Tutorial - The ABC of what to see on a hip X-ray of children

Swapnil M Keny[1], Nihar Modi[1]

There is a considerable difference between radiographs of the immature skeleton to skeletally mature individuals. The varied time of ossification of the four bones which form the hip joint, calls for a comprehensive understanding of the manner in which a pelvis with hips radiograph needs to be interpreted in children and adolescents

Positioning is Key

Anterior posterior AP View

A. The beam-to-detector distance is 120 with 15-degree internal rotation of the bilateral lower extremities.

B: The beam needs to be centred over the midpoint between the ASIS and the superior border of the pubic symphysis.

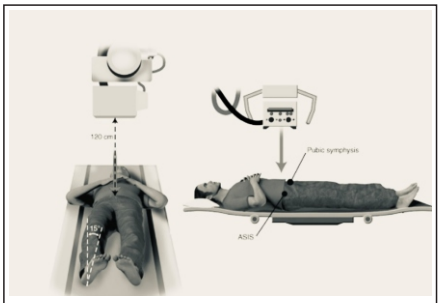

Figure 1: Positioning for AP view of the Pelvis

False Profile View

The ipsilateral foot is positioned parallel to the detector with the pelvis rotated back toward the contralateral hip 25°, making a 65° angle between the detector and the pelvis. The beam is oriented perpendicular to the detector.

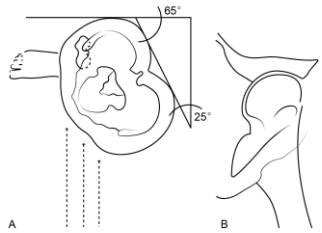

Figure 2: Positioning for false profile view

Cross Table Lateral View

The contralateral hip and knee are flexed to 90°, whereas the affected hip is internally rotated to 25°.

The detector is positioned 45° in relation to the hip and the beam, then oriented perpendicular to the detector.

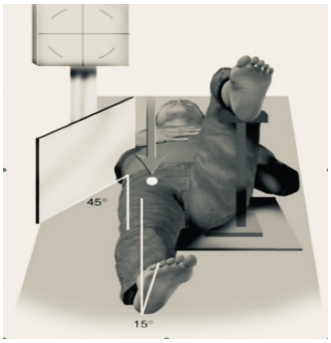

Figure 3: Positioning for cross table lateral view

Frog Leg Lateral View

With the affected hip abducted 45°, the ipsilateral knee flexed and the ipsilateral heel is placed on the medial aspect the contralateral knee.

The detector is placed under the patient and the beam is centered perpendicular to the hip with the beam located at the midpoint between the anterior superior iliac spine and the superior border of the pubic symphysis at a detector-to-beam distance of 90 cm.

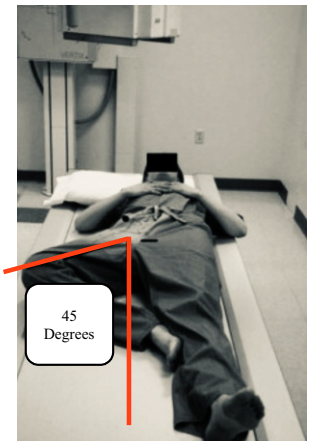

Figure 4: Positioning for Frog Leg Lateral View

45° & 90° Dunn's View

Technique of 45° Dunn's View:

With the hip flexed 45°, abduction of 20°, and neutral rotation, the beam is centered over the midpoint between the ASIS and the superior border of the pubic symphysis.

[1]Paediatric Orthopaedic Surgery, Sir H.N.Reliance Hospital, Mumbai, Maharashtra, India,
[2]Department of Orthopaedics, K. B. Bhabha Municipal General Hospital, Mumbai, Maharashtra, India.

Address of Correspondence
Dr. Swapnil M Keny,
Paediatric Orthopaedic Surgery, Sir H.N. Reliance Hospital, Mumbai, Maharashtra, India.
E-mail: peadortho@gmail.com

Submitted Date: 15 Jun 2022, Review Date: 05 Jul 2022, Accepted Date: 13 Oct 2022 & Published Date: 10 Dec 2022

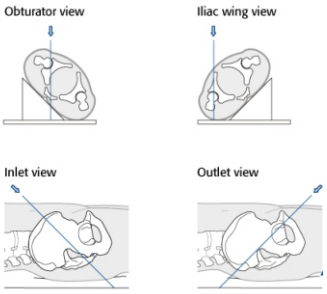

Figure 5.1: Technique for 45 and 90° Dunn's View

Technique of 90° Dunn's View:

The technique is similar to the method to obtain the 45° Dunn view, the hip is just flexed to 90°

Other Pelvis Views.

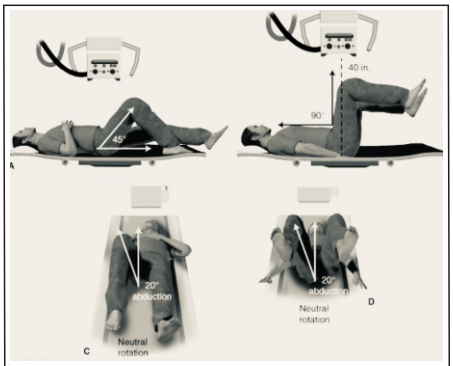

Figure 5.2: positioning for obturator View, Iliac wing view, inlet view and outlet view

The Normal Pelvic X-ray

Lordosis correction - The true Pelvis AP

If the diagnosis is FAI, the AP Pelvic view should be taken with lumbar lordosis correction to make the signs and measures of the acetabulum reliable

Adequate pelvis inclination: distance between the superior aspect of the pubic symphysis and the sacrococcygeal junction must be approximately 3 cms in men and 4 cms in women.

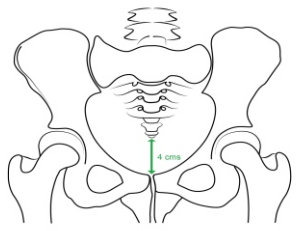

Figure 6: Lordotic Correction - The True Pelvis AP

Normal Anatomical Landmarks

Osseous anatomy: Important landmark lines

- Femoral heads (red line)
- Obturator foramina (blue line)
- Ischial spines (brown line)
- Greater and lesser trochanter (green line).

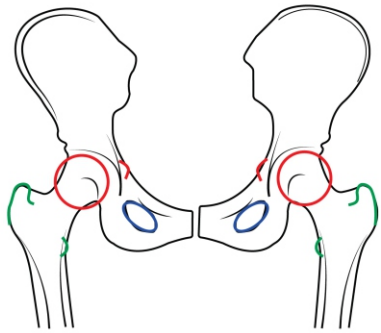

Figure 9: Normal Anatomical Landmarks

Normal Soft Tissue

- Gluteal fat pad (white arrow)
- Iliopsoas fat pad (blue arrow)
- Obturator fat pad (black arrow).

They must be rectilinear and well defined

- If they have a convexity implies distension of the hip joint with fluid
- The X-ray must be strictly in AP position for this assessment to be valid
- Flexion and hip rotation could produce false positives.
- Iliopubic line (blue)
- Ilioischial line (red)

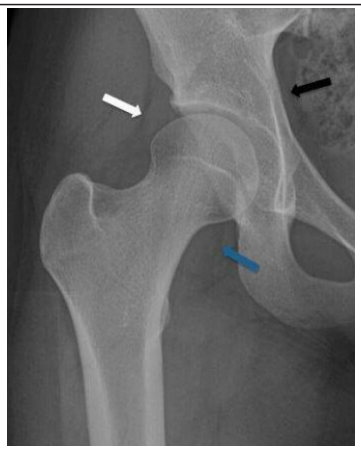

Figure 7: Normal soft tissue shadows

Iliopectineal or iliopubic line

Formed by the arcuate line of the ilium and the superior border of the superior pubic ramus. It determines the inner margin of the pelvic ring and it is part of the anterior column of the acetabulum.

Ilioischial line

It begins at the medial border of the iliac wing and extends along the medial border of the ischium to end at the ischial tuberosity. It is part of the posterior column of the acetabulum.

Acetabular floor

In normal conditions the floor of the acetabular fossa is lateral to the ilioischial line (2 mm in men, 1 mm in women).

The acetabular floor overlapping the ilioischial line is called as coxa profunda.

Acetabular protrusion is a more severe condition that occurs when the femoral head overlaps or overpasses the ilioischial line.

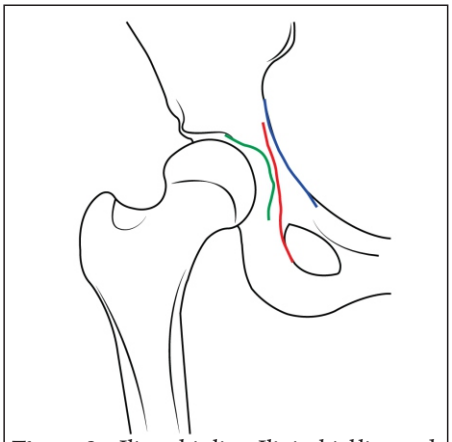

Figure 8: : Iliopubic line, Ilioischial line and Acetabular Floor

Acetabular Tear Drop

The teardrop does not correspond to an anatomical structure but represents a summation of shadows of the medial acetabular wall:

It is a useful sign when is asymmetric with the contralateral side. A wider teardrop or greater distance regard to the femoral head can indicate dysplasia or joint effusion.

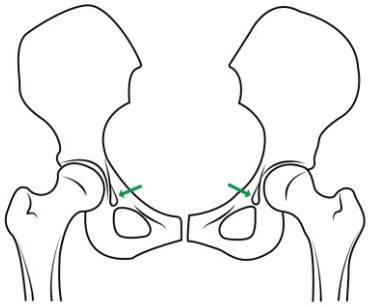

Figure 10: Acetabular Teardrop

Normal Hip Joint Space

In normal conditions, the femoral acetabular joint space is between 3 and 5 mm uniformly.

Figure 11: Normal Hip Joint Space

Acetabular coverage

Normally, the acetabulum covers 75% of the femoral head. It can be determined by three different measurements.

Acetabular Morphology

Lateral center-edge angle of Wiberg

Angle between a line through the center of the femoral head, perpendicular to the transverse axis of the pelvis, and a second line through the center of the femoral head, passing through the most superolateral point of the sclerotic weight-bearing zone of the acetabulum (acetabular sourcil).

Values of <20° indicate inadequate lateral coverage of the femoral head.

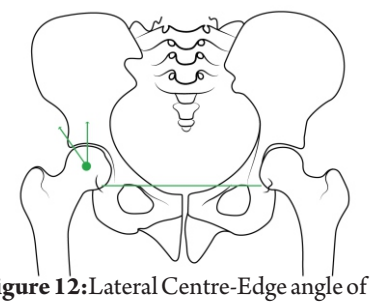

Figure 12: Lateral Centre-Edge angle of Wiberg

Anterior center-edge angle of Lequesne

Angle between a vertical line through the center of the femoral head, and a second line from the center of the femoral head, passing through the most anterior point of the acetabular sourcil.

Values of <20 indicate inadequate anterior coverage of the femoral head.

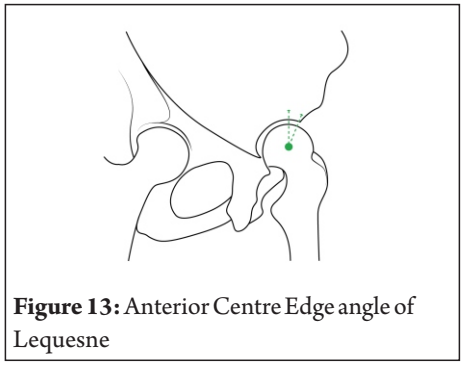

Figure 13: Anterior Centre Edge angle of Lequesne

Femoral head extrusion index

The percentage is calculated by dividing the horizontal distance of the part of the femoral head that is lateral to the edge of acetabulum (A) by the maximum total horizontal width of femoral head (B) and multiplied by 100.

This percentage must be <25%.

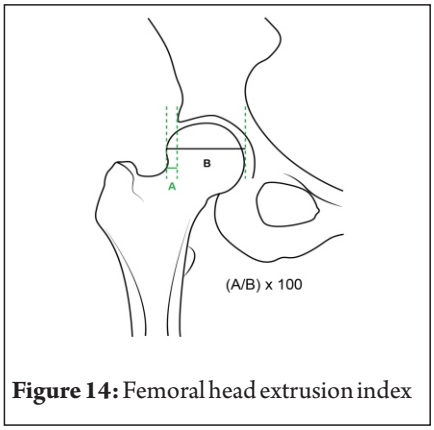

Figure 14: Femoral head extrusion index

Tonnis angle

Angle between the horizontal line, and a second line connecting the inferior and lateral aspects of the acetabular sourcil.

Values >10° are considered in higher risk for instability, <10° a risk factor for PINCER impingement.

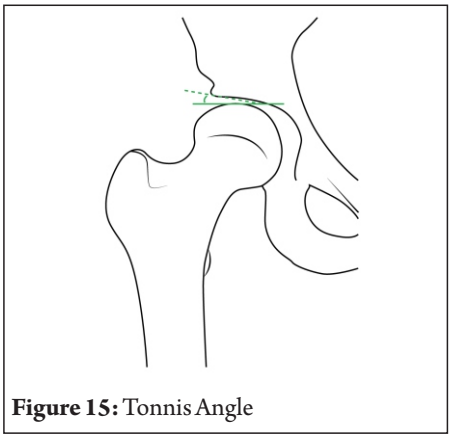

Figure 15: Tonnis Angle

Sharp's angle

Angle between a line horizontal to the inferior aspect of both pelvic teardrops, and a line from the inferior aspect of the teardrop passing through the most lateral point of the acetabular edge.

Angles >45° are considered dysplasia.

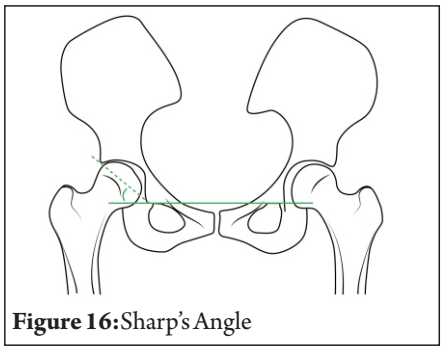

Figure 16: Sharp's Angle

Acetabular sourcil & sourcil sclope

- H denotes Hilgenreiner's line.
- S denotes line from which AI-S is measured. (Acetabular Index Sourcil)
- L denotes line from which AI-L is measured (Acetabular Index).

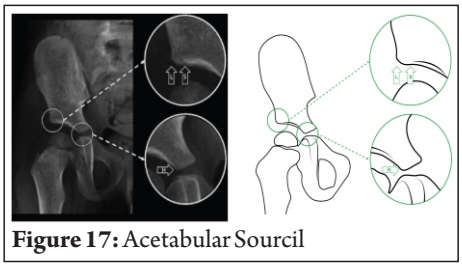

Figure 17: Acetabular Sourcil

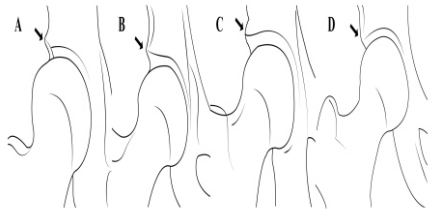

Figure 19: Acetabular Sourcil slope
A - Frank Dysplasia
B - Borderline Dysplasia
C-Normal Sourcil Slope
D - Negative Sourcil Slope

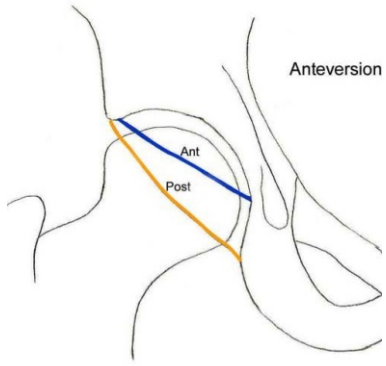

Figure 20: Acetabular Version

Acetabular Version

Under normal conditions the acetabulum is oriented in anteversion.

Acetabular Version

Acetabular retroversion

In X-ray the diagnosis is made with the crossover sign produced when the posterior wall of the acetabulum crosses the anterior wall before reaching the

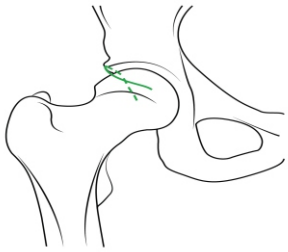

Figure 18: Acetabular Crossover Sign

Figure 21: Acetabular Retroversion

acetabular roof.

The acetabular retroversion is associated with the PINCER type impingement.

The ischial spine sign

The Ischial Spine Sign is considered positive when the ischial spine projects medial to the iliopectineal line in the AP

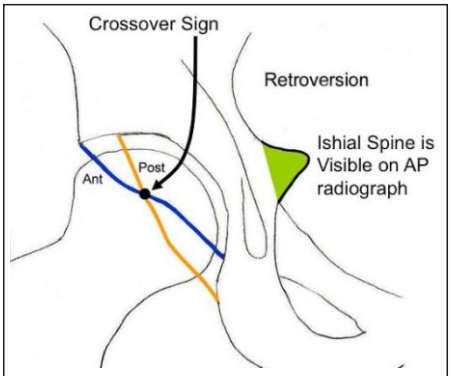

Figure 23: Ischial Spine Sign

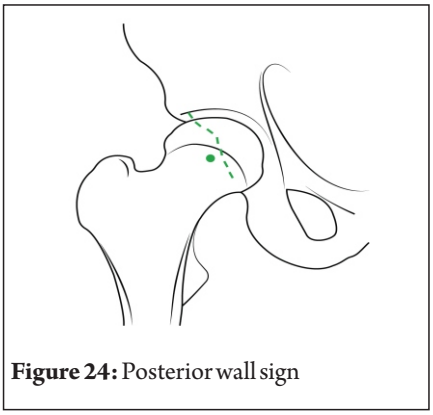

Figure 24: Posterior wall sign

X-ray of the lumbar spine, indicating that not only the acetabulum, but rather the pelvis, is inclined in retroversion.

The posterior wall sign

The posterior wall sign is considered positive when the posterior wall edge is medial to the femoral head center, indicating deficiency of the posterior wall.

Femoral Head Morphology

Under normal conditions, the femur has a concave and symmetrical outline at the femoral head-neck junction (femoral offset).

When the loss of this bone concavity is

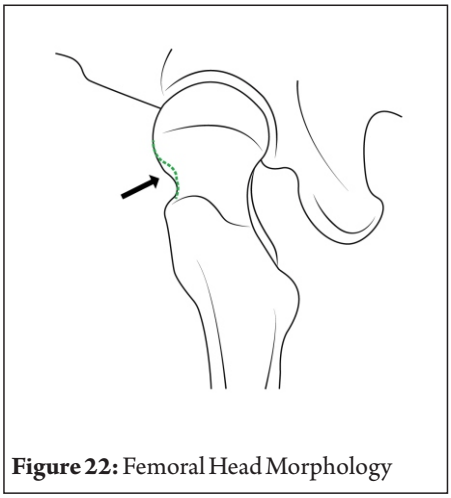

Figure 22: Femoral Head Morphology

produced by a bony protuberance or bump it can cause CAM type impingement.

Conclusion

- A plain X-ray is the most important investigation in various hip pathologies
- Proper positioning and exposure is important to different physiology from pathology
- The various radiological Indices can help define and differentiate the type of help decide treatment modalities.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

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Conflict of Interest: NIL
Source of Support: NIL

How to Cite this Article

Keny SM, Modi N. Tutorial - The ABC of what to see on a hip X-ray of children. Journal of Clinical Orthopaedics Jul-Dec 2022;7(2):33-37.