

Surgical Management of Recent Traumatic Epiphyseal Fractures-Detachments of the Distal Femur at Gabriel Touré University Hospital

Mahamadou Diallo^{1*}, Abdoul Kadri Moussa¹, Layes Toure², Kalifa Coulibaly³, Mamadou Bassirou Traoré¹, Cheick Oumar Sanogo³, Terna Traoré², Mamadou Diallo⁴, Amadou Maiga⁵, Adégné Togo⁵

¹Service d'Orthopédie-Traumatologie, CHU Gabriel Touré, Bamako, Mali

²Service d'Orthopédie-Traumatologie, Etablissement Hospitalier Publique Sikasso, Sikasso, Mali

³Service d'orthopédie traumatologie, CHU de Kati, Kati, Mali

⁴Service de Neurochirurgie, CHU Gabriel Touré, Bamako, Mali

⁵Service de chirurgie générale, CHU Gabriel Touré, Bamako, Mali

Email: *diallo_mohamed67@yahoo.fr

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Abstract

Traumatic epiphyseal detachment fractures of the distal end of the femur are a rare lesion whose severity is linked to disabling sequelae such as limb length inequality or most often axial deviation. In this report, surgical treatment aims to reconstruct the anatomy of the distal femur, to avoid secondary displacements and to allow early mobilization of the knee. Surgery carried out mainly by the technique of plugging in or screwing, opened or better still closed, can be a source of complications including migration of pins, infections, knee stiffness, and growth disorders. The aim of this work was to describe their epidemiological, anatomo-clinical, therapeutic and evolutionary aspects in the Department of Orthopedics-Traumatology at the CHU Gabriel TOURE. It was a retrospective study over 30 months from July 2019 to December 2021. In fact, it concerned 42 patients with traumatic epiphyseal detachment of the distal femur occurring within 21 days or less, on a healthy knee with cartilage fertile treated surgically and followed in the department. However, the diagnosis of traumatic epiphyseal detachment of the distal femur was retained thanks to the clinical examination and supplemented by radiographic images of the knee from the front and from the side. The treatment was surgical. The functional results were evaluated according to the functional criteria of the Eastern Orthopedic Traumatology Society (SOTEST). Forty-two patients included 32 boys and 10 girls of average age of 12 years with extremes of 8 years and 16 years. The lesions were classified according to

the Salter Harris classification. We noted 24% type I (n = 10), type II 71% (n = 30), type III 2% (n = 1), type IV 2% (n = 1). Union was achieved in all patients within an average of 6 weeks with extremes of 4 and 12 weeks. The functional result was considered good in 20% of cases and very good in 80%. Traumatic epiphyseal detachment fractures of the distal end of the femur are a rare lesion whose severity is linked to disabling sequelae such as limb length inequality or most often axial deviation. Surgical treatment aims to reconstruct the anatomy of the distal femur, to avoid secondary displacements and to allow early mobilization of the knee.

Keywords

Epiphyseal Detachment, Distal Femur, Treatment, Surgical

1. Introduction

Traumatic epiphyseal cleavages are injuries frequently encountered in child trauma; they account for 1% - 6% of physical injuries and 1% - 15% of child fractures [1] [2]. Its location at the distal end of the femur represents 30% with a clear male predominance [3] [4]. The reference treatment of these traumatic epiphyseal fractures-detachments of the displaced distal femur, combines anatomical reduction and internal osteosynthesis by pin or screw, under brightness amplifier respecting the growth cartilage. Unequal limb length, axial deviation and knee stiffness are classic complications of these fractures [3]. Indeed disabling femur shortenings occur in 30% and 50% [4] [5], and significant angular deviation of the knee in 20% and 60% [6] [7] diagnoses is made in the years following the trauma. The occurrence of these complications is correlated with the displacement of the fracture, the quality of its reduction and the type of treatment. Several studies have shown multiple aspects of fractures-detachments mostly related to a particular type of bone or skeletal extremity [8] [9]. But in the orthopedic trauma unit of the CHU-Gabriel Touré, this kind of lesion has not yet been the subject of any study concerning the distal femoral region, and most importantly concerning the surgical aspect and its treatment.

The purpose of this work was to describe the anatomical-pathological lesions of the epiphyseal fractures-detachments of the distal femur and to evaluate the anatomical and functional results of the surgical treatment in the orthopedic and traumatology department of the CHU Gabriel Touré.

2. Material and Methods

We collected patients with recent traumatic epiphyseal fractures-detachments of the distal extremity of the femur in the orthopedic and trauma department of the Gabriel Touré Hospital. This was a 30-month retrospective study (July 2019 to December 2021) of all patients aged 0 to 16 years with traumatic epiphyseal detachment occurring within 21 days or less. On a healthy knee with fertile carti-

lage surgically treated and monitored in the ward. Pathological fractures, vicious calcs and epiphyseal detachment of the orthopedically treated distal femur and the loss of sight were not included in this study. For each patient, the following data were studied: age, gender, etiology of trauma, mechanism, anatomopathological type according to the classification of Salter and Harris, associated lesions, type of osteosynthesis according to the opening or not of the focal spot, and the functional result according to the functional criteria of the Eastern Trauma Orthopaedic Society (SOTEST).

Thus 42 patients including 32 boys and 10 girls of average age of 12 years (extremes 8 years and 16 years) totaling 42 fractures were retained. They were victims of a public road accident in 30 cases (71.4%), a tree fall in 7 cases (16.6%), a recreational accident in 2 cases (6.2%) and a sports accident (football) in 3 cases (9.3%). The mechanism most frequently found was a direct shock to the leg from the inside out in 32 patients, and indirect in 10 patients.

The description of pathological lesions was based on the classification of fractures according to Salter-Harris [10], associated lesions and immediate complications. The surgical treatment was carried out in all our patients. Under anesthesia (anesthesia spine or general anesthesia), on ordinary table. It consisted of anatomical reduction under fluoroscopic control. Osteosynthesis was performed in 35 patients with a closed focus and in 7 patients with a posterolateral approach to the lower third of the thigh. After the cutaneous incision, the opening of the fascia lata was done in the direction of its fibers in front of the external intermuscular partition. The large lateral was then detached from the bulkhead, moving progressively towards the diaphysis on 6 cm. Hemostasis of the perforating vessels was carried out. The reduction was obtained after the interposition of the periosteum was lifted. The bone fixing was done by two "X" pins (Figure 1) or by two screws (Figure 2), or by a combination pin and screw. The screw-driving was strictly transverse to avoid damaging the perichondral shell without crossing the growth cartilage [11]; the metaphysical fragment was recalled. Bone fixation was performed by Kirschner pins with a 22 "X" diameter in 32 cases, by 6.5 spongy screws in 5 cases and by Kirschner pins and spongy bone screws in 5 cases. This surgical treatment was combined with a cruro-malleolar plaster for duration of 6 weeks. After the removal of the plaster functional rehabilitation sessions had been done regularly in 88.5% of patients. The average length of hospitalization was 72 hours with 48-hour and 8-day extremes.

Measurements were taken post-operative and at the last setback. They concerned the length of the traumatized femur and the angle deviations on the control images. They were considered pathological when a length inequality, such as a shortening of the traumatized femur, greater than 2 cm or a frontal angular deviation greater than 5°. The consolidation was evaluated clinically by palpation of a fusiform formation corresponding to the consolidation bony cal, the support painless and without lameness. Radiologically the existence of a continuous bony cal between the proximal and distal segments with disappearance of the fracture line on at least three corticales meant consolidation.

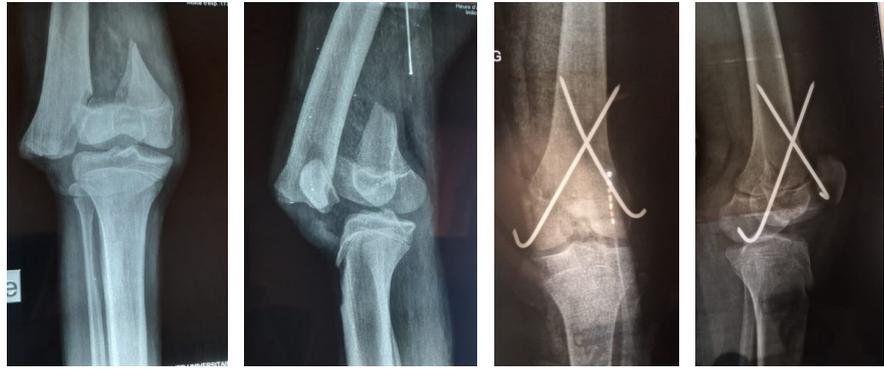


Figure 1. Salter and Harris' type II postoperative control after reduction and pinning.



Figure 2. Salter-Harris type II epiphyseal detachment postoperative control.

For patients, functional evaluation was done, after removal of the plaster and/or implants, according to the functional criteria of SOTEST [12] (Eastern Trauma Orthopaedic Society) (Table 1). Data management and analysis has been processed with SPSS 2.0, Word and Excel 2010.

3. Results

In 30 months we had received and treated 42 patients with recent epiphyseal detachment fractures of the distal femur following trauma. The socio-demographic features of patients are summarized in Table 2.

The lesion was always unilateral. In 33 cases the epiphyseal detachment was located at the distal end of the right femur and in 9 others on the left side. According to the classification of Salter Harris we noted 24% type I (n = 10), type II 71% (n = 30), type III 2% (n = 1), type IV 2% (n = 1). All epiphyseal detachment fractures were closed.

Vascular and nerve lesions were not found. We observed 2 cases of associated fracture (1 case of wrist fracture, 1 case of forearm). Neine patients (21%) were received as second-hand patients, initially treated traditionally or through non-specialized facilities. The average turnaround time was 42 hours with extremes of 2 hours and 13 days.

Osteosynthesis: Bone fixation was performed by Kirschner pins 22 in "X" diameter in 32 cases (type I n = 7, type II n = 25), by 6.5 spongy screws in 5 patients (type I n = 1, type II n = 3, Type III n = 1), and by Kirschner pins and

Table 1. SOTEST functional criteria [12].

Quoting	3	2	1	0
Pain	Absent	Intermittent or at the end of the day	On effort	Permanent
Walk	Normal	Lameness on exertion	Permanent lameness	A cane
Activity	Same activity Redoing sport	Same activity Uncapable to redoing sport	Change Job Decrease in activity	Invalid
Mobility	Normal	Complete extension 120° > flexion < 90°	90° > flexion < 60°	10° of extension error Stiffness Flexion < 60°
Stability	Normal	A few deviations	Frequent deviation	A Cane Important instability
Length	Normal	Reduction < 2 cm	Reduction more than 2 cm less 4 cm	Reduction less than 4 cm
Axis	Normal	Varus < 5° Valgus < 5° Flessum < 5° Récurvatum < 5°	10° > Varus > 5° 10° > Valgus > 5° Flessum < 5° Récurvatum > 5°	Varus > 10° Valgus > 10° Flessum > 10° Récurvatum > 10°

Table 2. The socio-demographic features of patients.

Age	Gender		Total
	M	F	
0 - 5	0	0	0
6 - 10	5	1	6
11 - 15	25	9	34
15 years and over	2	0	2
Total	32	10	42

spongy bone screws in 5 cases (type II n = 3, type III n = 1, Type IV n = 1). This surgical treatment was combined with a cruro-malleolar plaster for a duration of 6 weeks. After the removal of the plaster, functional rehabilitation sessions were performed in 88.5% of patients. Closed focus osteosynthesis was performed in 35 patients (type I n = 9, type II n = 25, Type III n = 1), and open focus in the other 7 patients (type I n = 1, type II n = 5, Type IV n = 1). The average decline was 16 months with extremes of 10 and 25 months. Consolidation was achieved in all patients within an average of 6 weeks with extremes of 4 and 12 weeks.

The complications were:

- 1 case of skin pain due to proximal fragment hyperpressure.
- 2 cases of superficial post-operative infection, located at the pin inlet.

She was treated with local care and probabilistic anti-staphylococic antibiotic therapy. Developments have been favourable.

- 1 case of pin migration requiring early pin removal at 4 weeks post-operative;
- 4 cases of unequal limb length of which 3 (type I n = 1, type II n = 1, type III n = 1) had a shortening of less than 2 cm and 1 patient (type IV) a shortening of between 2 and 3 cm (**Table 5**);
- 3 cases (type II n = 2, type III n = 1) of deformation with 5° or less.

The overall functional result of our patients was good in 20% of cases and very good in 80% (**Figure 3** and **Figure 4**). We have obtained the best functional outcome in the Salter and Harris' type II (n > 25, 60%) (**Table 3**). Depending on the therapeutic methods, functional outcome has been judged excellent in non abraded tissue osteosyntheses (n = 29, 69%) (**Table 4**), these excellent outcome results from pin osteosyntheses (n = 27, 64%) (**Table 5**).

Table 3. Distribution of functional results according to lesion type.

Types	Best Results	Good Results	Total
I	7	3	10
II	25	5	30
III	1	-	1
IV	1	-	1
V	-	-	0
Total	34	8	42

Table 4. Distribution of functional results according to the therapeutic method.

	Best Results	Good Results	Total
Open hearth	5	2	7
Close hearth	29	6	35
Total	34	8	42

Table 5. Breakdown of functional results according to type of osteosynthesis material.

Type of osteosynthesis material	Functional results		
	Best results	Good results	Total
Screw	5	-	5
Pin	27	5	32
Screw + pin	5	-	5
Total	37	5	42



Figure 3. Functional result of Salter and Harris' type II patient after reduction and screwing.



Figure 4. Functional result at 17 months postoperative.

4. Discussion

The limits of this study are the size of the population, several operation surgeons, insufficient delay.

Epiphyseal detachment fractures of the distal end of the femur are a relatively rare pathology in children [13] [14]. These injuries account for 1% - 6% of the physical injuries and 1% of the child's fractures [14]. Some authors [15] [16] estimate that in recent years, a decrease in growth cartilage injuries related to road accidents has been observed, with an increase in injuries related to sports, particularly violent sports. Prevalence in road accidents was found in our series.

Anatomy-pathology: All epiphyseal detachment fractures were closed and unilateral. In 33 cases, it was located at the level of the distal end of the right femur. Salter and Harris's classification, types I and II were the most frequently encountered: type I 24% (n = 10), type II 71% (n = 30). Many authors [17] [18] find the high frequency of these two types. The average admission time was relatively short compared to other African series [18] [19], this could be explained by the origin of our patients from the urban and peri-urban area of Bamako. The treatment of an epiphyseal fracture-detachment is the best the same day [20],

because the method of reduction using forced maneuvers and late reductions beyond 10 days are harmful.

The treatment, whether orthopedic or surgical, should not be an additional trauma [21]. Our series is characterized by the exclusivity of the surgical act compared to other series. This surgical stabilization is reserved for unstable Salter-Harris type I and II epiphyseal detachments, displaced type III and IV epiphyseal detachments with joint incongruence and secondary displacements during orthopedic treatment [21].

Surgical treatment was performed in all our patients: Percutaneous osteosynthesis under fluoroscopic control in 35 patients and osteosynthesis after a posterolateral approach in 7 patients. This treatment is recommended by some authors [22] [23]. Currently, osteosynthesis techniques have been adapted to children and have become common practice [23], ensuring long-term results and preventing misalignment complications. NEUGEBAUER [24] recommends percutaneous fixation under arthroscopy in Salter-Harris type IV with joint incongruence. This method allows visualization of the articular surface, the repositioning of the fragment and the repair of any associated lesion. Fluoroscopic control makes it possible to evaluate the reduction and the fixation.

Surgical approach to an epiphyseal fracture-detachment has its rules:

- Epiphyseal fragment must retain its vascularization.
- Careful approach saves the periosteal flap which is sometimes the only element that joins the epiphysis to the metaphysis.
- Approach must spare the perichondral shell.
- No deperiostomy is authorized, even to check the quality of the reduction; the check must be done by a short arthrotomy for the types with articular incongruence.

High rate of surgical indication is related on the one hand to the advantages of percutaneous osteosynthesis, and on the other hand, to the risks of secondary displacements observed during orthopedic treatment and which are relatively high in some authors [23] [24].

Fixation was achieved by KIRSCHNER wires in 32 patients in our series, screws (cancellous, with or without washer) in 5 patients, pins and associated screws in 5 patients. Fixing detachments with KIRSCHNER wires of small caliber, 15 to 18/100 is recommended by many authors [24], however care must be taken to avoid crossing the wires at the level of the growth cartilage, source of poor control of rotation and placement of the pin all at once when it has to cross the physis [24]. Screwing is strictly transverse to avoid damaging the perichondral shell; the screw must not cross the growth cartilage except at the end of growth [25].

Complications: Stiffness and amyotrophy were present in some of our patients, they are not related to trauma to the growth cartilage but to the immobilization of the knee, to percutaneous osteosynthesis and finally to the difficulties of mobilization and functional rehabilitation postoperative in child [26]. Existence of a shortening was noted in 7 patients, 5 of whom presented a shortening

of less than 2 cm and 2 patients a shortening between 2 and 4 cm. Varus deformity existed in 4 patients with varus less than or equal to 5°, one patient presented a valgum of more than 5°. These angular deviations and these epiphysiodeses have several origins: the trauma itself, iatrogeny (several passages of the pins through the growth plate, the screws tightening the growth plate), the reduction defect [26].

After therapeutic evaluation, our results were satisfactory (80% very good results, 20% good results) unlike the neglected epiphyseal undermining of the distal end of the femur where the results were generally poor [27]. They are consistent with those of the literature where better results were obtained with osteosynthesis than with orthopedic treatment. Orthopedic treatment is only justified if the reduction is perfect and seems immediately stable, this eventuality seems rare.

5. Conclusion

Traumatic epiphyseal fractures-detachments of the distal extremity of the femur are a rare lesion whose severity is linked to disabling sequelae such as unequal limb length or most often axial deviation. They occur most often in adolescents, which tempers the consequences of early growth cartilage epiphysiodesis. Surgical treatment aims to reconstruct the anatomy of the distal femur, avoid secondary displacement and allow early knee mobilization. Surgery performed essentially by the technique of pinning or screwing, with an open hearth or better still with a closed hearth can be a source of complications, in particular by the migration of the pins, infections, stiffness of the knee, growth disorders. A better knowledge of this pathology is essential to improve its management, in order to prevent these complications.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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