

Surgical Management of Unstable Superior Femoral Epiphysiolysis with Great Displacement

Kalifa Coulibaly^{1*} , Cheick Oumar Sanogo¹, Mahamdou Diallo², Abdoul Kadri Moussa², Laye Toure³, Soumana Traore¹, Aboubacar Diallo¹, Sory Ibrahim Tambassi¹, Souleymane Diallo¹, Ousmane Traoré¹

¹Orthopaedic Trauma Department, Kati University Hospital, Koulikoro, Mali

²Orthopaedic Trauma Department, Gabriel Touré University Hospital, Bamako, Mali

³Orthopedic Trauma Department, Sikasso Regional Hospital, Sikasso, Mali

Email: *kalifacoulibaly49@yahoo.fr

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Abstract

Introduction: Superior femoral epiphysiolysis (SFE) is a most progressive but sometimes abrupt displacement of the femoral head relative to the superior femoral metaphysis through the cervicocerebral growth plate of the femur. The displacement of the femoral head is most often downward and backward. It is a typical pathology of the pubescent adolescent, most often overweight. It occurs on average at the age of 12 years in girls and 14 years in boys. Unstable forms with large displacements have a high risk of femoral head necrosis and chondrolysis. Although in situ fixation is the generally accepted treatment for minor SFE, the treatment of more severe cases remains controversial. When the extent of the displacement makes it impossible to pass a screw between the femoral neck and the femoral head, the only option is to reduce the displacement. This reduction must be gentle, progressive and limited to the minimum necessary for osteosynthesis. **Objective:** The aim of the work was to evaluate the results of the technique of progressive reduction of epiphyseal displacement by transtibial traction followed by percutaneous fixation of the femoral head by screw. **Patients and Method:** This was a retrospective descriptive study over a 10-years period from January 1, 2013 to December 31, 2022. It focused on the surgical treatment of unstable upper femoral epiphysiolysis with large displacement in the orthopaedic trauma department of the University Hospital of Kati. All patients operated on in our department for large displacement SFE were included in this study. Cases of secondary large displacement upper femoral epiphysiolysis and patients who had already undergone surgery on the proximal femur were excluded. Continuous progressive traction on the Boppe splint through a pin under the an-

terior tibial tuberosity was performed for 15 days in all patients. The hip was flexed to 45° and the knee to 35°. Fixation was performed with one or two screws. No contralateral preventive fixation was performed. Minimum follow-up was one year. Functional outcome was assessed by the Postel Merle d'Aubigné score. Anatomical outcome was assessed by the quality of reduction, the occurrence or non-occurrence of femoral head necrosis, and chondrolysis. **Results:** We identified nine patients with a mean age of 12.8 years and extremes of 9 and 17 years. There were three boys and six girls. Trauma was mentioned in four cases. The cause was idiopathic in five cases. Functional impotence was complete in all patients. The slippage was acute on a chronic background in all patients. The left side was affected in 7 cases and the right side in 2 cases. The patients were overweight in 7 cases. The patient's weight was within the normal range in two cases. At final follow-up, all nine patients were asymptomatic. Anatomically, all nine patients had a femoral head free of avascular necrosis. In eight patients, the posterior tilt was absent, identical to that obtained after the traction period. Only one patient had a moderate posterior tilt with a neck uncovering of less than 25%. Functionally, the PMA score was very good in eight cases and good in one case. **Conclusion:** This study shows that the treatment of acute and unstable forms of upper femoral epiphysiolysis by progressive reduction with transtibial traction can lead to satisfactory results. Reduction in large displacement forms should be gentle, progressive and limited to the minimum necessary for osteosynthesis. Magnetic resonance imaging examination is an essential and indispensable prognostic element. Indications for preventive fixation should be selectively reserved for specific cases.

Keywords

Epiphysiolysis, Unstable, Femoral Head, Continuous Traction

1. Introduction

Superior femoral epiphysiolysis (SFE) is a most often progressive but sometimes abrupt displacement of the femoral head relative to the superior femoral metaphysis through the cerviccephalic growth plate of the femur [1]. The displacement of the femoral head is most often done down and back. It is a typical pathology of the pubescent adolescent, most often overweight [2] [3]. It occurs on average at the age of 12 years in girls and 14 years in boys [2]. The incidence of upper femoral epiphysiolysis is approximately 2 per 100,000 population in the general population [4]. Various forms of upper femoral epiphysiolysis have been identified. Although in situ fixation is the generally accepted treatment for minor SFE, the treatment of more severe cases remains controversial [5]. Large unstable slips are defined by the fact that more than 60 percent of the femoral neck is discovered by the femoral head. Thus, Rostoucher *et al.* [6], comparing different methods of treatment of femoral epiphysiolysis, obtained the best results with in situ fixation for displacements less than 60°, and proposed a careful re-

duction and fixation for tilts greater than 60° . A rapid reduction in epiphyseal displacement was alleged to cause epiphyseal ischemia. Harman [7] reported, in a series of nine unstable SFE, three necrosis out of five complete reductions and no necrosis in case of partial reduction. When the importance of the displacement makes it impossible for a screw to pass between the femoral neck and the femoral head, the only possibility is to reduce the displacement. This reduction must be gentle, progressive and limited to the minimum necessary for osteosynthesis. Large displacement slips present a high risk of femoral head necrosis and chondrolysis. Monin *et al.* [8] reported 6.6% femoral head osteonecrosis and 13% chondrolysis. Kamaruzulman *et al.* [9] also reported 26.3% osteonecrosis of the femoral head and 4.2% chondrolysis. The aim of this work was to evaluate the results of the technique of progressive reduction of epiphyseal displacement by transtibial traction followed by percutaneous fixation of the femoral head with screws in unstable large displacement slips.

2. Patients and Method

This was a retrospective descriptive study over a 10-year period from January 1, 2013 to December 31, 2022. It was about surgical treatment of unstable upper femoral epiphysiolysis with large displacement in the orthopaedic trauma department of Kati University Hospital (**Figure 1**). All patients operated in our department for large displacement SFE were included in this study. Cases of secondary large displacement upper femoral epiphysiolysis and patients with previous proximal femoral surgery were excluded. The minimum follow-up was one year. All patient records were evaluated in the centre by one of the authors. SFE cases were labelled as stable or unstable based on the Loder criteria [10]. Large-displacement unstable glides were defined by more than 60% of the femoral neck unearthed by the femoral head on standard radiography. Demographics, nature of treatment and time from onset to treatment were recorded. Initial radiographs, immediate postoperative radiographs and those of the last follow-up were analysed by the authors. The variables studied were slip reduction, occurrence of femoral head osteonecrosis and chondrolysis. The data medium was the individual clinical follow-up form and the surgical protocol register. The data were entered and analysed on the Epi info version 6 software.



Figure 1. Superior femoral epiphysiolysis with large displacement.

2.1. Therapeutic Protocol

During the pre-operative period, progressive traction continued on the Boppe splint through a transtibial pin under the anterior tibial tuberosity for 15 days. The hip was bent at 45° and the knee at 35° . Hip rotation was neutral. The hip was slightly abducted. The suspended weight was based on the patient's weight. The 7th of the patient's body weight was used (**Figure 2**). Per operation, the anesthesia was general or locoregional. The installation was done on orthopedic table in supine position. The reduction was achieved by extending, abducting and medial rotating the hip 20° without pulling on the limb. The brightness amplifier was used to control the reduction and position of the osteosynthesis material. The first route was lateral and percutaneous. The guide pin was placed in the middle of the femoral neck. Drilling and screwing was done strictly parallel to the guide pin. The cervical screw with discontinuous thread was used. The fastening was done either with one or two screws (**Figure 3**). No preventive contralateral fastening was done. Walking without support on the side operated with two axillary crutches was authorized the day after the intervention. Partial support with an axillary crutch was authorized from the second month of the intervention. Walking without a crutch was allowed from three months of operation. The removal of the osteosynthesis material was done at the end of growth.

2.2. Evaluation Method

The functional outcome was assessed by the score of Postel Merle d'Aubigné (**Table 1**). The anatomical result was appreciated by the quality of the reduction, the occurrence or not of necrosis of the femoral head as well as chondrolysis.



Figure 2. Continuous progressive traction on the Boppe splint.

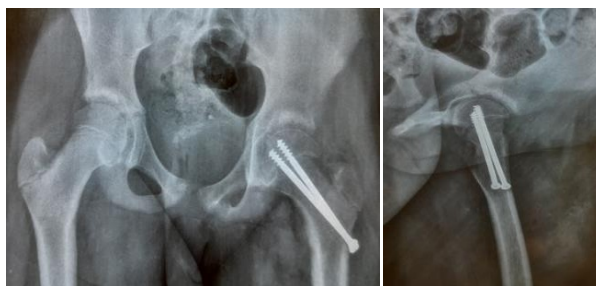


Figure 3. Osteosynthesis with two discontinuous threaded screws.

Table 1. Postel merle d'Aubigné score.

Score	Pain	Mobility			Walking-Stability
		No vicious attitude	Vicious flexion or RE posture	Vicious attitude in ABD, ADD, RI	
6	No	Flexion > 90	No	No	Normal
5	Rare Slight	70 à 90°	No	No	Limited or slight lameness if prolonged Long distance cane No instability
4	After 30 minutes to 1 hour of walking	50 à 70°			Cane to go out Net lameness Slight instability
3	After 10 to 20 minutes of walking	30 à 50°	Lower the score by 1 point	Lower the score by 2 points	Cane permanently Instability
2	Before 10 minutes of walking	<30°			2 rods
1	Immediately on the march				Crutches
0					Unable to walk

According to the PMA score: Very good: PMA score = 18; 17 Good: PMA score = 16; 15 Fair: PMA score = 14; 13 Poor: PMA score = 12 - 9 Poor: PMA score < 9.

3. Results

We identified nine patients with a mean age of 12.8 years with extremes of 9 and 17 years. There were three boys and six girls. Trauma was mentioned in four cases. The cause was idiopathic in five cases. Functional impotence was complete in all patients. The slippage was acute on a chronic background in all patients. The left side was affected in 7 cases and the right side in 2 cases. The patients were overweight in 7 cases. The patient's weight was within the normal range in two cases. The average time to management was 40.4 days with extremes of 19 and 90 days. The average postoperative follow-up was 21.7 months with extremes of 12 and 48 months.

The average follow-up time was 4 years 4 months with a range of 12 months to 14 years. The patient data are summarised in **Table 2**. At the final follow-up, all nine patients were asymptomatic. Radiologically, all nine patients had a femoral head free of avascular necrosis (**Figure 4**). No chondrolysis was noted in our study. In eight patients, the posterior tilt was negligible, identical to that obtained after the traction period (**Figure 3**). A single patient had a moderate posterior rocking with less than 25% femoral neck stripping. No early or late postoperative slippage was observed in any of the nine patients. The screw was removed in a 17-year-old patient after closure of the growth plate. Functionally, the mean PMA score was 17.2 with extremes of 15 and 18. The PMA score was very good in 8 cases and good in one case. In our series we noted one case of bilateralization.

4. Discussion

Large-displacement unstable glides pose a high risk of femoral head necrosis and

Table 2. Summary of patient data.

Patients	Age	Gender	On the side	Overweight	Trauma	Timeframe (days)	Functional outcome		Anatomical result		
							PMA score	Reduction of displacement	Osteonecrosis	Chondrolysis	Assessment
1	15	M	G	Yes	No	35	18	Anatomical	Absent	Absent	Very good
2	10	F	G	No	Yes	40	17	Anatomical	Absent	Absent	Very good
3	11	F	G	Yes	Yes	20	18	Anatomical	Absent	Absent	Very good
4	15	F	D	Yes	No	60	17	Anatomical	Absent	Absent	Very good
5	12	F	G, D	Yes	No	45	18	Anatomical	Absent	Absent	Very good
6	17	M	G	Yes	No	19	17	Anatomical	Absent	Absent	Very good
7	16	M	G	Yes	Yes	25	17	Anatomical	Absent	Absent	Very good
8	9	F	D	No	Yes	30	18	Anatomical	Absent	Absent	Very good
9	10	F	G	No	Yes	90	15	Displacement $\leq 60\%$.	Absent	Absent	Good

**Figure 4.** Result of the surgery at the end of the growth period.

chondrolysis. The fixation in place of the epiphysis in the forms with great displacement is a bad solution because it allows to continue an architectural vice. This fixation in the vicious position of the epiphysis is responsible for a retrorsa coxa with a vicious attitude in external rotation of the lower limb, a hip stiffness and osteoarthritis in the medium term [11]. In unstable severe epiphysiolysis, the treatments proposed in the literature are controversial, both in terms of urgency and the technique of reduction [5]. Some cases of severe unstable epiphysiolysis can be complicated by vascular lesions, which occur at the time of slippage and before any treatment is possible. Preoperative magnetic resonance imaging examinations revealed that 17.4% of the upper femoral epiphysis was underperfused in unstable severe epiphysiolysis [12]. This is an essential prognostic element and it seems essential that the patient is fully informed. We have not been able to evaluate our patients with preoperative magnetic resonance imaging due to lack of resources. Published series have shown variable results depending on the time from admission to treatment. We found no effect of the time between the onset of slippage and surgical treatment. Madan [13] and Sankar [12]

found the same. Other authors [14] have emphasised the importance of reduction within 24 hours of slip. They point out that the slipped epiphysis is itself responsible for vascular compression. Progressive reduction by transtibial traction of unstable forms of upper femoral epiphysis avoids aggravation of the initial damage to the epiphyseal vessels. It allows a reduction of at least 63% of the initial displacement [15]. Spontaneous movement between the femoral neck and head does not cause tension in the posterior vascular elements [1]. Voluntary medial rotation of the lower limb reduces the displacement [5], causing ischaemia by tensioning the posterior vascular elements.

Necrosis of the femoral head is a serious complication of acute unstable epiphysis, secondary to the interruption of epiphyseal vascularisation. Its incidence varies according to the series, between 25% and 50% of cases [5]. This cephalic necrosis is much more frequent when a reduction of the displacement is performed under general anaesthesia before osteosynthesis [16]. In our study with progressive reduction by transtibial traction, no necrosis of the femoral head was detected in the nine cases. In contrast, Vialle R. *et al.* [17] reported two cases of femoral head necrosis in a short series treated by glued traction. Chondrolysis, responsible for a more or less extensive destruction of the articular cartilage without real necrosis of the epiphyseal bone, has a debated origin. Some authors [18] accuse the joint effusion, which is frequently haemorrhagic in unstable forms of epiphysiolysis, of causing cartilage necrosis. This has led some authors to propose systematic evacuation of the intra-articular haematoma during surgical treatment. Other authors [19] [20] cite intra-operative technical problems such as the exit of pins into the joint space during epiphyseal screw fixation. Aronsson [4] and Loder [21] point out that chondrolysis is the consequence of the osteosynthesis material protruding into the joint due to epiphyseal necrosis, which causes the femoral head to collapse. With an average follow-up of 4 years, no chondrolysis was noted in our study. We observed only one case of contralateral slippage in our series. For most authors, given this low rate of bilateralization and the reported complications associated with in situ screw fixation, particularly screw removal, it is not always useful to systematically perform preventive fixation. However, Bidwell and Suzan Slot [22] and Riad *et al.* [23], who observed bilateralization complication rates of 31% and 23% respectively, recommend systematic preventive fixation for any epiphysiolysis occurring before 10 years of age in girls and before 12 years of age in boys. The indications for preventive fixation are now selectively reserved for very specific cases: obesity, hormonal treatment, endocrinopathy or the young age of patients where the incidence of bilateralization would be very high. This work has its limitations. It is a single-centre retrospective study. The number of patients is small. Multicentre studies with large numbers and significant follow-up are needed to compare our results.

5. Conclusion

This study shows that the treatment of acute and unstable forms of upper fe-

moral epiphysiolyis by progressive reduction with transtibial traction can lead to satisfactory results. Reduction in large displacement forms should be gentle, progressive and limited to the minimum necessary for osteosynthesis. Magnetic resonance imaging examination is an essential and indispensable prognostic element. Indications for preventive fixation should be selectively reserved for specific cases.

Conflicts of Interest

The authors declare that they have no conflicts of interest in this article.

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