Ultrasonography and radiography of the hip in infants

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Both hip joints in 156 children, aged 2 months to 2 years, were examined by ultrasonography (ultrasound) and radiography. Pathologic findings were based on an increased acetabular index, bony defects of the lateral acetabular rim, and lateral and/or proximal displacement of the proximal femur. Each hip was classified as normal, dysplasia, subluxation, or dislocation. The same diagnosis was reached by ultrasound and radiography in 303 of the 312 hips. The accordance was good in normal joints, in subluxation, and in dislocation. However in 7 of the 15 hips with radiographic dysplasia, ultrasound was normal. These patients were not treated, and spontaneous normalization or improvement occurred in all of them. One parameter only, the distance from the lateral margin of the ossification center of the femoral head to Perkins' line, was measured by both ultrasound and radiography; the correlation was high ($r = 0.73$). We recommend ultrasound as the primary imaging technique when congenital dislocation is suspected clinically.

Radiographically, congenital dysplasia and dislocation of the hip joint (CDH) have been divided into three subgroups: dislocation, subluxation, and dysplasia. However, radiographs of the hip joints of children in the first months of life may be difficult to assess, and the limits between the subgroups usually have been based on subjective evaluation (Bjerkreim 1974, Palmén 1984, Visser 1984). Consequently, different authors may have used somewhat different criteria.

Ultrasonography (ultrasound) was introduced in the diagnosis of CDH by Graf (1980). Although criteria for pathologic ultrasound findings have been proposed by Graf (1984), others have found his measuring method somewhat unreliable or difficult to use in clinical practice (Morin et al. 1985, Zieger et al. 1986, Niethard and Roesler 1987). In addition, little is known about the correlation between pathologic findings by radiography and ultrasound.

Whether radiography or ultrasound is used to assess the hip joints in infants and children, defined limits between normal and dysplastic hips, as well as between the various subgroups of pathology, are desirable. A classification is necessary when the frequency of late-diagnosed CDH in different studies is compared, and such studies are useful as a test for the effectiveness of the neonatal screening. Defined diagnostic criteria are also useful when comparing the results of treatment between various patient series.

The aims of our study were to establish reliable diagnostic criteria by ultrasound and radiography for normal and pathologic hip joints after the newborn period, and to evaluate the correlation between the two methods.

Patients and methods

The hip joints of 288 consecutive children in the age range 2–23 months were examined during 1986 and 1987. However, 132 children were excluded from the present study because of the following reasons:

1. Radiography was omitted in 65 children because they had normal clinical and ultrasound findings.
2. The radiograph was taken with the child incorrectly positioned in 18 cases, including an index of pelvic rotation below 0.56 or above 1.8 (Tönnis 1976) in 10 cases, and abduction of one or both legs of more than 10° in 8 cases.

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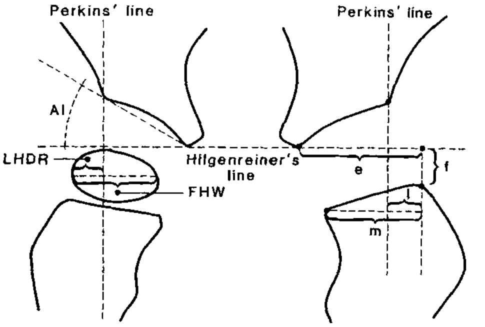

Figure 1. Radiographic measurements. In the right hip, the acetabular index (AI), the lateral head distance (LHDR), and femoral head width (FHW) are indicated. In the left hip, the distances e, f, l, and m are shown.

3. An ultrasound image for documentation was not obtained in 45 children because of normal findings by visual impression during the ultrasound examination.

4. Neurologic disorders in 4 children.

Thus, the material comprised 312 hips in 156 children with available radiographs and ultrasound images. There were 117 girls and 39 boys with a mean age of 8.2 months. The children were divided into the following groups:

Group 1. Age 2–5 months (42 girls, 10 boys).

Group 2. Age 6–11 months (48 girls, 20 boys).

Group 3. Age 12–23 months (27 girls, 9 boys).

Forty-six children had been treated with a Frejka pillow for 4 months because of neonatal hip instability, and they were examined after the treatment had been completed. The others were referred because of familial occurrence of CDH (33 children) or because of clinical suspicion of the disease. The most frequent reasons for referral were restricted or asymmetric hip abduction (31 children), asymmetric skin folds (18 children), and an externally rotated leg (12 children).

Radiography

With the child supine, a conventional anteroposterior radiograph of the pelvis, including both hips, was obtained. The radiographic classification was based on measurements of distances and angles of the hips (Figure 1). Hilgenreiner's line was drawn at the inferior margin of the acetabular roof. Perkins' line was drawn from the most lateral point of the acetabular roof perpendicular to Hilgenreiner's line. The medial and lateral margins of the proximal femoral metaphysis were marked, and vertical lines were drawn through the lateral points. The acetabular index (AI) was measured according to Kleinberg and Lieberman (1936). In hips where the ossification center of the femoral head had appeared, the distance from the lateral tangent of the ossification center to Perkins' line (lateral head distance, LHDR) was measured, as was the width of the ossification center (femoral head width, FHW) parallel to Hilgenreiner's line. When the whole ossification center was medial to Perkins' line, LHDR was given a minus sign. When the FHW was above 10 mm, the migration percentage (MP) was calculated according to the formula LHDR/FHW x 100 (Reimers 1980); this expresses the percentage of the femoral head lateral to Perkins' line. The distance from the lateral margin of the metaphysis to Perkins' line (l) and the width of the metaphysis parallel to Hilgenreiner's line (m) were measured, and the metaphyseal percentage (MEP), l/m x 100, was calculated; this expresses the percentage of the metaphysis lateral to Perkins' line. In addition, the vertical distance from the lateral metaphysis to Hilgenreiner's line was measured (f), as was the distance along Hilgenreiner's line from the lateral metaphysis to the inferior bony margin of the acetabular roof (e).

Based on these measurements every hip was classified as normal, dysplasia, subluxation, or dislocation (Table 1). Dysplasia involved a high acetabular

Table 1. Radiographic criteria for three subsets of CDH

Dysplasia	Subluxation	Dislocation
1. Bony defect of lateral acetabular rim, or flattened rim 2. Acetabular index ≥32° at 2–11 months, and ≥30° at 12–23 months	1. Metaphyseal percentage (MEP) > 70 at 2–5 months, > 60 at 6–11 months, and > 50 at 12–23 months 2. Distance e above upper normal limit, or f below lower normal limit 3. Unilateral cases: Side difference in e or f > 3 mm Two of the three criteria must be present	1. MEP >100 2. Unilateral cases: Side differences in e or f > 7 mm

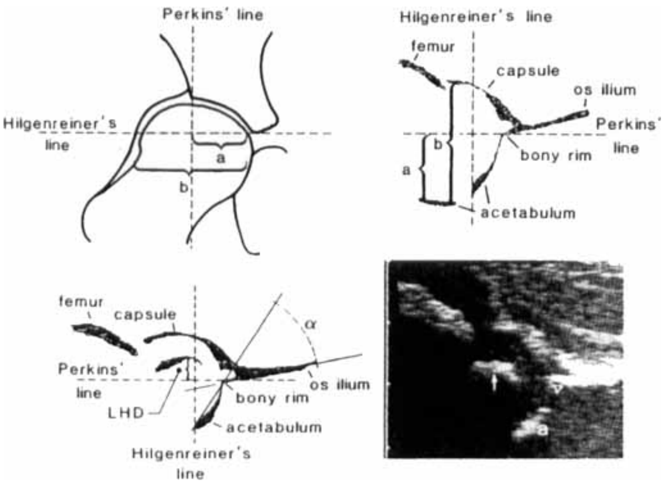

Figure 2. Ultrasound measurements. Upper left: the distances a and b as they would appear with femur distally and pelvis proximally. Upper right: the distances a and b as they appear by ultrasound. The femur and pelvis are rotated 90° compared with the upper left figure. Lower right and left: ultrasound picture and schematic drawing of a hip with visible ossification center of the femoral head (↑). The lateral head distance (LHD) and the α-angle are indicated. △ Lateral bony rim of the acetabular roof; a acetabulum.

index and bony defects of the lateral acetabular rim. Subluxation involved lateral and/or proximal displacement of the femoral head and the metaphysis. Dislocation was diagnosed when the whole metaphysis was lateral to Perkins' line.

Ultrasound

Real-time ultrasound was performed with a sector or linear transducer of 5 MHz (Sonoline SL-1, Siemens, Erlangen, West Germany). Ultrasound was always done before the radiographs were seen in order not to let the radiographs influence the ultrasound evaluation.

The child was in the supine position. With the transducer placed on the lateral aspect of the hip region, longitudinal and transverse scans were taken. The examiner held the transducer with one hand and the leg of the infant with the other. Initially, a dynamic impression of the hip stability was obtained by passively moving the leg into various positions. However, since the aim was to compare ultrasound and radiographic measurements in the neutral position, the results of the dynamic evaluation were not included in the present report.

The longitudinal scan, only, was used for the measurements. It was aimed at keeping the transducer parallel to the long axis of the body of the child. The leg was slightly flexed to visualize the femoral neck, and in the neutral position regarding rotation and abduction/adduction. No force was applied to push the leg in any direction.

The position of the femoral head in relation to the acetabulum was assessed. When no ossification center had appeared (Figure 2) or when this center was very small, the distance from the floor of the acetabulum to the lateral bony rim of the acetabulum was measured (*a*), as was the distance from the same

Table 2. Ultrasound criteria for the three subsets of CDH

Dysplasia	Subluxation	Dislocation
1. Bony defect of lateral acetabular rim, or rounded bony rim 2. Bony rim percentage (BRP) 40–50 3. α-angle below 50°	1. Bony defect of lateral acetabular rim or rounded bony rim 2. BRP 10–40 3. Lateral head distance (LHD) 5–10 mm at 2–5 months, 6–10 mm at 6–11 months, and 7–12 mm at 12–23 months	1. BRP < 10 2. LHD > 10 mm at 2–11 months and > 12 mm at 12–23 months
Criterion 1 must always be present. One of criteria 2 and 3 must be present	Two of the 3 criteria must be present	Criterion 1 is used only if the ossification center of the femoral head has not appeared

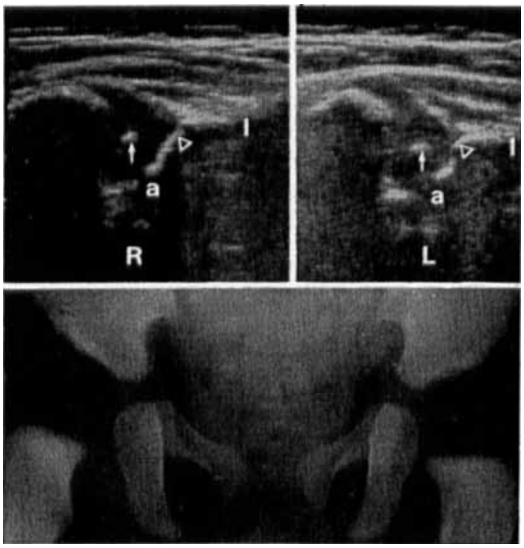

Figure 3. Ultrasound pictures and radiograph of dysplasia of the right hip (R) in a girl 5 months of age. The acetabular index is increased and there is a bony defect of the lateral acetabular rim. I os ilium; other labels as in Fig. 2. The left hip (L) is normal.

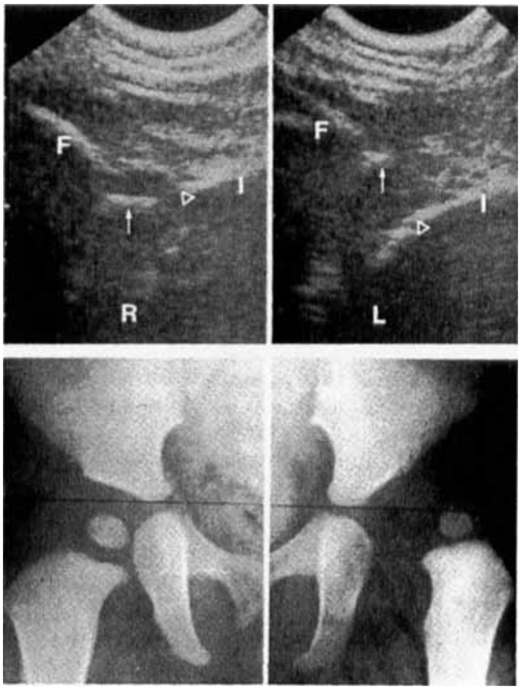

Figure 4. Ultrasound pictures and radiograph of dislocation of the left hip (L) in a girl aged 9 months. F femur, I os ilium; other labels as in Figure 2. The femoral head is laterally and proximally dislocated, and there are bony defects of the lateral acetabular rim. The right hip (R) is normal.

point of the acetabular floor to the lateral joint capsule (*b*). Both measurements were taken along a line perpendicular to the long axis of the transducer and thus parallel to Hilgenreiner's line when the transducer was correctly positioned. The bony rim percentage (BRP) was calculated as a/b x 100; this expresses the percentage of the femoral head covered by the bony acetabulum. In cases with subluxation or dislocation, the floor of the acetabulum is difficult, or impossible, to define, and the measurements were then taken from the medial tangent of the femoral head.

In patients where the ossification center of the femoral head had appeared, the distance from the lateral tangent of the bony nucleus to the lateral bony rim of the acetabular roof (lateral head distance, LHD) was measured along a line perpendicular to the long axis of the transducer (Figure 2). LHD corresponds to LHDR by radiography, and is an indirect expression of the acetabular coverage of the femoral head. When the whole ossification center was medial to the lateral acetabular rim, the LHD was given a minus sign.

In addition to these measurements, the shape of the lateral bony rim of the acetabular roof was assessed, whether it was sharp and angulated, rounded, or had bony defects. In cases where the α-angle of Graf (1984) could be measured accurately, this was used to assess the slope of the acetabular roof.

The ultrasound measurements provided the basis for classification (Table 2) as dysplasia (a steep acetabular roof and bony defect of the lateral rim of the acetabulum, Figure 3), or subluxation and dislocation (lateral displacement of the femoral head, Figure 4).

Statistics

In order to evaluate the intraobserver and interobserver variation, the ultrasound measurements of BRP and LHD were made twice by the same observer in 48 hips of 24 infants, and by independent measurements by two different observers in 24 hips of 12 infants. The mean, range, and standard deviation (SD) of the differences were calculated.

The Student's *t*-test was used to calculate the differences between groups. The differences were considered significant at *P*-values below 0.05. The correlation coefficient (*r*) was employed for evaluation of the correlation between the various parameters by ultrasound and radiography.

Table 3. Radiographic measurements of normal and pathologic hip joints. For the normal hips, the limits of normal variation (mean plus or minus 2 SD) are given

	Normal (n 286)			Dysplasia (n 15)	Subluxation (n 6)	Dislocation (n 5)
Age (months)						
Mean	4	8	14	7	8	10
Range	2–5	6–11	12–23	3–23	3–21	6–15
Acetabular index						
Mean	24	24	23	35	33	38
Mean + 2 SD	33	32	30			
LHDR						
Mean	–1	0	1	3	8	13
Mean + 2 SD	3	5	7			
MP						
Mean		8	10			
Mean + 2 SD		45	38			
MEP						
Mean	36	29	25	55	81	115
Mean + 2 SD	61	53	46			
Distance *e*						
Mean	18	20	22	20	25	28
Mean + 2 SD	22	24	26			
Distance *f*						
Mean	10	10	10	8	6	2
Mean – 2 SD	6	7	7			

Acetabular index (degrees); LHDR lateral head distance by radiography (mm); MP migration percentage; MEP metaphyseal percentage.

Results

Radiography

The radiographs of both hips were normal in 131 children. Twenty-four girls and 1 boy had unilateral (24 cases) or bilateral (1 case) hip pathology. The numbers of hips classified as having dysplasia, subluxation, and dislocation were 15, 6, and 5, respectively (Table 3).

In the normal hips, there were no differences in acetabular index between the age groups. The lateral head distance was in the range –2 to 2 mm in most normal hips (Figure 5), but increased from the youngest age group to the medium one ($P = 0.002$), and from the latter group to the oldest one ($P < 0.001$). The mean migration percentage was 8–10 in normal hips, and did not change with age; the upper normal limit was approximately 40.

The metaphyseal percentage was smaller in the medium age group when compared with the youngest infants ($P < 0.001$), and it was further reduced in the older children ($P = 0.02$). The upper normal limit decreased from 60 in the youngest infants to 45 in the oldest group.

The distance *e* of normal hips increased with increasing age ($P < 0.001$). The upper normal limits of the three age groups were 22, 24, and 26 mm. The mean value of the distance *f* in normal hips was 10 mm, and no differences with increasing age occurred.

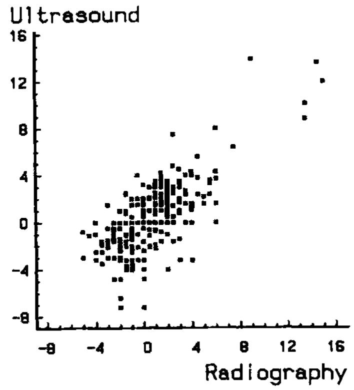

Figure 5. The relation between the lateral head distance (mm) by ultrasound (LHD) and radiography (LHDR) in hips with visible ossification centers by both methods.

In dysplastic hips, all the radiographic parameters except the distance *l* differed from those of normal hips. The acetabular index, lateral head distance and metaphyseal percentage were increased, whereas the distance *f* was decreased ($P < 0.001$ for all the parameters).

Table 4. Ultrasound measurements of normal and pathologic hip joints. In normal hips, the limits of normal variation (mean plus or minus 2 SD) are given

	Normal (n 293)			Dysplasia (n 7)	Subluxation (n 8)	Dislocation (n 4)
Age (months)						
Mean	4	8	14	8	8	10
Range	2–5	6–11	12–23	4–24	3–21	6–15
BRP						
Mean	64	62		48		
Mean – 2 SD	50	52				
LHD						
Mean	–1	0	1	3	8	12
Mean + 2 SD	3	4	5			
α-angle						
Mean	59	61	61	46	46	
Mean – 2 SD	47	51	49			

BRP bony rim percentage; LHD lateral head distance (mm); α-angle (degrees).

In subluxation the lateral head distance, metaphyseal percentage, and distance *e* were increased as compared with the dysplastic hips ($P < 0.001$ for all the parameters). The distance *f* was smaller than in normal hips ($P < 0.001$), but did not differ from that of dysplastic hips. There were no differences in acetabular index between dysplasia, subluxation and dislocation.

In the dislocated hips, the lateral head distance and metaphyseal percentage were greater than in those with subluxation ($P = 0.04$ and 0.001, respectively).

The lateral rim of the acetabular roof was flattened or had bony defects in all the pathologic hips.

Ultrasound

Both hips of 137 children were normal by ultrasound (Table 4). Pathologic hips occurred in 19 children, all girls and unilateral. The number of hips with dysplasia, subluxation, and dislocation were 7, 8, and 4.

The bony rim percentage could be measured in the youngest age groups only, and there was no difference between normal hips of the two groups; the lower normal limit was approximately 50 percent. The mean lateral head distance of normal hips was in the range –2 to 2 mm in most cases (Table 4, Figure 5). It was greater at 6–11 months of age than at 2–5 months ($P < 0.001$), and it was further increased at 12–23 months of age ($P < 0.001$). The upper normal limit increased from 3 mm in the youngest infants to 5 mm in the oldest. The mean α-angle was approximately 60°, and no differences

Table 5. The relation between ultrasound and radiographic diagnosis, expressed as the number of hips in each group

	Radiography			
	Normal	Dysplasia	Subluxation	Dislocation
Ultrasound				
Normal	286	7		
Dysplasia		7		
Subluxation		1	6	1
Dislocation				4

with increasing age occurred; the lower normal limit was about 50° irrespective of age.

The dysplastic hips had a lower bony rim percentage, greater lateral head distance, and smaller α-angles than normal hips ($P < 0.001$, $P = 0.002$, and $P < 0.001$, respectively). The lateral head distance in subluxation was increased compared with dysplasia ($P < 0.001$), and it was further increased in dislocation ($P < 0.001$). The α-angle was smaller in subluxation compared with normal hips ($P < 0.001$), whereas no difference between subluxation and dysplasia occurred.

In all the pathologic hips, the lateral bony rim of the acetabular roof was rounded or had bony defects, while it was sharp and angulated, or only slightly rounded in normal hips.

Correlation ultrasound/radiography

There was a good agreement between the methods (Table 5), as the same diagnosis was reached in 303

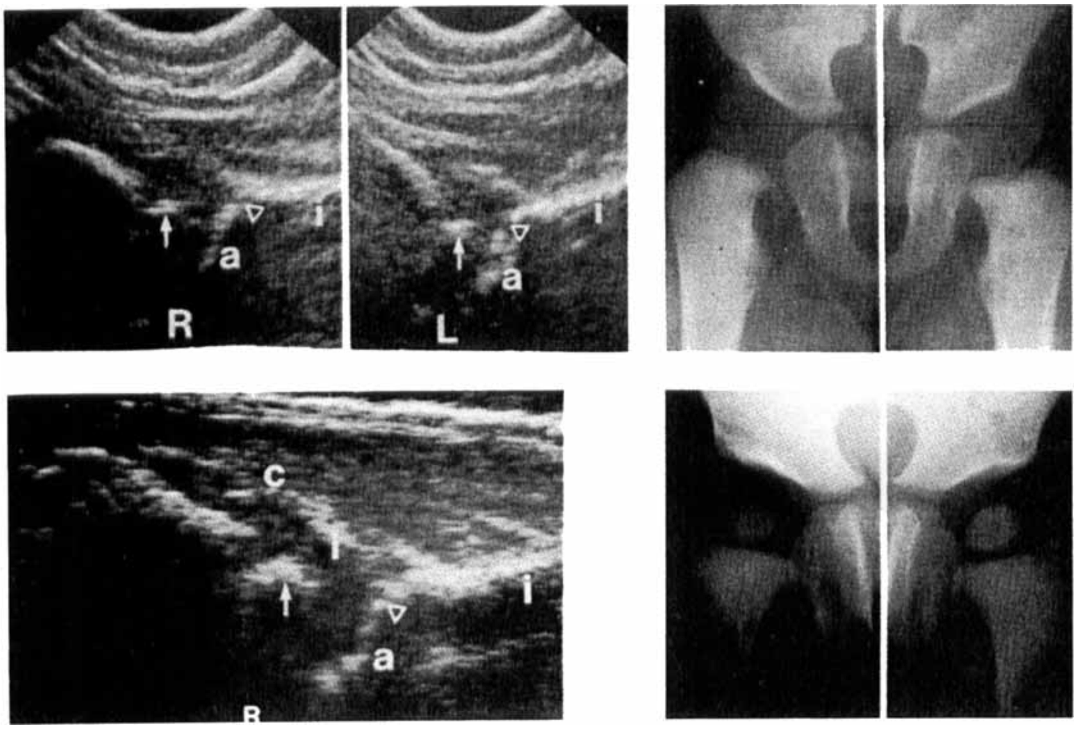

Figure 6. Upper left and right: ultrasonograms and radiograph of a girl aged 5 months. Radiography shows dysplasia of the right hip, whereas ultrasound shows normal right (R) as well as left (L) hip. Lower left and right: without any treatment the right hip normalized, as is seen on the radiograph and sonogram 1 year later. i os ilium; c lateral joint capsule; l labrum; other labels as in Figure 2.

Table 6. Correlation coefficients (*r*) between various ultrasound and radiographic parameters. Only correlations with a significance level below 0.001 are included

	Ultrasound		Radiography				
	LHD	α-angle	AI	LHDR	MEP	*e*	*f*
BRP	−0.80	0.49	−0.52	−0.59	−0.50	−0.30	
LHD		−0.44	0.48	0.73	0.49	0.56	−0.37
α-angle			−0.55	−0.44	−0.53		0.37

BRP bony rim percentage; LHD lateral head distance; AI acetabular index; LHDR lateral head distance by radiography; MEP metaphyseal percentage.

Correlation ultrasound/radiography

There was a good agreement between the methods (Table 5), as the same diagnosis was reached in 303 of the 312 hips (97 percent). All the pathologic hips by ultrasonography were also pathologic by radiography. Two of the nine hips with a discrepancy were subluxated by ultrasound, whereas the radiographic diagnosis was dysplasia in one hip and dislocation in the other. The other seven hips with a discrepancy were dysplastic by radiography, while the ultrasound findings were normal. These 6 children (1 with bilateral dysplasia) were not given any treatment. They have been followed up for 1–2 years, and spontaneous radiographic normalization in six hips (Figure 6) and improvement in one hip have occurred.

One parameter only, the lateral head distance (LHD and LHDR), was measured by both methods (Figure 5), and the correlation coefficient was 0.73. The discrepancy ranged from 0 to 7 mm, and the mean (SD) discrepancy was 1.6 (2.1) mm.

ic parameters, except for BRP/distance f and α-angle/distance e.

The reproducibility of the ultrasound measurements of the bony rim percentage and lateral head distance was good, as the mean intraobserver variation was 2.6 (0–7) percent, SD 1.9 for BRP, and 0.6 (0–2) mm, SD 0.5 for LHD.

The mean interobserver variation with regard to the BRP was 2.7 (0–6) percent, SD 1.8, and to the LHD 0.9 (0–2) mm, SD 0.5. Accordingly, a 95 percent confidence interval for an unknown value based on a single measurement equals the measured value ± 3.6 percent for the bony rim percentage and ± 1 mm for the lateral head distance.

Discussion

Radiographs of the hip joints in infants, especially in the first 3 to 4 months, are often difficult to assess because of immature bony structures, technically inferior radiographs, and improper positioning of the child. Thus, the evaluation is, to a great extent, subjective. Pelvic rotation and tilt influence the acetabular index (Tönnis 1976), and external rotation of the legs may lead to the misdiagnosis of subluxation (Blank 1981). In order to make the classification less dependent on such factors, we preferred a system based on several parameters rather than one only. Our classification might seem time-consuming and cumbersome, but this is not the case. The points and lines of reference are easily drawn in most cases, and all the measurements of both hips rarely take longer than 5 minutes.

In pathologic hip joints, the lateral bony rim of the acetabular roof may be impossible to localize exactly because the bony defects make the roof steep and the rim flattened. In unilateral cases, Perkins' line can be drawn by using the same width of the acetabular roof as that of the contralateral hip (Figure 1, e minus l).

While Kleinberg and Lieberman (1936) considered an acetabular index above 30° in newborns and infants as pathologic, others have found this limit too narrow. According to Caffey et al. (1956) and Tönnis (1976), the upper normal limit is approximately 33° in girls at 5–6 months of age and 30° at 12 months. These values correspond well with those of our normal hips.

According to many authors, the diagnosis of hip dysplasia cannot be based solely on a high acetabular index (Caffey et al. 1956, Laurenson 1959, Komprda 1984). The lateral rim of the acetabulum is an important parameter, as bony defects of the rim or a flattened rim are indicative of dysplasia (Hilgenreiner 1925, Pratt et al. 1982, Komprda 1984). This is in agreement with our pathologic hips, which all showed more or less impressive changes of the acetabular rim.

The migration percentage is less reliable as a diagnostic parameter in the first year of life because the ossification center is often very small. Besides, it may be eccentrically placed in the femoral head and moves laterally with external rotation of the leg (Blank 1981). So, we included the metaphyseal percentage in the measurements. This value is increased by external rotation and abduction of the leg, which was the reason why we used such ample upper normal limits as 70 percent at age 2–5 months and 60 percent at 6–11 months.

The distances e and f are equivalent to, but not identical with the distances d and h introduced by Hilgenreiner (1925). While he used the midpoint of the proximal femur, often corresponding with the highest point of the metaphysis, we used the most lateral point of the metaphysis, i.e., the transition between the metaphysis and the lateral femoral neck. This point usually corresponds to the highest point of the metaphysis, and thus Hilgenreiner's h corresponds well with our values of f. The upper normal limit of d according to Hilgenreiner (1925) is less than our distance e. The discrepancy is probably due to different reference points.

When ultrasound is used for assessing hip joints in infants, the classification of Graf (1984) is the most widely used (Schuler and Rossak 1984, Casser and Forst 1985, Berman and Klenerman 1986, Dorn and Hattwich 1987). This is based on measurements of two angles: the bony roof angle (alpha) and the cartilage roof angle (beta). However, the reference points, on which these angles are based, are not always clearly depicted; thus, various authors have found the method difficult or impractical (Morin et al. 1985, Zieger et al. 1986, Brandstetter et al. 1987, Suzuki et al. 1987). Especially the beta angle has proven unreliable (Zieger et al. 1986, Brandstetter et al. 1987). In addition, measurements of angles on sonograms are attended with an error of no less than 10°, according to Niethard and Roesler (1987); they felt that measurements of angles were not more useful than qualitative assessment oriented on the lateral bony rim and the cartilaginous rim of the acetabular roof. Other measuring methods have been proposed by Morin et al. (1985), Dahlström et al. (1986) and Suzuki et al. (1987).

Our choice of method of ultrasound measurement was based on the fact that the position of the femoral head in relation to the acetabulum is the most important parameter (Terjesen et al. 1988); the method was applicable to all age groups.

The bony rim percentage is an expression of the femoral head coverage by the bony roof of the acetabulum. This might be called the "head coverage," but this term was used by Morin et al. (1985), who used another line through the lateral acetabular rim than we did. Our reference line was parallel to the baseline of the ultrasound image, while theirs was a tangent to the distal part of the lateral ilium. Because the outline of the lateral ilium is not always clearly depicted and because it is not a straight line but somewhat curved in many cases, our reference line is more clearly defined and thus easier drawn.

In infants where the ossified nucleus has appeared, the lateral head distance indicates the position of the nucleus related to the lateral bony rim of the acetabulum. This distance is the same as that measured on the radiographs, and thus represents a connection between the two methods; the values corresponded well in most normal as well as pathologic hip joints.

Changes of the bony rim of the acetabular roof by ultrasound was a reliable sign of hip pathology, which is in agreement with Niethard and Roesler (1987).

The good correspondence between ultrasound and radiography in normal hips and in hips with severe pathology confirmed the experience of Clarke et al. (1985). In radiographic dysplasia, however, the agreement was not so good. The fact that the dysplastic changes in hips with discrepancy spontaneously improved or normalized without treatment indicated that the ultrasound assessment was adequate. This corresponds with the experience of others that hips with radiographic dysplasia in many cases normalize spontaneously (Pratt et al. 1982, Heikkilä et al. 1985).

What are the consequences of the experience of the present study? Ultrasound has definite benefits compared with radiography, as it is not attended by exposure to radiation, as cartilage and soft tissues can be visualized, and as a dynamic evaluation of the hip joint in three planes is obtained. Our study showed that ultrasound was reliable in detecting hip pathology, which is consistent with our experience in newborns (Terjesen et al. 1989) and in children above 2 years of age (Terjesen et al. 1989). Thus, ultrasound is recommended as the primary imaging technique in clinical suspicion of CDH and in the routine control of infants with risk factors for CDH, and radiography might be replaced by ultrasound in most of the follow-ups after treatment for CDH.

Hip ultrasound should be performed by an examiner with adequate knowledge not only of ultrasound, but also of hip pathology and dynamics. We recommend that orthopedic surgeons who work with hip problems in children be provided with the necessary ultrasound equipment and education, and perform the ultrasound evaluation at the same time as the child is examined clinically. In cases with normal ultrasound findings, radiography can be omitted. In cases with obvious pathologic or uncertain findings by ultrasound, the evaluation should be supplemented by radiography. However, in order to gain experience, it seems advisable to use both methods during a period as was done in the present study.

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