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Original article

Severe slipped capital femoral epiphysis: A French multicenter study of 186 cases performed by the SoFOP☆

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ABSTRACT

Introduction: The treatment of severe slipped capital femoral epiphysis (SCFE) remains controversial. Despite numerous treatments being available, the outcome of published studies has been variable. Recent studies emphasize that poor reduction of the severe SCFE is responsible for the appearance of joint cartilage lesions and progression towards early osteoarthritis. But surgical reduction of severe SCFE also results in a significant rate of necrosis.
Objective: Evaluate the results of various treatment strategies for severe SCFE and identify the optimal course of action.
Material and methods: This was a French multicenter retrospective study of severe SCFE cases (>45° displacement) evaluated a minimum of 12 months after treatment. The stability of the slipped epiphysis, type of the treatment, delay before treatment, early and short-term complications, Harris and WOMAC functional scores and radiological signs of femoroacetabular impingement (FAI) at the last review were evaluated. A total of 186 cases of severe SCFE in 182 patients were included. One hundred and seven (58.7%) of these were male. The average age was 13 years. The average follow-up was 23 months. The average displacement was 60°. The SCFE was considered stable in 94 cases (50.5%) and unstable in 92 cases (49.5%). The main surgical treatments used by the various centers were in situ fixation (ISF), lateral Dunn, anterior Dunn and reduction using traction or under anesthesia (for unstable forms).
Results: In the stable SCFE cases, there were 6 cases of necrosis (6.4%), all of which occurred after reduction by osteotomy; there were 32 cases of radiological FAI (34%), 30 of which occurred after ISF. The necrosis rate in the unstable SCFE cases was 21.7%: one (11%) after ISF, seven (19%) after anterior Dunn, eight (21%) after preoperative reduction and three (43%) after lateral Dunn.
Conclusions: The results of this study confirm the diverse nature of SCFE treatments available and the variability of their results. When selecting a treatment for severe SCFE, the goal is to stop the slip and also to prevent osteoarthritis by correcting the hip deformities. The "anterior" Dunn procedure was able to achieve these two goals, while having a lower complication rate than the other reduction techniques.
Level of evidence: IV.

1. Introduction

Slipped capital femoral epiphysis (SCFE) corresponds to slipping of the epiphysis relative to the neck through the growth plate. This is the most common hip condition in adolescents, with an estimated incidence of 1 per 10,000 children in the West [1–3].

Although in situ fixation (ISF) is the generally accepted treatment for minor SCFE, the treatment of more severe SCFE cases remains controversial [1]. Although remodeling is possible, cases of severe SCFE that are fixed in situ often quickly progress towards labrum lesions and osteoarthritis, which occurs even more quickly when large residual deformities exist [4–6]. The objectives of this study were to report on the various treatment methods used within the SoFOP (French Society of Pediatric Orthopedics) and then to

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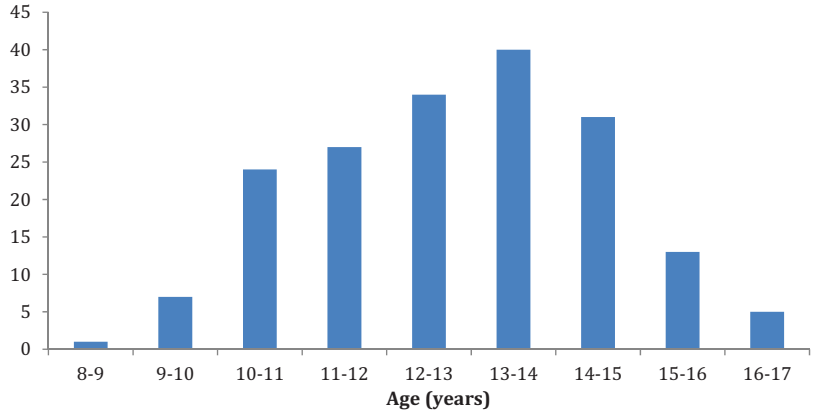

Fig. 1. Age distribution for the 182 patients with severe slipped capital femoral epiphysis, the average age was 13 years.

analyze the complications associated with these methods to define a decision tree for the optimal course of action.

2. Materials and methods

This was a French multicenter retrospective study of severe SCFE cases with more than 45° displacement (Southwick method [7]) treated between January 2010 and June 2013. Secondary SCFE cases and patients who had previously been operated in the proximal femur were excluded. The minimum follow-up was 1 year; this made it possible to determine the occurrence of complications and, in particular, detect occurrences of delayed osteonecrosis.

All the patient records were evaluated at the participating centers by one of the three co-authors. The demographics, nature of the treatment, and time between admission and treatment were recorded. The SCFE cases were labelled as stable or unstable based on Loder's criteria [8]; the complication rates were compared between these two subgroups and to those reported in published studies. When MRI was performed, the preoperative epiphyseal perfusion in unstable forms of SCFE was recorded. All the initial radiographs, immediate postoperative radiographs and those at the last follow-up were then analyzed by the three authors together. The radiographs from the last follow-up visit were reviewed for signs of femoroacetabular impingement (FAI) [9–11]. The functional outcomes were evaluated using the Harris Hip Score [12] and the WOMAC score [13].

Comparisons between the different surgical techniques and the differences between the pre- and postoperative radiological parameters were made using paired *t*-tests; a *P*-value below 0.05 was considered significant. The statistical analysis was carried out using Excel (Microsoft, Redmond, WA, USA).

2.1. Patient demographics

Twenty-five health care facilities (with 22 of them being university hospitals) participated in the study and contributed 186 cases of severe SCFE (182 patients). One hundred seven (58.7%) of them were male; the sex ratio was 1.36. The average age at the time of the diagnosis was 13 years (range: 8.5–17) (Fig. 1).

The average weight was 61 kg (range: 25–110) and the average body mass index was 24.8 (range: 15–37). In 138 patients (76%), the SCFE was unilateral and considered severe; the right leg was affected in 63 patients and the left in 75 patients. The SCFE was bilateral in 44 patients (24%); 4 of them had severe SCFE in both legs and the 40 others had severe epiphyseal displacement in only one leg (right in 16 cases, left in 24).

The average displacement was 60° (range: 45–100°). Based on Loder's classification, 94 cases (50.5%) were stable and 92 (49.5%) were unstable. The average follow-up was 23 months (range 12–42).

2.2. Treatment methods

Various treatment methods had been used (Table 1):

- in situ fixation with screws or K-wires [14];
- preoperative reduction using progressive traction and/or under general anesthesia followed by fixation [14];
- surgical reduction:
  - according to Dunn's original technique [15,16], which we labelled "lateral" Dunn,
  - with hip dislocation according to the technique described by Leunig, Slongo and Ganz [17,18], which we labelled "modified" Dunn,
  - with femoral neck osteotomy below the growth plate,
  - with trans-growth plate osteotomy and femoral neck shortening through an anterior approach according to the modified Compère technique [14,19,20], which we labelled "anterior" Dunn.

2.3. Stable SCFE

There were 94 cases of stable severe SCFE. The average displacement was 57° (range: 45–90°). The treatments carried out on these cases are shown in Table 1. The average procedure time was 2 hours 44 min (± 60 min) for osteotomy procedures and 1 hour 13 min (± 60 min) for in situ fixation. Weight bearing was allowed

Table 1
Type of treatments used in this multicenter study.

	N	ISF, *n* (%)	Preoperative reduction, *n* (%)	Anterior Dunn, *n* (%)	Lateral Dunn, *n* (%)	Modified Dunn, *n* (%)	Femoral neck osteotomy, *n* (%)
Stable severe SCFE	94	37 (39.4)	9 (9.6)	36 (38.3)	8 (8.5)	1 (1.1)	3 (3.1)
Unstable severe SCFE	92	9 (9.8)	38 (41.3)	36 (39.1)	7 (7.6)	0 (0)	2 (2.2)

n: number; ISF: in situ fixation.