LONG-TERM RESULTS AFTER REALIGNMENT OPERATIONS FOR SLIPPED UPPER FEMORAL EPIPHYSIS

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We reviewed the long-term results of the treatment of slipped upper femoral epiphysis (SUFE) using realignment procedures in 36 patients (37 hips) at an average follow-up of 33.8 years (26 to 42). There were serious short-term complications in seven of the 22 hips treated by subcapital osteotomy, three of the 11 hips treated by intertrochanteric osteotomy and three of the four hips treated by manipulative reduction.

At re-examination, the clinical and radiological results were excellent or good in 41% of the hips treated by subcapital osteotomy, in 36% treated by intertrochanteric osteotomy and in none treated by manipulative reduction. In all, seven hips (19%) had had arthrodesis or total hip replacement.

The natural history of SUFE was probably not improved by any of the treatments used in our study. We therefore discourage the use of subcapital and intertrochanteric osteotomy as well as manipulative reduction in the primary treatment of chronic SUFE.

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The treatment of slipped upper femoral epiphysis (SUFE) depends on the degree of the slip. In mild cases with an angle of slip of 30° or less, the treatment of choice is fixation in situ (Boyer, Mickelson and Ponseti 1981; Hansson, Hägglund and Ordeberg 1987; Aronson and Carlson 1992; Wenger 1993; Jerre, Billing and Karlsson 1996), but for moderate (31° to 60°) or severe slips (over 60°) the management is still controversial. Fixation in situ has been advised whenever it is technically possible (Howorth 1966; O’Brien and Fahey 1977; Boyer et al 1981; Hansson et al 1987), but a number of different realignment procedures have been recommended (Dunn 1964; Southwick 1967; Kramer, Craig and Noel 1976; Abraham, Garst and Barndada 1993).

The short- and long-term results after the closed reduction of SUFE have been shown to be unsatisfactory (Jerre 1957; Ordeberg, Hansson and Sandström 1987) and this method has been abandoned in favour of osteotomy of the proximal femur. This can be performed at subcapital, neck or intertrochanteric levels. Dunn (1964) advocated subcapital osteotomy since this can completely correct the deformity but it is associated with a high risk of avascular necrosis (AVN) of the femoral head (Gage et al 1978), which leads to the development of osteoarthritis (Hansson et al 1987; Krahn et al 1993). To reduce this risk, Kramer et al (1976) recommended a lateral femoral-neck osteotomy.

Two different intertrochanteric osteotomies have been described by Imhäuser (1960) and by Southwick (1967) and shown to have favourable short-term results, but Frymoyer (1974) found chondrolysis in five of nine hips and Salvati, Robinson and O’Dowd (1991) in six of 21 hips after Southwick intertrochanteric osteotomies.

The most important late complication after SUFE is osteoarthritis, but this is often not evident until mid-life (Jerre 1957; Lunceford 1966). A follow-up period of 20 years or more is therefore needed to draw firm conclusions on the outcome of various treatments (Fürmaier 1949). There are few reports on such long-term results after realignment procedures (Boyer et al 1981; Hägglund et al 1986; Carney, Weinstein and Noble 1991).

Our aim was to determine the clinical and radiological long-term results after the treatment of SUFE by manipulative reduction and subcapital or intertrochanteric osteotomy.

PATIENTS AND METHODS

From 1946 to 1959, a total of 41 patients with SUFE was treated by realignment operations at the Department of Orthopaedics, Sahlgren Hospital, Gothenburg, Sweden. Of these, 36 (37 hips) were reviewed clinically and radiologically after an average follow-up of 33.8 years (26 to 42) (Table I). Of the five excluded, two patients who had died and one who had emigrated had no short-term complications. The other two refused to participate; one had devel-
 develops AVN after subcapital osteotomy and the other had an infection with resorption of the femoral head after manipulative reduction and internal fixation.

SUFE was classified as acute, acute on chronic, chronic or asymptomatic as defined in Table II. If trauma had been reported it was recorded as severe (car accident, fall from over 3 m), moderate (bicycle accident, fall from 1 to 3 m) or mild (simple fall). The angle of slip at the time of operation was recorded as the angle between the epiphyseal plate and the plane of anteversion (Billing 1954; Billing and Eklöf 1984; Jerre et al 1994; Jerre 1995). There were three treatment groups:

Group I. Subcapital osteotomy in 22 hips.
Group II. Intertrochanteric osteotomy in 11 hips.
Group III. Manipulative reduction in four hips.

Subcapital osteotomies had been fixed by a single screw in 17 hips, by a single Nyström pin in four and by a single Sven Johansson nail in one. Intertrochanteric osteotomies had been fixed by a wire in four hips, by a plate and screws in two and had had no internal fixation in five. Manipulative reduction had been performed closed for one hip with no internal fixation. Three hips had had open reduction with fixation by a single screw in two and a single Nyström pin in one. After operation, all 37 hips had been immobilised in a hip spica, usually for three months.

At review the Harris hip score (HHS; Harris 1969) was used to assess the clinical results and radiography included five different views of each hip (Hansson et al 1993). These were an anteroposterior view non-weight-bearing, a Billing (1954) lateral view non-weight-bearing, and anteroposterior, anterolateral and posterolateral views with weight-bearing (Ahlbäck and Rydberg 1985). The joint space was measured and degenerative changes were classified as normal, mild or severe (Table III; Hansson et al 1993). We also combined the HHS and radiological results to classify the overall outcome as excellent, good, fair or poor (Table IV).

### RESULTS

The detailed clinical and radiological results are given in Table V.

**Group I (n = 22).** There were short-term complications in seven patients (32%). Total AVN occurred in three and
partial changes in two. Two of these five patients required total hip replacement (THR) at the ages of 41 and 47 years. Of the other three hips with AVN, one had a good result and two were poor. One patient developed chondrolysis about one year after operation and required an arthrodesis at the age of 33 years. Another had nonunion of the osteotomy, but reoperation after 13 months with an intertrochanteric procedure provided union without further complications, but gave a poor long-term result.

Of the 15 patients with no short-term complications, one had required a THR at the age of 50 years. Of the 14 who had no secondary surgery, four had severe osteoarthritis and two had mild changes (Figs 1 and 2). The mean HHS for the 14 hips was 87 ± 13 points (59 to 100).

**Group II** (n = 11). There were short-term complications in three patients (27%). Total AVN developed in one and chondrolysis was seen in another two years after the operation. Another developed a hump on the femoral neck which restricted abduction. This was removed six months later, but all three hips had poor long-term results.

Of the eight patients with no short-term complications, one had required THR at the age of 51 years. Of the 14 who had no secondary surgery, four had severe osteoarthritis and two had mild degenerative changes, another two had severe osteoarthritis and four had mild degeneration (Fig. 3). The mean HHS for the eight hips was 86 ± 8 points (74 to 96).

**Group III** (n = 11). There were short-term complications in three patients. Total AVN developed in two, both requiring arthrodesis at the ages of 12 and 36 years respectively. The only hip in this group with no short-term complications had severe radiological osteoarthritis but no pain, and had an HHS of 94.7 points.

**DISCUSSION**

After subcapital osteotomy we saw the short-term complications of AVN, chondrolysis or pseudarthrosis in 32% of the hips. This agrees with the study of Hägglund et al (1986) and with the literature review of Gage et al (1978) who found an incidence of AVN of 21% after subcapital osteotomy, but were unable to assess that of chondrolysis.

We found excellent results in only 23% after subcapital osteotomy in our long-term study, slightly worse than those of Hägglund et al (1986), who found 31% of hips with no evidence of osteoarthritis in 32 patients reviewed at between 16 and 32 years after the same procedure. The difference in these results may be explained by longer follow-up and a more sensitive radiological method in our study (Hansson et al 1993).

As regards the natural history of SUFE, Ordeberg, Hansson and Sandström (1984) reviewed 35 hips at 20 to 60 years after a severe slip with no primary treatment. These patients came from the same orthopaedic department as those of Hägglund et al (1986). Only 20% of the untreated hips showed no evidence of osteoarthritis. These results suggest that subcapital osteotomy does not appear to improve the natural history of severe SUFE and the value of this procedure must be questioned.

After intertrochanteric osteotomy there were slightly fewer short-term complications than after subcapital osteotomy, but the long-term results were worse. Only 9% of the hips had excellent results, confirming the report of Boyer et al (1981) of an incidence of osteoarthritis of 92% after intertrochanteric osteotomy in patients followed up for 27 to 47 years. These results are even worse than the natural history of severe SUFE, but in both our series and that of Boyer et al (1981) older surgical techniques had been used before the intertrochanteric osteotomy of Southwick (1967) was introduced.

After manipulative reduction, three of our four hips had serious short-term complications and all four had a poor long-term outcome. This is in accordance with the reports of Boyer et al (1981) and of Ordeberg et al (1987).
latter authors found that the results of closed reduction and a hip spica were worse than in untreated hips; we agree that manipulative reduction should not be used in the treatment of chronic SUFE.

Both Boyer et al (1981) and Carney et al (1991) found better clinical and radiological long-term results after severe SUFE in patients treated without realignment compared with hips treated with realignment and recommended pinning in situ regardless of the severity of the slip. Hägglund, Hansson and Sandström (1987) reviewed 72 hips with severe SUFE treated by pinning in situ with a follow-up of 20 to 42 years; they found no evidence of

Radiographs of a patient with bilateral chronic SUFE. The right hip had a subcapital osteotomy at the age of 14 years 10 months and the left hip was treated in a hip spica. The preoperative angle of slip was 80° on the right and 62° on the left (a). At four months AP (b) and lateral (c). At 51 years of age he had severe osteoarthritis of both hips (d).
osteoarthritis in 62% of these hips. These results are better than the long-term results after no treatment or treatment with realignment reported by us and others (Boyer et al 1981; Ordeberg et al 1984, 1987; Hägglund et al 1986; Carney et al 1991). The relatively satisfactory long-term results after pinning in situ may be explained by the remodelling of the femoral neck which occurs after a slip (Billing 1954; O’Brien and Fahey 1977; Siegel et al 1991; Kallio et al 1992); this may also explain why loss of movement decreases with time (Siegel et al 1991) and usually becomes clinically irrelevant in the long term (Jerre et al 1996).

Regardless of the form of treatment, the long-term results after SUFE depend at least in part on the degree of the slip. In untreated cases the slip may progress during adolescence (Billing and Severin 1959; Ordeberg et al...
1984) and it is essential to prevent further slipping. This can be achieved by fixation in situ (Boyer et al 1981; Hansson et al 1987; Carney et al 1991).

We conclude that the use of subcapital and intertrochanteric osteotomy and of manipulative reduction should be discouraged in the primary treatment of chronic slipped upper femoral epiphysis.

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REFERENCES


