrical Significance of Cavity

The upper part of the pelvic cavity is cylindrical while the lower portion is curved. If the axis of cavity is viewed from the side, it will be clear that the fetal head descends directly downwards till it reaches the ischial spines and then curves forward. It is at this level where internal rotation occurs.

Importance of Ischial Spines (Plane of Least Pelvic Dimension)

Ischial spines on each side are important bony landmarks on the ischium at the mid pelvis.

- Ischial spines form the origin of the levator ani muscles.
- It is at this level that the internal rotation occurs (and the level of arrest when it does not, since it is the plane of least pelvic dimension).
- It marks the beginning of the forward curve of the pelvic axis.
- The ischial spines are easily felt on vaginal examination and the degree of descent of fetal head into the pelvis (usually termed station of head) can be clinically judged in relation to them. The level of the ischial spine termed as '0' station, above this level, stations are –1, –2, etc. While below this level, stations are +1, +2, etc. If the head has reached the level of the ischial spines, it is certain that it has engaged in the pelvic brim except when there is excessive molding and caput formation (sometimes mistaken as the lower limit of the head) or when face presents.
- They are important landmark for pudendal nerve block for analgesia.

Outlet

From an obstetric point of view, it is better to regard the pelvic outlet as a constricted lower portion and not merely its lower bony limits. Therefore, the pelvic outlet is described as an ***obstetrical outlet*** and an ***anatomical outlet***.

Obstetrical Outlet

It is a shallow bony segment (and not bony landmark) bounded above by the plane of least pelvic dimensions and below by the anatomical outlet (Fig. 3.10).

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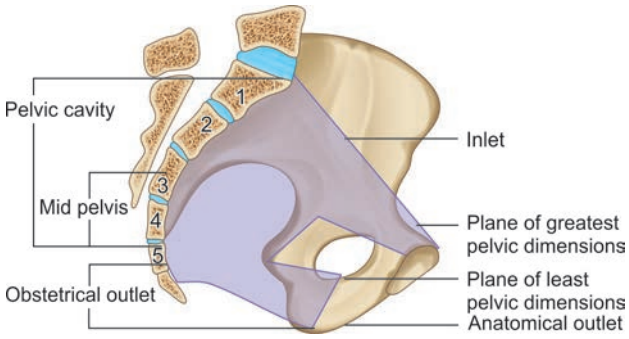


Fig. 3.10: Diagrammatic representation of pelvic segments (cavity mid pelvis and obstetrical outlet) and bony landmarks (inlet, plane of greatest and least pelvic dimensions, and anatomical outlet)

This space has lateral and posterior walls. Its anterior wall is deficient at the pubic arch, the lateral wall includes the greater part of ischial bones and the posterior wall includes the whole of the coccyx.

- ***Shape:*** It is oval anteroposteriorly.
- ***Plane:*** It is the same as the plane of least pelvic dimensions.
- ***Axis:*** It is represented by a line-joining the center of the plane of least pelvic dimensions with the sacral promontory. Its direction is almost vertical.
- ***Diameters***
  - ***Transverse or bispinous diameter (10.5 cm):*** It is measured between the two ischial spines.
  - ***Anteroposterior diameter (11 cm):*** It extends from the lower border of the symphysis pubis to the tip of the sacrum.

Anatomical Outlet

It is a bony boundary as mentioned earlier. Viewed from below, one can easily make out its boundaries. It is bounded in front by the inferior border of the symphysis pubis, and laterally by the ischiopubic rami, ischial tuberosities and sacrotuberous ligaments. Posteriorly the tip of the coccyx bounds it.

Thus, it consists of two triangular planes with a common base formed by a line joining the ischial tuberosities. The pubic arches present the sides of the anterior triangle with the apex at the inferior border of symphysis pubis. From an obstetric point of view this triangle is of great importance because the fetal head must use this space to exit from the pelvis. Women have a wide pubic arch whereas men have a narrow pubic arch. The apex of the posterior triangle is at the tip of coccyx.

- ***Shape:*** It is diamond or rhomboid shaped.
- ***Plane:*** It is represented by a line joining the lower border of the symphysis pubis to the tip of the coccyx.
- ***Axis:*** It is a line drawn at right angles to the plane of the outlet and its direction is downwards and forwards.
- ***Diameters***
  - ***Anteroposterior:*** It extends from the center of the lower border of symphysis pubis to the tip of the coccyx. It is obvious that the length of the anteroposterior diameter is reduced by forward projection of the coccyx. During labor, however, the movement of the coccyx at the sacrococcygeal joint carries it backwards so that length of this diameter is increased. But when the sacrococcygeal joint is ankylosed, this movement cannot occur and hence, the available diameter is either reduced or fracture of coccyx occurs. The anteroposterior diameter with coccyx pushed back is 13 cm and with coccyx at normal position is about 11 cm (2–2.5 cm less).
  - ***Transverse diameter (11 cm):*** It is also called the bi-ischial or intertuberous diameter or transverse diameter of the outlet. It is the distance between the inner borders of ischial tuberosities.
  - ***Subpubic angle (85° ± 5°):*** It is formed by the joining of the two descending pubic rami.
  - ***Waste space of Morris:*** Normally the pubic arch is wide and a round disc of 9.4 cm (diameter of a well-flexed fetal head) can pass through the pubic arch at a distance of 1 cm from the midpoint of the inferior border of symphysis pubic (Fig. 3.11). This is called the ***waste space of Morris***. If the pubic arch is narrow, the fetal head is pushed backwards and less space is available for the fetal head to pass through. Therefore, if the waste space of Morris is increased from normal, the fetal head has to pass through a smaller diameter, termed as the ***available anteroposterior diameter,*** injuring the perineum or sometimes causing arrest of the head.

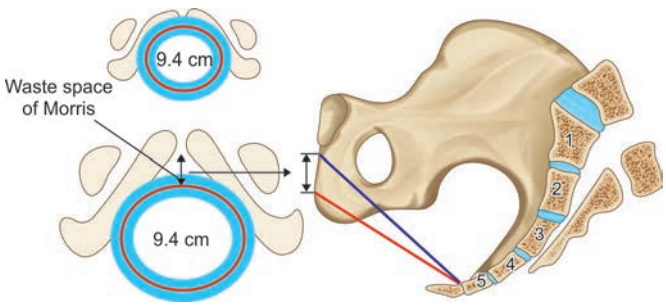


Fig. 3.11 Waste space of Morris at subpubic angle

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Pelvic Axis

Anatomical

If the axes of inlet, cavity and outlet are joined together, they form a uniform curve, which traverses the center of the canal of the bony pelvis with its convexity snugly fitting the concavity of sacrum. This is also called ***the curve of Carus*** and is directed at first downwards and backwards (axis of inlet), then gradually more and more forwards until it reaches the axis of the oultet.

Self-assessment Exercise

1. Write short notes on:
   i. Diameter of pelvic
   ii. Angle of inclination
   iii. Mid pelvis

2. True/False
   i. Axis of inlet is a line drawn between center of inlet and perpendicular plane of inlet.
   ii. Bispinous diameter is about 10 cm.
   iii. Obstetric outlet is a shallow bony segment.
   iv. Pelvic inlet is also known as brim.

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