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Sonography in congenital dislocation of the hip

A new technique for ultrasonic examination of the hip joint was evaluated in neonatals and infants. An anterior approach was used with the sound sector centered over the femoral head and parallel to the femoral neck. The ultrasonograms corresponded to lateral radiographs of the joint with the leg in Lorenz' first position. It was possible to evaluate the size and depth of the acetabulum and the size and position of the femoral head. The projection also permitted a dynamic examination for determination of hip instability. Thus, the technique provided a method for an objective diagnosis in congenital dislocation of the hip (CDH). In 216 hips, the results of clinical evaluation for CDH were correlated with the degree of instability demonstrated by ultrasound. The comparison showed the clinical diagnosis to be highly inaccurate.

Håkan Dahlström
Lars Öberg
Sven Friberg

Departments of Orthopedics and Diagnostic Radiology, University of Umeå, S-90 185 Umeå, Sweden

A prerequisite for sonographic diagnosis is that the tissues examined have a sound transmitting ability resembling that of water. Mineralized bone reflects and absorbs almost all of the sound waves and can only be detected, but not examined, with ultrasound. Cartilage, on the other hand, allows transmission of sound waves. Thus, ultrasound constitutes a method for examination of the hip joint in infants before the mineralization process has progressed too far.

Different methods for ultrasonic examination of the anatomy of the hip joint in infants were used by Graaf (1983), Novick et al. (1983), and Harcke et al. (1984). In addition to clinical examination for detection of congenital dislocation of the hip (CDH), Dahlström et al. (1984) described a technique for ultrasonic examination of the dynamics of the joint.

We have used an anterior approach (Dahström et al. 1984) for ultrasonic diagnosis of CDH in neonates and infants and present a technique for the demonstration of the actual degree of instability of the hip joint. We have correlated the sonographic results with clinical examinations of the hips.

Patients and methods

From the total material of ultrasonic examinations of the hip joint in infants, 216 consecutive examinations in 108 newborn children (<30 days old) were evaluated. All patients were admitted by experienced pediatricians for suspected instability of one or both hip joints. Treatment with abduction splintage was used only in hips shown by sonographic examination to be unstable or possible to dislocate. Exceptions to this rule were 4 children who were treated in spite of a normal sonographic examination. They were all investigated when our experience of the technique was limited, and the indications for treatment were based on the physical examination solely. All infants not treated (n = 62) were reexamined by clinical and ultrasonic examinations 4 weeks after the initial diagnosis. These children were then reexamined clinically at the child health care center at routine intervals up to an age of 18 months. The median follow-up period was 12 (5–25) months.

A Technicare Auto sector scanner, with a 7.5 MHz transducer, was used. The transducer was applied directly to the skin surface using gel as the couplant. The anatomy was documented on film and the dynamic study on video tape.

The patient was placed in the supine position on a firm mattress. An existing abduction splint was not necessarily removed, but merely opened up in front. The transducer was placed anterior to the hip joint and centered over the femoral head with the sound beam sector parallel to the femoral neck (Figure 1). The position of the infant and transducer produced sonograms depicting a longitudinal section of the femoral neck and head and a horizontal section of the acetabulum.

Instability of the hips was examined according to Barlow (1962). This maneuver was chosen because it left the groin accessible to the transducer. The criterion for instability was a provoked subluxation of the femoral head exceeding 20 per cent of its diameter. Complete dislocation was considered to be present when the subluxation of the head exceeded 50 per cent of its diameter.

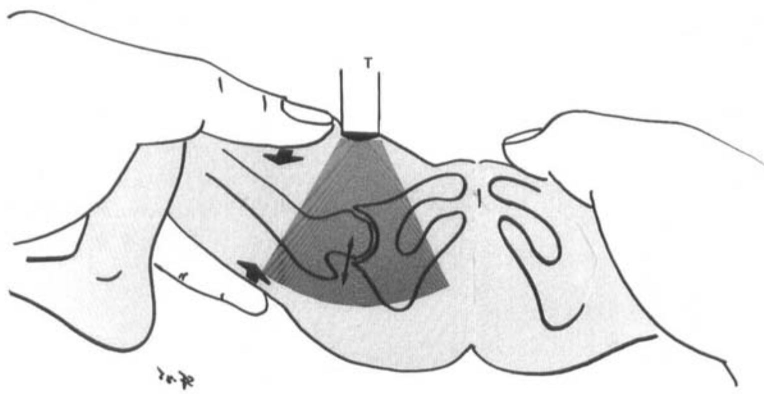


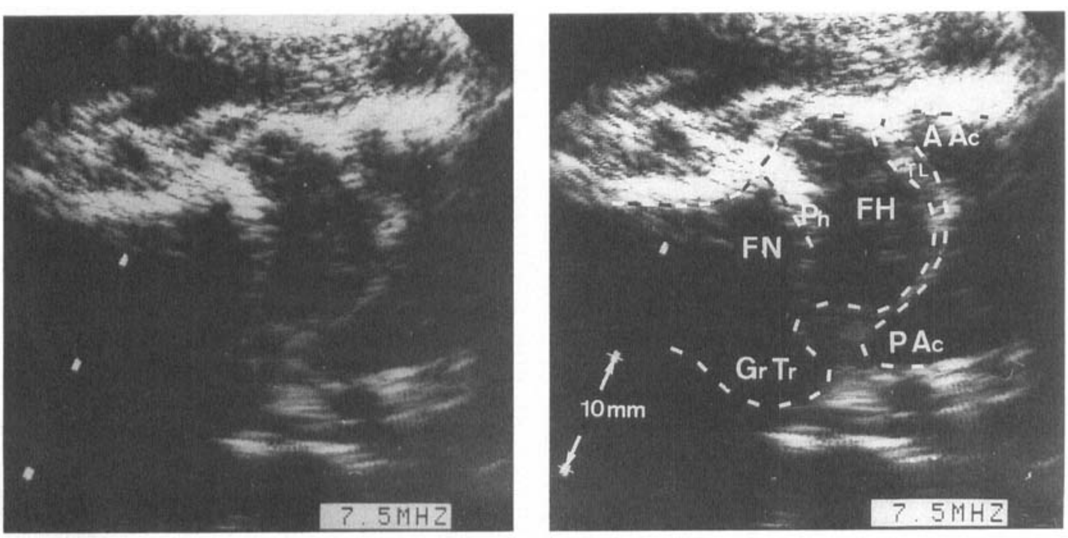
Figure 1. Position of the child and the transducer (T) during the sonographic examination. The plane of the sound beam sector in relation to the structures of the hip joint is shown. The Barlow maneuver for detection of hip instability is indicated by arrows.

Results

Ultrasonic findings. The femoral head was always identified and well defined as a circular area surrounded by a white zone representing the surface echoes of the cartilage (Figure 2). If no calcified nucleus was present, the entire femoral head was visualized. A small nucleus resulted in a negligible shadow. With increasing size of the nucleus, information concerning the deeper structures of the joint was lost (Figure 3). Because of the position of the patient, the central fovea was located in the anterior part of the head.

Lateral to the femoral head and perpendicular to the longitudinal axis of the femoral neck, a strong linear echo was found. This echo represented the boundary between the noncalcified epiphysis and the metaphysis (Figure 2).

The calcified femoral neck produced a marked linear echo on the sonogram (Figure 2). This echo became slightly arched as it continued distally into the proximal part of the diaphysis of the femur. Because the children were examined in the frog position, the echo allowed an estimation of the varus-valgus angulation of the femoral neck. The anteversion



A

B

Figure 2. A. The sonographic image of the right hip in a 2-month-old infant produced by the anterior approach of the sound sector. B. The sonogram is identical to A. The structures of the hip joint are indicated. FH = femoral head, FN = femoral neck, Ph = physis, Gr Tr = greater trochanter. AAc = anterior acetabular edge. PAc = posterior acetabular edge. TL = teres ligament.

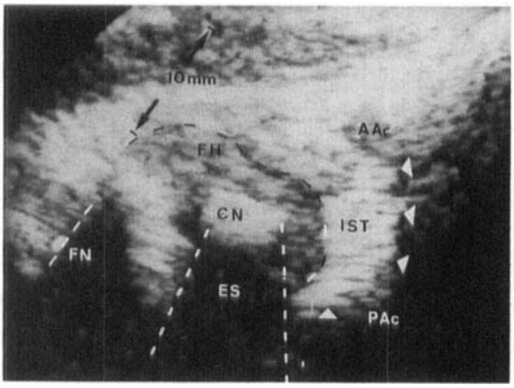


Figure 3. Sonographic image of the right hip of a recently reduced, late discovered dislocation in a 5-month-old girl. The calcified nucleus and the lateralization are visualized. FH = femoral head, FN = femoral neck, CN = calcified nucleus, ES = echo shadow, AAc = anterior acetabular edge, PAc = posterior acetabular edge, IST = interposing soft tissues. Arrows outline the acetabulum.

of the neck could be estimated with the hips extended.

The acetabulum was easily identified when the femoral head was in the normal position. The joint space was well defined. The anterior edge of the fossa was always demonstrated (Figure 2). Provided there was no calcified nucleus in the epiphysis, the entire posterior edge of the acetabulum was visualized below the femoral head. In the dislocated hip joint the empty acetabulum was always identified.

The degree of instability could be estimated during the investigation or measured by analysis of the video recording. During dislocation an echo appeared between the two parts of the joint. The anterior rim of the acetabulum and an echo interpreted as the joint capsule followed the femoral head in the dorsal direction. The Ortolani sign was present only when 50 per cent or more of the diameter of the femoral head slipped over the posterior edge of the acetabulum (Figures 4 and 5). A calcified nucleus did not disturb the evaluation of existing instability.

Clinical versus ultrasonic diagnosis

Sixty-three per cent of the hip joints considered unstable or possible to dislocate at the clinical evaluation were found to be stable at the ultrasonic examination (Table 1). In the group of clinically stable joints, 11 per cent were found by ultrasound to be unstable and 9 per cent were possible to dislocate.

Six-two hips considered stable and therefore not treated were all normal at the examination 4 weeks later. In this group the succeeding examinations at the child care centers have not disclosed any further hip abnormalities.

Discussion

The introduction of clinical examination (Ortolani 1948, Barlow 1962) of the hip joint as a routine procedure in all neonates (von Rosen 1957) was expected to eliminate the presence of late discovered CDH (McCarroll 1965). This hope has not been fulfilled. Despite the efforts to detect the disease during the first days of life, the number of patients with a late diagnosis of CDH has not decreased to an acceptable level (Bjerkreim 1974, Thompson & Rang 1980, Palmén 1984).

A definite need exists for a reliable method to study the structures and stability of the hip joint in newborn children and infants. The method must be suitable for screening examinations and must be easily performed and harmless for the child.

Hip radiographs below the age of 2–6 months are difficult to interpret because of the lack of mineralization of the joint structures (Mitchell 1963, Barlow 1968, Smaill 1968, Huffam 1970, MacKenzie 1972, Lemperg et al. 1973, Visser 1984). Arthrography is presently considered to be the radiographic examination with the highest degree of reliability (Mitchell 1963, Almby & Lönnerholm 1978, Ishii et al. 1980, Visser 1984). However, arthrography is

Table 1. The relation between the clinical examination and the ultrasonic diagnosis in CDH

Clinical examination	Ultrasonic diagnosis		
	Stable	Unstable	Dislocation
Stable	65	9	7
Unstable	65	11	12
Dislocation	20	6	21
Total	150	26	40

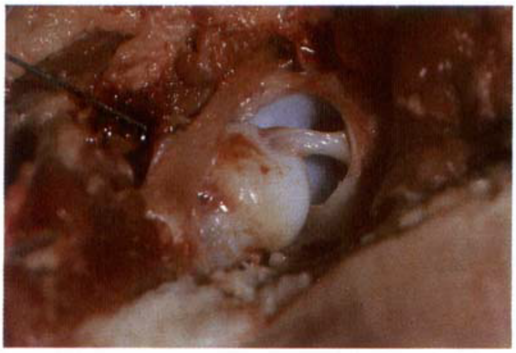


Figure 4. Autopsy specimen demonstrating the structures of the right hip joint after dislocation produced by the Barlow maneuver. The view of the hip corresponds to the ultrasonic projection.

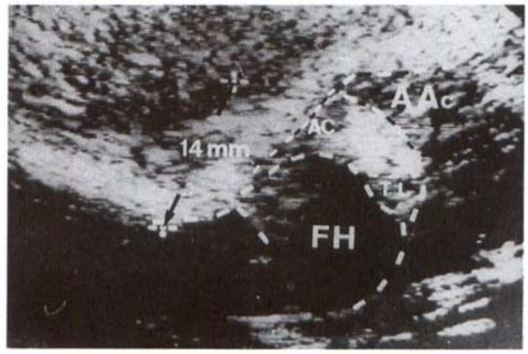


Figure 5. Sonographic image illustrating a dislocating right hip joint in a newborn infant. FH = femoral head, AAc = anterior acetabular edge, AC = anterior joint capsule, TL = teres ligament.

invasive with an inherent risk of complications, the dose of radiation is not negligible, and the method demands general anesthesia.

Ultrasonic investigation of the noncalcified hip joint can visualize both the anatomy and the dynamics of the unstable hip joint in infants. In our study the transducer was placed in the groin anterior to the hip. The sonographic projection will then coincide with the direction of existing instability. With this application, provocation of the hip according to Barlow was easily performed during the investigation. Graaf (1983, 1984) used a lateral application of the transducer producing a sonogram corresponding to an AP radiograph. This application does not allow a closer study of existing instability. The medial approach suggested by Novick et al. (1983) can visualize the movements of the femoral head during provocation, but the actual relationship of the head to the acetabulum cannot be interpreted.

For determination of the position and stability of the femoral head, ultrasonic examination seems to be the method of choice in infants with a nonexisting or small calcified nucleus. As the calcification of the epiphyses proceeeds, ultrasonic investigation will become more inconclusive and radiography will finally supersede ultrasound as the method of choice for depiction of the hip joint.

Our investigation showed that major discrepancies existed between the clinical diagnosis and the actual degree of instability found at the ultrasonic examination. In general, the clinical examination resulted in a larger number of children being suspected of having instability or dislocation than was demonstrated by the ultrasonic investigation. This is in agreement with the experience that the number of treated children far exceeds the expected number of CDH (Hiertonn & James 1968). It was more serious that in the group of hips clinically diagnosed as stable or unstable, but not possible to dislocate, the ultrasonic examination demonstrated that 11 per cent of the hips could be dislocated. This discrepancy showed that the diagnostic accuracy of the clinical examination must be seriously questioned. Further, the findings provide a possible explanation of the relatively high frequency of late discovered CDH.

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