Clinics in Diagnostic Imaging (69)

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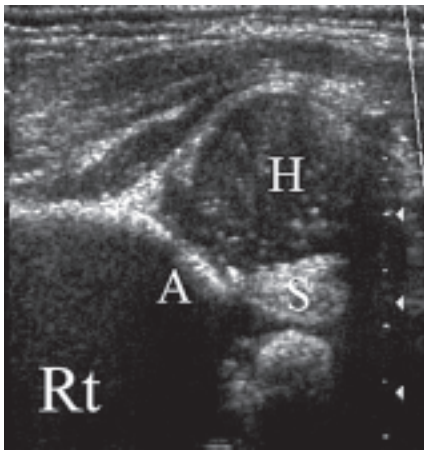

Fig. 1a Coronal US scan of the right hip taken in 90 degrees of flexion.

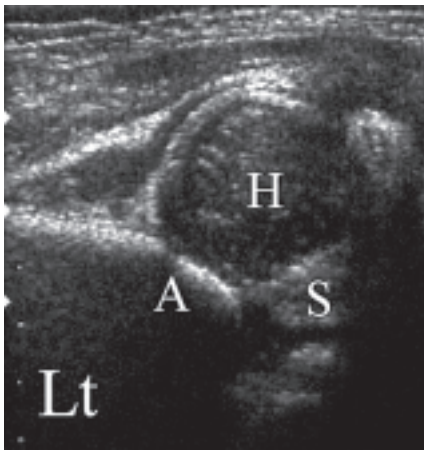

Fig. 1b Coronal US scan of the left hip taken in 90 degrees of flexion.

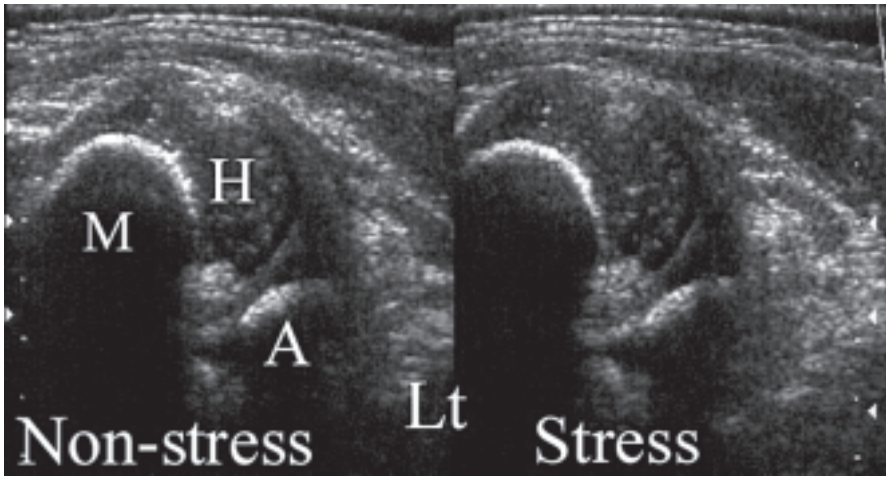

Fig. 1c Transverse US scans of the left hip taken without (left) and with stress (right) manoeuvre.

CASE PRESENTATION

A full-term male infant was delivered by forceps after the mother experienced premature rupture of the membranes more than 24 hours prior. On physical examination, the child was noted to have bilateral subluxed hips but was otherwise well. Barlow and Ortolani signs were positive. The patient was placed in a Pavlik harness. Ultrasonography (US) of the hips was performed when the patient was one month old (Figs. 1a-c). What does the US show? What is the diagnosis?

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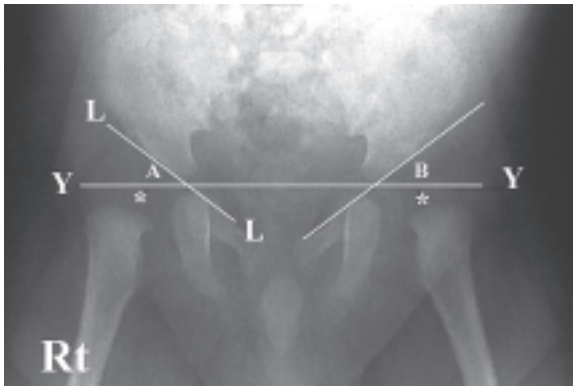

Fig. 2 AP radiograph of the pelvis taken at three months shows the expected positions of the unossifed femoral heads (*) to be partially subluxed. The acetabular indices (angles A and B) are 34 and 36 degrees, respectively (normal <30 degrees). These findings are consistent with the diagnosis of DDH. (Y-Y = line joining the triradiate cartilages; also known as the Hilgenreiner line. L-L = the line connecting the inferior medial and the most superolateral bony corners of the acetabular roof).

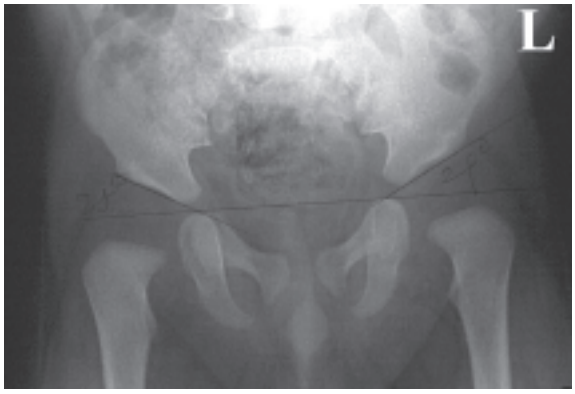

Fig. 3 AP radiograph of the pelvis taken at six months shows that the acetabular indices are 28 degrees bilaterally which was within normal limits. The femoral heads had still not ossified but the hips were stable on physical examination.

Fig. 4a Photograph shows the coronal scanning plane with the hip in flexion. The hips are flexed 90 degrees and the high-resolution linear transducer is placed in the coronal plane.

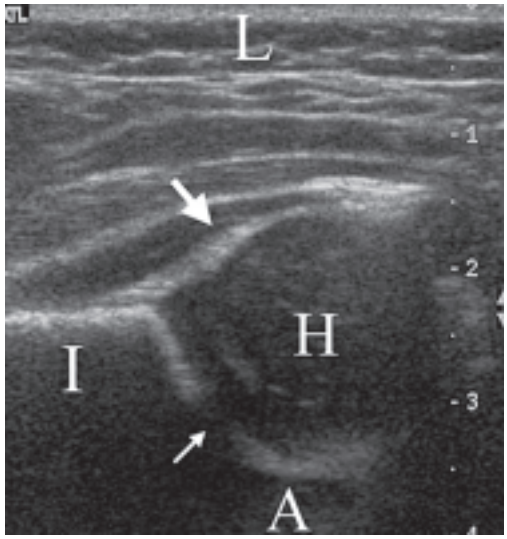

Fig. 4b Normal coronal flexion view obtained in the mid-acetabular plane. The iliac bone (I) is straight and the point where the iliac bone and triradiate cartilage join in the medial part of the acetabulum is visualised (small arrow). The echogenic tip of the labrum is also visible (large arrow). (H = unossified femoral head, I = iliac bone, A = acetabulum, L = lateral).

Fig. 5a Photograph shows the transverse scanning plane with the hip in flexion.

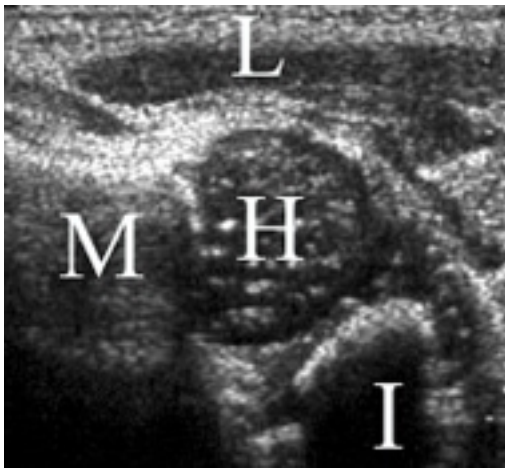

Fig. 5b Normal transverse view with the hip in flexion. The femoral head (H) is situated in close contact with the ischium (I). (M = femoral metaphysis, L = lateral).

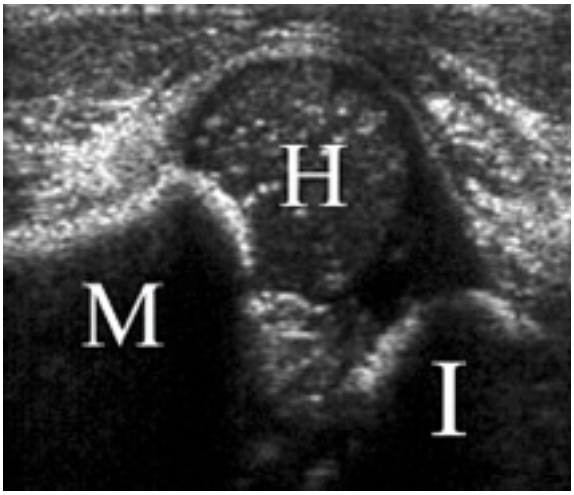

Fig. 5c Same patient as Fig. 5b. This view is obtained after the application of the stress manoeuvre where the femur is gently pushed in a posterior direction similar to the Barlow manoeuvre. The femoral head (H) is subluxable and is displaced laterally and posteriorly away from the ischium (I). (M = femoral metaphysis).

IMAGE INTERPRETATION

These coronal US views were obtained with the hips in 90 degrees of flexion (Figs. 1a, b). Both femoral heads (H) were displaced laterally from their respective acetabulae (A). The left femoral head was more severely displaced (Fig. 1b) compared to the right (Fig. 1a). Both acetabulae were also flat and shallow, and do not demonstrate the normal concave configuration. Echogenic soft tissue (S) or pulvinar was seen, situated between both femoral heads and their respective acetabulae.

The transverse US scans of the left hip were obtained with the hips in 90 degree flexion and were performed at rest and after the application of the stress manoeuvre (Fig. 1c). There was no increased subluxation/dislocation of the hip with stress. Similar findings were found in the right hip (not shown).

DIAGNOSIS

Bilateral developmental dysplasia of the hip (DDH).

CLINICAL COURSE

The patient continued treatment with the Pavlik harness and a pelvic radiograph was performed at the next follow-up visit when the patient was three months old (Fig. 2). This showed the femoral heads to be still unossified. The femoral heads were partially subluxed. The acetabular index is the angle between the Y-Y line or Hilgenreiner line (the line drawn between the two triradiate cartilages) and the L-L line (the line connecting the inferior medial and the most superolateral bony corners of the acetabular roof). The acetabular indices (i.e. angles A and B) of the right and left hips were 34 degrees and 36 degrees, respectively (normal <30 degrees). This corroborates with the findings on US and is consistent with the diagnosis of DDH.

At the next follow-up visit when the patient was six months old, a pelvic radiograph (Fig. 3) showed the acetabular indices to be 28 degrees bilaterally. This is within normal limits. The femoral heads had not yet ossified but the hips were stable on physical examination. A follow-up pelvic radiograph taken when the patient was one year old was normal (not shown).

DISCUSSION

DDH was formerly called "congenital hip dysplasia" as it used to be thought that infants were born with this problem. Although some are, most infants develop DDH after birth. DDH is a condition encompassing a spectrum of abnormality ranging from acetabular dysplasia to frank dislocation of the hip. Risk factors include breech presentation and skull moulding deformities at birth, neuromuscular disorders, congenital torticollis, congenital foot deformities and a family history (6% risk, parent or sibling)[1]. The most common cause of DDH is believed to be due to abnormal ligamentous laxity, accentuated by high levels of maternal oestrogens[2]. The incidence of DDH in our local population is about 4.7 per 1,000 live births[3]. Females are affected about six times more commonly than males. DDH is bilateral in up to one-third of patients[2]. DDH can be detected on physical examination. By femoral abduction and flexing the hip joint, the Ortolani manoeuvre reduces the dislocated hip and produces an audible "clunk". The Barlow manoeuvre displaces a dislocatable hip by flexion, adduction and applying posterior pressure to the hip joint.

Radiographs are no longer widely used in the evaluation of DDH in the neonatal period. This is because radiographs are unable to visualise the unossified cartilaginous portions of the hip joint and false negative interpretations may occur. Positioning in the frog-lateral radiograph also reduces a dysplastic hip. Radiographs are thus not accurate in the diagnosis of DDH in young infants[4]. However, once the femoral head has ossified (three to six months in females and four to seven months in males), evaluation should be continued with radiographs. US becomes difficult once the femoral head has ossified because the ossified femoral head obscures ultrasonographical evaluation of the underlying acetabulum.

US of the hips is reliable and accurate for the early diagnosis of DDH in young infants[5]. US is relatively cheap, lacks ionising radiation and is well-accepted by both patients and clinicians. The cartilaginous femoral head and much of the acetabulum can be visualised. US enables hip joint movements to be observed directly during the dynamic examination. The main

disadvantage of US is that it is operator-dependant, requiring proper training and experience. US is also difficult to perform once the femoral head has ossified.

US is indicated in infants who, on clinical examination, are suspected of having DDH. Screening of infants with risk factors is useful in detecting clinically-occult cases of DDH[6] and may decrease the rate of late-presenting cases of DDH requiring operative procedures. US should be performed when the patient is four to six weeks of age. Performing the US at this time allows resolution of physiological hip instabilities that normally occur in the first month of age[7]. It also detects abnormalities in time for optimal treatment before the patient is eight weeks old. High resolution 7.5 MHz linear array transducers should be used. The child must be relaxed for the examination to be successful. The "dynamic standard minimum examination" for hip US is a combination of the techniques of Graf and Harcke[8]. The components of this examination are assessment of the hip in the coronal plane at rest, and in the transverse/flexion plane at rest and with the application of stress.

The coronal view is obtained with the hip either in flexion or in the neutral position. A high-resolution linear transducer is placed on the lateral aspect of the hip in the coronal plane (Fig. 4a). To ensure consistency, the standard mid-acetabular plane must be obtained. This is achieved when there is visualisation of a straight iliac line and the point where the iliac bone and triradiate cartilage join in the medial part of the acetabulum (Fig. 4b). The echogenic tip of the labrum should also be visible in this plane.

The second component of the 'dynamic standard minimum examination' is evaluation in the transverse/flexion plane with stress. In this plane, the transducer is placed parallel to the femoral shaft with the hip held in 90 degrees of flexion (Fig. 5a). The stress manoeuvre is performed by gently pushing the femur in a posterior direction similar to the Barlow manoeuvre. When the hip is subluxable or dislocatable, the femoral head moves lateral to the acetabulum (Figs. 5b, c).

The US report should address the following:

1. Whether the bony acetabulum or the labrum are normal.
2. The presence or absence of excess soft tissue or pulvinar within the acetabulum.
3. The position of the femoral head and whether it is normally situated in the acetabulum, subluxable, subluxed, dislocatable or dislocated.
4. Whether it is possible to reduce the dislocated hip[9].

When the diagnosis of DDH is made in the newborn infant, the patient is placed in a Pavlik harness. This harness holds the hip in abduction with the femoral head situated within the acetabulum. US of the hips is performed when the patient is four to eight weeks old. If the hips are stable, the harness can be weaned off when the patient is 10 weeks old. A pelvic radiograph taken in the antero-posterior (AP) projection is performed at the end of this weaning period. This radiograph is used to assess the bony acetabulum and position of the femoral head which is beginning to ossify at this stage. This radiograph also serves as a baseline for future follow-up.

If the hips are still dislocated at the initial US, a Pavlik harness is generally still used for treatment. Regular weekly follow-up with US may be performed until the head is relocated within the acetabulum. Open operative reduction of the femoral head is sometimes necessary in persistently dislocated femoral heads.

ABSTRACT

Developmental dysplasia of the hip (DDH) is a condition encompassing a spectrum of abnormality. The ultrasonography features of DDH in a male infant is illustrated. Follow-up after treatment with a Pavlik harness shows resolution of the DDH. In the neonatal period, ultrasonography (US) is the modality of choice used to evaluate babies with suspected developmental dysplasia of the hip. The unossified cartilaginous femoral head and much of the acetabulum can be visualised on US. When the femoral head begins to ossify, pelvic radiographs can be used to follow-up patients with developmental dysplasia of the hips.

Keywords: Developmental dysplasia of the hip, ultrasound, infants

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