Pediatric ultrasound for development dysplasia of the hip: an educational pictorial review

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Authors: F. Moloney, M. Twomey, M. Moore; Cork/IE
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Learning objectives

1. To describe the clinical features of development dysplasia (DDH) of the hip.
2. To describe the different techniques for performing ultrasound of the pediatric hip when screening for DDH.
3. To present sample cases of DDH on ultrasound.
Background

Developmental dysplasia of the hip describes hips that are unstable, subluxated, completely dislocated, or have malformed acetabula.

The femoral head and acetabulum develop from the same block of primitive mesenchymal cells with a cleft to separate them developing at 7 to 8 weeks’ gestation. Development of the hip joint is complete by 11 weeks’ gestation.

At birth, the femoral head and the acetabulum are primarily cartilaginous. The acetabulum continues to develop postnatally. The growth of the fibrocartilaginous labrum that surrounds the bony acetabulum deepens the socket. Hip dysplasia may occur in utero, perinatally, or during infancy and childhood. (1) Hence, the term developmental is more commonly used rather than congenital, as many of the features of DDH may not be present at birth.

The hip is at risk for dislocation during 4 periods: the 12th gestational week, the 18th gestational week, the final 4 weeks of gestation, and the postnatal period. (1)

The incidence of DDH in unscreened populations is estimated to be one to two cases per 1,000 children of European origin while it is rare in black Africans. (2)

The most significant risk factor for hip dysplasia is a positive family history. Other risk factors include breech presentation, foot deformities, oligohydramnios, primiparity and female sex. (3)

Clinical examination using the Ortolani and Barlow maneuvers remains the primary method for diagnosing DDH. (4) The Ortolani maneuver is performed by fixing the contralateral hip while abducted and gently pulling the hip anteriorly under examination. The sensation of instability in a positive Ortolani maneuver is the palpable and sometimes audible "clunk" of the femoral head moving over the posterior rim of the acetabulum and relocating in the cavity. The Barlow maneuver is performed by adducting the hip while pushing the thigh posteriorly. If the hip goes out of the socket, it is called "dislocatable" and the test is termed "positive."

Clinical indications for ultrasound of the infant hip include but are not limited to:

Abnormal findings on physical examination of the hip, family history of DDH, breech presentation at birth, postural molding conditions (torticollis, foot deformity), and for monitoring of treatment of DDH. Ultrasound is usually not performed on infants less than 2 weeks old due to the presence of physiologic laxity. (5)

The AAP Subcommittee on Developmental Dysplasia of the Hip recommends careful clinical examination of all babies at birth and during follow-up examinations during the first year of life. If the results of newborn examinations are negative or equivocally
positive, risk factors may be considered. In addition to physical examination, selective ultrasound at age 4 to 6 weeks (or radiography at 4 months if ultrasound is not available) is recommended for babies with risk factors or questionable physical examination. (1)

It is vital to detect DDH early as the earlier a dislocated hip is detected, the simpler and more effective is the treatment with better treatment outcomes.

Despite screening programs, DDH continues to be detected late in childhood, delaying appropriate therapy and leading to litigation.

The use of ultrasonography in screening for DDH remains uncertain with programs not yet achieving better long-term outcomes at a reasonable cost compared with programs that rely on physical examination alone. (6) In one study, ultrasound screening resulting in a higher treatment rate and follow-up rate than clinical screening alone, without a significant reduction in the prevalence of late subluxation of dislocation. (7)
Imaging findings OR Procedure Details

Real-time ultrasonography has been established as the most accurate method for imaging the hip during the first few months of life. Radiographs are of little use at this stage as the femoral heads are composed entirely of cartilage. The ossification center develops in the femoral head by 4 to 6 months of age and at this stage radiography becomes the first-line investigation for detecting DDH.

Ultrasound allows for visualization of the cartilage, assessing the stability of the hip and the morphologic features of the acetabulum.

Different techniques include static evaluation of the morphological features of the hip (Graf method) and dynamic evaluation (Harcke method) that assesses the hip for stability of the femoral head in the socket, as well as static anatomy.

The Graf method is a static method based on the depth and shape of the acetabulum as seen on coronal ultrasound images. (8) The hip is evaluated by measuring two angles formed by drawing three lines from three landmarks on a static grey-scale ultrasound image; the lateral edge of the acetabulum, the bottom of the acetabulum, and the acetabular labrum. The three lines are the bony roofline, the baseline, and the cartilage roofline measured at the acetabular labrum. After these lines have been drawn, the bony roof angle (alpha angle) and the cartilage roof angle (beta angle) are measured. The alpha and beta angles determine the subtype and correspond to a scale of severity.

In the Graf classification, a type I hip (α > 60°) is considered normal. A type IIa/b hip (α angle 50-59°) has a slightly shallow acetabular cup and a rounded rim with the femoral head in a normal position and is considered to be abnormal in infants more than 3 months of age. A type III hip (α < 43°) is subluxated, and a type IV hip (α < 43°) is dislocated. (8)

The advantages of this technique is that it is fast, relatively easy to perform, and reproducible between operators.

The Harcke method consists of using real-time ultrasonography to visualize the hips during physical examination in multiple positions. (9) The transducer is placed laterally in the region of the greater trochanter and two views are obtained. For the 'transverse-neutral' view, the infant is supine and the hip is in the neutral position. The image is essentially a transverse image of the hip joint, femoral head, and neck. For the 'coronal-flexion' view, the infant remains in the supine position and the hip joint is flexed to 90 degrees and the transducer is rotated through 90 degrees. This gives a coronal section of the flexed hip joint.
Fig. 1: Coronal ultrasound image of the left hip. Normal type I hip (alpha angle > 60 degrees).

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**Fig. 2:** Coronal ultrasound image of the left hip. Type IIa hip (alpha angle of 50-59 degrees).

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Fig. 3: Coronal ultrasound image of the right hip. Type III with decentering of the femoral head (alpha angle < 43 degrees).

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Fig. 4: Axial ultrasound image of the left hip. The femoral head is subluxable on dynamic maneuvers.

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**Fig. 5:** Coronal ultrasound image of the right hip. The femoral head is dislocated superiorly and laterally.

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Fig. 6: Coronal ultrasound image of the left hip. Type III with femoral head decentering (alpha angle < 43 degrees)

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Fig. 7: Coronal ultrasound image of the left hip. Type IIc hip (alpha angle 43-49 degrees).

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**Fig. 8:** Coronal ultrasound image of the left hip. The femoral head is subluxed.

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Fig. 9: Coronal ultrasound image of the left hip. The femoral head is sublimed with approximately 10% coverage of the femoral head.

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**Fig. 10:** Coronal ultrasound image of the left hip. The femoral head is sublimed with an alpha angle < 43 degrees (type III hip).

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Conclusion

Early diagnosis of DDH is associated with better treatment outcomes. Ultrasound in selected patients is an accurate method for detecting DDH in the first few months of life and knowledge of the technique and typical radiological findings is essential for the performing radiologist.
References