

# Ultrasonography for diagnosis of slipped capital femoral epiphysis

## Comparison with radiography in 9 cases

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In 7 of 8 patients with non-acute slipped capital femoral epiphysis, the slip was visualized by ultrasound. The mean epiphyseal displacement was 6.0 mm, measured on an anterior ultrasound scan. Grading of slip severity by ultrasound was consistent with the radiographic assessment. Two patients had a moderate hip joint effusion which did not affect the final outcome, whereas one patient with an acute slip had a pronounced effusion, and necrosis of the

epiphysis occurred. The anteversion angles of the affected hips were reduced as compared to those of the normal hips. It was concluded that ultrasonography was reliable in detecting pronounced and mild degrees of epiphyseal slips, whereas minimal slips could be missed. The detection of hip effusion is important because a tamponade may cause vascular impairment of the epiphysis, unless aspirated.

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Ultrasonography has proved useful in the diagnosis of hip disease in children (Graf 1984, Schuler and Rossak 1984, Kallio et al. 1985, Wingstrand 1986, Terjesen et al. 1991). However, apart from a recent study by Kallio et al. (1991), no reports have focused on the use of ultrasound in slipped capital femoral epiphysis (SCFE).

The aim of my study was to answer the following questions: 1) Is ultrasound reliable in the diagnosis of SCFE? 2) What additional information can be provided by ultrasonography in relation to conventional radiography in the evaluation and follow-up of the disease?

## Patients and methods

During the 4-year period 1987-1990, 9 children with SCFE have been treated in our department (Table 1). 8 patients had non-acute slipping with symptoms for 1-12 months before diagnosis and 1 boy had an acute slip after a fall at sports. Radiographs in the neutral position and in the frog-leg lateral position (Lauenstein projection) were assessed with regard to the grading of severity of epiphyseal displacement according to Wilson et al. (1965). Of the children with chronic disease, 5 had a mild slip (less than one third of the width of the epiphyseal plate), and 3 had a moderate slip (between one third and one half of the width). The

disease was bilateral with mild slipping of both hips in 2 cases. The boy with acute symptoms had a severe slip (more than one half of the epiphyseal width). On admission, all had a more or less pronounced reduction of hip mobility, especially internal rotation.

Table 1. Clinical, ultrasonic, and radiographic data in slipped capital femoral epiphysis. The ultrasound examination was performed preoperatively in the first 8 cases and one week postoperatively in Case 9

| A                                          | B | C  | D | E | F                              | G    | H   | I  | K  | L |
|--------------------------------------------|---|----|---|---|--------------------------------|------|-----|----|----|---|
| 1                                          | M | 13 | C | R | 0                              | 4.6  | 3.6 | 9  | 5  | 1 |
| 2                                          | M | 12 | C | L | 3                              | 3.2  | 4.0 | 0  | 6  | 1 |
| 3                                          | F | 12 | C | L | 8                              | 3.0  | 4.0 | 4  | 23 | 2 |
| 4a                                         | M | 12 | C | R | 0                              | 4.0  |     | 16 |    | 1 |
| 4b                                         |   |    |   | L | 4                              | 3.0  |     | 14 |    | 1 |
| 5                                          | M | 12 | C | R | 10                             | 5.6  | 3.0 | 11 | 23 | 2 |
| 6                                          | M | 13 | C | L | 10                             | 4.0  | 4.0 | 5  | 15 | 2 |
| 7                                          | M | 16 | C | L | 3                              | 5.0  | 4.7 | 3  | 13 | 1 |
| 8a                                         | M | 13 | C | R | 4                              | 6.2  |     | 15 |    | 1 |
| 8b                                         |   |    |   | L | 2                              | 3.8  |     | 12 |    | 1 |
| 9                                          | M | 11 | A | L |                                | 10.0 | 3.8 |    |    | 3 |
| A Case                                     |   |    |   |   | Anterior capsule distance (mm) |      |     |    |    |   |
| B Sex                                      |   |    |   |   | G affected hip                 |      |     |    |    |   |
| C Age                                      |   |    |   |   | H normal hip                   |      |     |    |    |   |
| D Duration of symptoms                     |   |    |   |   | Anteversion angle (degrees)    |      |     |    |    |   |
| A acute                                    |   |    |   |   | I affected hip                 |      |     |    |    |   |
| C chronic (> 3 wks)                        |   |    |   |   | K normal hip                   |      |     |    |    |   |
| E Side: R right, L left                    |   |    |   |   | L Radiographic slip            |      |     |    |    |   |
| F Anterior physeal slip by ultrasound (mm) |   |    |   |   | 1 mild                         |      |     |    |    |   |
|                                            |   |    |   |   | 2 moderate                     |      |     |    |    |   |
|                                            |   |    |   |   | 3 severe                       |      |     |    |    |   |

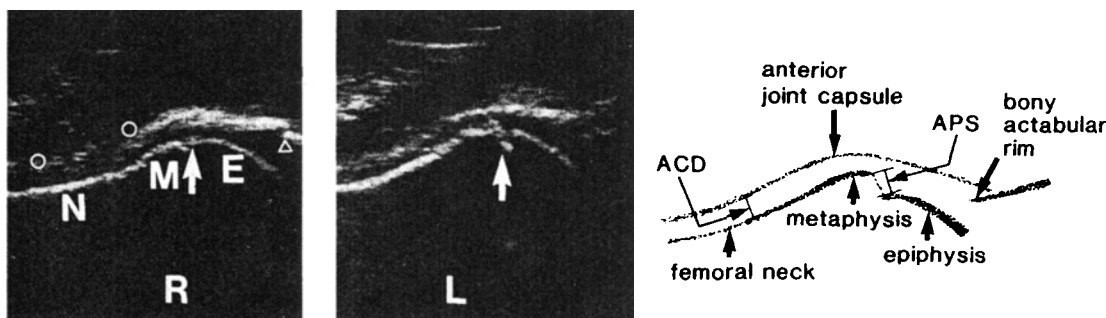


Figure 1. Anterior ultrasonograms of the normal right hip (R) and the left hip (L) with a mild physeal slip in a 12-year-old boy. On the schematic drawing of the left hip, the anterior physeal slip (APS) and the anterior capsule distance (ACD) are indicated. The ultrasonograms show the anterior outline of the femoral neck (N), the metaphysis (M), the epiphyseal plate (arrow), the anterior surface of the epiphysis (E) of the femoral head, the anterior bony acetabular rim (triangle), and the joint capsule (circles).

6 of the 8 children with chronic disease were treated by internal fixation in situ with 2 or 3 screws; in 2 cases skeletal traction for 1 to 2 weeks was used in attempting to improve the position of the epiphysis before fixation. The acute slip was treated with closed reduction and internal fixation.

### Ultrasonography

All children with chronic disease were examined pre-operatively and the examiner did not see the radiographs until after the ultrasound examination. The patient was lying supine with extended, parallel legs and hips in neutral rotation or slight external rotation, if an external rotational contracture was present. Real-time ultrasonography was carried out with a 5 MHz linear transducer. Two scans were used, anterior and lateral.

The anterior scan was performed with the transducer along the long axis of the femoral head and neck. The central part of the epiphysis and metaphysis were focused, depicting also the anterior acetabular rim and the joint capsule (Figure 1). In a normal hip of an adolescent there is no step between the metaphysis and epiphysis. In SCFE the epiphysis is posteriorly displaced and a physeal step is visualized. This anterior physeal slip (APS) was measured. Slip severity was graded according to Kallio et al. (1991): APS < 7 mm mild, 7–11 mm moderate, and > 11 mm severe. The distance between the anterior joint capsule and the femoral neck was also measured (anterior capsule distance, ACD). In cases with hip effusion, ACD is increased. A difference in ACD between affected and unaffected sides of more than 2.0 mm indicates an increased amount of intraarticular fluid (Zieger et al. 1987, Terjesen and Östhus 1991).

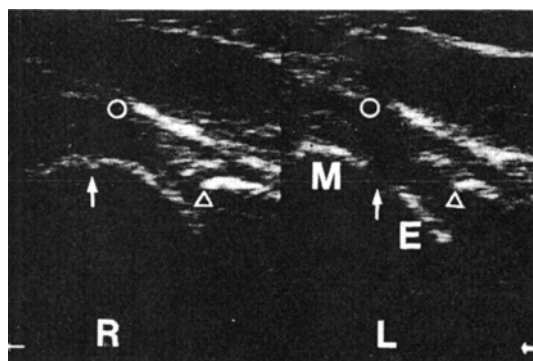


Figure 2. Lateral ultrasonograms of the same patient as in Figure 1. The lateral metaphysis (M), the epiphyseal plate (arrow), the lateral outline of the epiphysis (E), the lateral bony acetabular rim (triangle), and the joint capsule (circle) are visualized. The right hip (R) is normal, whereas the left hip (L) has a broadened epiphyseal plate and a mild physeal slip.

The longitudinal lateral scan, performed according to Terjesen et al. (1991), visualizes the lateral outline of the epiphysis and metaphysis, the lateral acetabular rim, and the proximal part of the lateral joint capsule (Figure 2). In normal hips the contour of the femoral head is smooth, convex, and spherical.

The femoral anteversion (AV) angle was determined according to our previously described technique (Terjesen et al. 1990), using the anterior tangent of the femoral head and greater trochanter (head-trochanter tangent) as the reference line, and tilting the transducer until this tangent appeared as horizontal on the monitor screen. To obtain the real AV angle, 10° was subtracted from the measured angle.

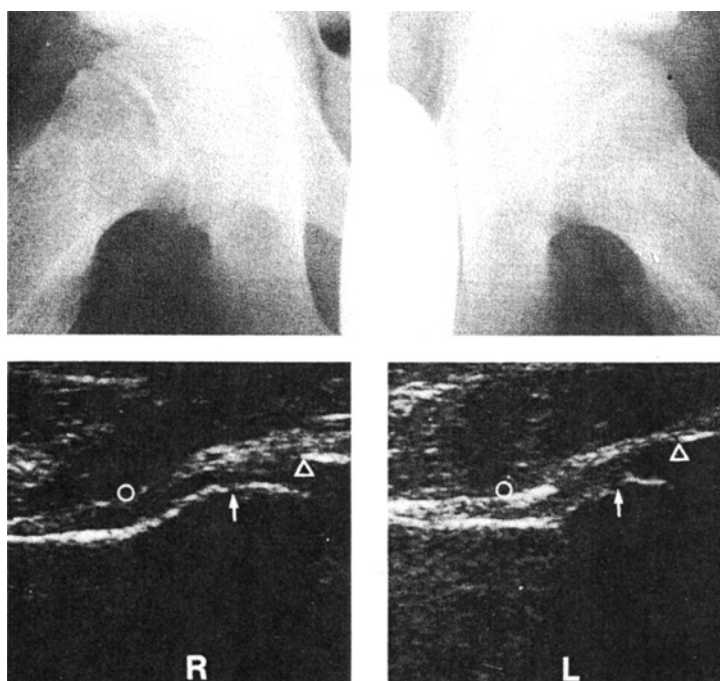


Figure 3. Anterior ultrasonograms and frog-leg lateral radiographs of a 13-year-old boy, with labels as in Figure 1. The radiograph shows a minimal physeal slip of the right hip (R). No slip is seen on the sonogram, but the metaphysis appears somewhat less prominent than on the left side because of metaphyseal remodeling.

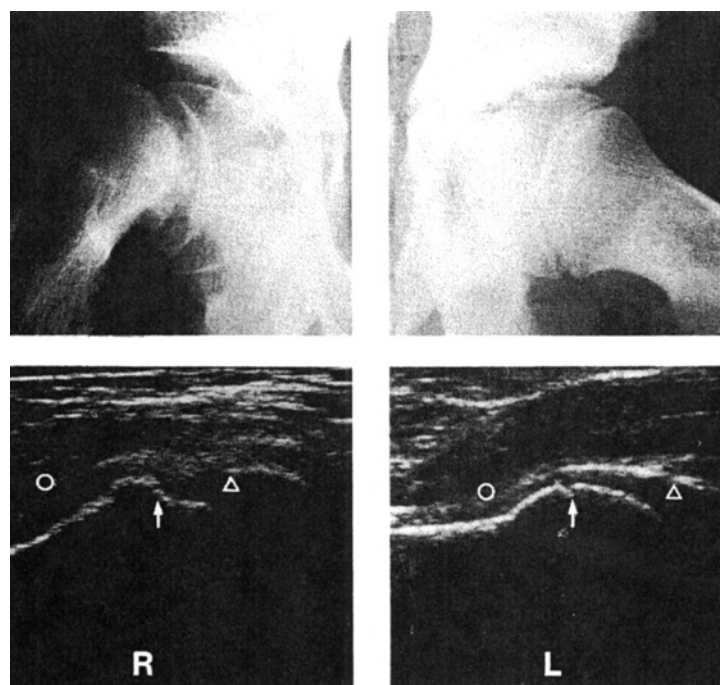


Figure 4 A. Anterior ultrasonograms and frog-leg lateral radiographs of a 12-year-old boy with a 10 mm physeal slip of his right hip (labels as in Figure 1). The anterior capsule distance of the right hip is increased, indicating a moderate hip effusion.

## Results

### Chronic slip

A physeal slip was diagnosed by ultrasound in 7 of the 8 patients and in 8 of the 10 hips (Table 1). Slipping was most easily observed in the anterior scan. In the 2 hips where no slip was detected by ultrasound, a less prominent contour of the anterosuperior metaphysis was observed, indicating metaphyseal remodeling, whereas radiography showed a minimal slip of 2-3 mm in the frog-leg lateral projection (Figure 3). In the remaining hips, there was a good correspondence between ultrasonography and radiography, as mild and moderate slips were diagnosed by both methods in 5 and 3 hips, respectively (Figure 4). The mean anterior physeal slip by ultrasound was 6.0 (3-10) mm.

2 of the hips had effusion, with side differences in ACD of 2.4 and 2.6 mm (Figure 4). The lateral longitudinal scan usually showed less pronounced slipping than the anterior one, and no measurements were used to quantify the slip. The most common findings were a broader epiphyseal plate or a physeal step, and a loss of sphericity of the metaphysis and epiphysis (Figure 2).

The mean AV angle of the 10 hips with SCFE was 8.9° (0-16°),

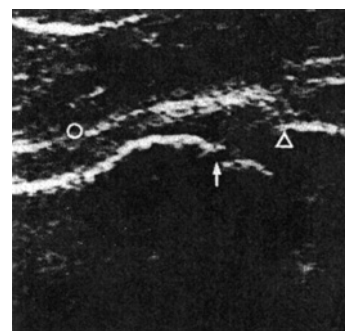


Figure 4 B. The right hip one year post-operatively. Remodeling of the metaphysis has taken place and there is now only a mild physeal step.

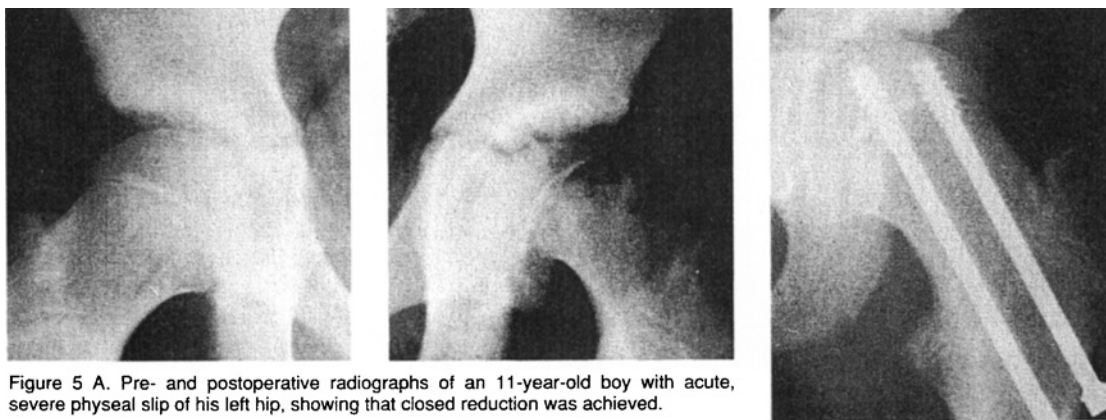


Figure 5 A. Pre- and postoperative radiographs of an 11-year-old boy with acute, severe physeal slip of his left hip, showing that closed reduction was achieved.

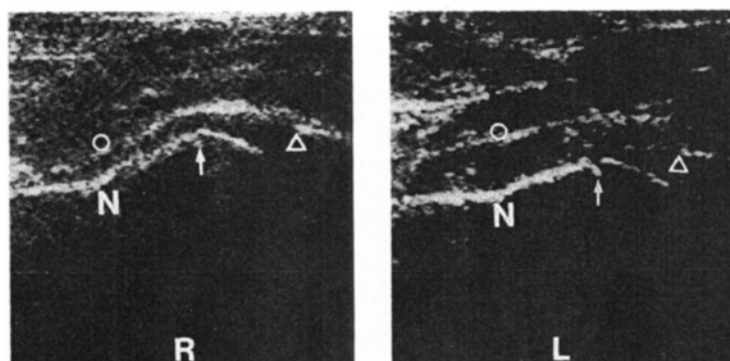


Figure 5 B. Anterior ultrasonograms one week postoperatively (labels as in Figure 1), depicting a considerable hip effusion but no physeal slip of the left hip.

and of the 6 unaffected hips  $14.2^\circ$  ( $5$ – $23^\circ$ ). In the 6 children with unilateral involvement, the mean AV angle of the affected hips was  $5.3^\circ$  ( $0$ – $11^\circ$ ). The affected hips had a lower AV angle than the contralateral normal hips ( $P$  0.036, two-tailed paired samples  $t$ -test); the mean side difference was  $8.8^\circ$ .

During follow-up, remodeling of the metaphysis and epiphysis was demonstrated by ultrasound (Figure 4). In addition, the contralateral hip in unilateral cases was observed with regard to physeal slip. In one patient with bilateral mild slip by radiography and unilateral slip by ultrasound at the primary examination, a mild slip in the other hip was visualized by ultrasound 6 months later and internal fixation was thereafter performed.

#### Acute slip

The patient with acute SCFE was not examined by ultrasound preoperatively because he was admitted in the evening and operated forthwith. Good reduction was achieved by closed means (Figure 5). Ultrasound

from the anterior aspect was performed one week postoperatively. There was then no physeal step but the ACD was markedly increased, indicating intraarticular exudate or blood (Figure 5). Later, necrosis of the femoral epiphysis occurred.

## Discussion

Ultrasonographic criteria for mild, moderate, and severe slipping were recently suggested by Kallio et al. (1991). These criteria, when used in the present study, were in good agreement with radiographic assessment based on percentage epiphyseal displacement. Ultrasound was reliable in the diagnosis of SCFE in all cases of moderate slip and in most hips with mild slip, whereas a minimal slip, i.e., less than 2–3 mm, could be missed. Because of metaphyseal remodeling with some resorption of the anterosuperior portion in chronic cases, the degree of slipping could be less pronounced by ultrasound than the real slip, assessed by

angle measurements on radiographs. However, this metaphyseal remodeling can be observed by ultrasound and is a diagnostic criterion in cases with a minimal slip.

Compared with radiography, ultrasound provided additional information because joint effusion and AV angles were identified. In chronic SCFE, effusion was present in only 2 of the 8 hips; it was slight and did not seem to influence the clinical course. Kallio et al. (1991) reported joint effusion in 11 out of 26 hips with SCFE, mainly with a short duration of symptoms.

In the acute slip, a pronounced effusion was visualized by ultrasound one week after closed reduction, and necrosis was later diagnosed. Whether the fluid was exudate or blood could not be determined by ultrasound. This distinction is probably of little importance, because the effect of increased fluid, whatever its nature, is a rise in intraarticular pressure, increasing the risk of necrosis of the femoral epiphysis (Kallio and Ryöppy 1985, Wingstrand 1986). Thus, when the effusion is considerable, the joint should be aspirated.

According to Gelberman et al. (1986), SCFE is associated with reduced femoral anteversion, and this was confirmed in the present series. Gelberman et al. (1986) suggested that the decreased anteversion might lead to increased shear stress of the growth plate, increasing the risk of slipping. The clinical effect of decreased AV is limited internal hip rotation, which is a consistent finding (Wilson et al. 1965). During the follow-up period, the gradual remodeling of the metaphysis and the epiphysis, documented by radiography (Jones et al. 1990, Wong-Chung and Strong 1991), was visualized by ultrasound. Another important point is the examination of the contralateral hip in unilateral cases. Since a frequency of bilateral cases of up to more than 50 percent has been reported (Billing and Severin 1959, Hägglund et al. 1988), yearly examinations until skeletal maturity are essential. Ultrasound may replace radiography in such follow-ups.

We have maintained that ultrasonography should be the primary imaging technique in children referred for clinical suspicion of congenital hip dislocation (Terjesen et al. 1989, Terjesen et al. 1991), increased femoral anteversion (Terjesen et al. 1990), and transient synovitis (Terjesen and Östhus 1991). Further experience is required before any conclusion can be drawn as to whether this policy should also be recommended in SCFE. At present, all children and adolescents referred to our department for pain in the hip or thigh regions, are primarily evaluated by clinical examination and ultrasonography. Both examinations are performed by the same orthopedic surgeon, which saves time and resources. If hip mobility is normal and no pathologic findings are revealed by ultrasound, radiography is omitted. Because most of these patients have normal

hips, this policy has reduced the exposure to radiation. If, however, abnormal or questionable findings are detected by either clinical examination or ultrasonography, or both, the evaluation is supplemented by standard radiography.

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