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Original article

## Unicondylar fractures of the distal femur



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### ABSTRACT

**Background:** Unicondylar fractures of the distal femur are rare, complex, intra-articular fractures. The objective of this multicentre study was to assess the reduction and fixation of unicondylar fractures.

**Hypothesis:** Anatomic reduction followed by strong fixation allows early rehabilitation therapy and provides good long-term outcomes.

**Material and methods:** We studied 163 fractures included in two multicentre studies, of which one was retrospective ( $n = 134$ ) and the other prospective ( $n = 29$ ). Follow-up of at least 1 year was required for inclusion. The treatment was at the discretion of the surgeon. Outcome measures were the clinical results assessed using the International Knee Society (IKS) scores and presence after fracture healing of malunion with angulation, an articular surface step-off, and/or tibio-femoral malalignment.

**Results:** Mean age of the study patients was  $50.9 \pm 24$  years, and most patients were males with no previous history of knee disorders. The fracture was due to a high-energy trauma in 51% of cases; 17% of patients had compound fractures and 44% multiple fractures or injuries. The lateral and medial condyles were equally affected. The fracture line was sagittal in 82% of cases and coronal (Hoffa fracture) in 18% of cases. Non-operative treatment was used in 5% of cases and internal fixation in 95% of cases, with either direct screw or buttress-plate fixation for the sagittal fractures and either direct or indirect screw fixation for the coronal fractures. After treatment of the fracture, 15% of patients had articular malunion due to insufficient reduction, with either valgus-varus (10%) or flexion-recurvatum (5%) deformity; and 12% of patients had an articular step-off visible on the antero-posterior or lateral radiograph. Rehabilitation therapy was started immediately in 65% of patients. Time to full weight bearing was 90 days and time to fracture healing 120 days. Complications consisted of disassembly of the construct (2%), avascular necrosis of the condyle (2%), and arthrolysis (5%). The material was removed in 11% of patients. At last follow-up, the IKS knee score was  $71 \pm 20$  and the IKS function score  $64 \pm 7$ ; flexion range was  $106 \pm 28^\circ$  ( $< 90^\circ$  in 27% of patients); and 12% of patients had knee osteoarthritis.

**Conclusion:** Anatomic reduction of unicondylar distal femoral fractures via an appropriate surgical approach, followed by stable internal fixation using either multiple large-diameter screws or a buttress-plate, allows immediate mobilisation, which in turn ensures good long-term outcomes.

**Level of evidence:** IV, cohort study.

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### 1. Introduction

Unicondylar fractures of the distal femur are rare lesions [1–3] that often occur in combination with other post-traumatic injuries and may therefore fail to be recognised initially. They are caused by

a direct impact on the flexed knee during weight bearing [4]. The fracture line starts in the lateral or medial intercondylar-trochlear groove. At the lateral condyle, the fracture line radiates either in the coronal plane, detaching the most posterior part of the condyle (Hoffa fracture or AO-33 B3 [B3] type fracture); or in the sagittal plane, in an oblique upwards and lateral direction (Trélat fracture or AO-33 B1 [B1] type fracture) [5]. At the medial condyle, the fracture line is rarely in the coronal plane (Hoffa fracture or AO-33 B3 [B3] type fracture) and more often in the sagittal plane (Trélat fracture

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or AO-33 B2 [B2] type fracture) [4–6]. Fracture lines located more posteriorly tend to be located in a more coronal plane [7].

Post-traumatic osteoarthritis is among the complications of intra-articular unicondylar distal femoral fractures [4,8]. Fractures of the lateral condyle carry a risk of malalignment and of degenerative disease of the patello-femoral compartment due to comminution of the cartilage at the anterior part of the fracture line [7]. Avascular necrosis is a potential complication of posterior unicondylar fractures with marked displacement.

To date, no consensus exists regarding the treatment type, surgical approach, or optimal internal fixation technique for unicondylar distal femoral fractures [6,7,9,10].

Our objective was to evaluate correlations linking early and late functional and anatomic outcomes to the treatment used in a multicentre cohort of patients with unicondylar distal femoral fractures. We hypothesised that anatomic reduction and strong fixation would lead to good long-term outcomes by allowing early rehabilitation therapy.

## 2. Patients and methods

Two multicentre studies, one retrospective and the other prospective, were conducted in 12 surgical centres.<sup>1</sup>

Patients with unicondylar fractures of the distal femur were included. Exclusion criteria were pathological fracture, peri-prosthetic fracture of the knee, child younger than 15 years and 3 months, and epiphyseal separation. In all, 163 patients were included. The retrospective cohort consisted of 134 assessable cases managed over a 10-year period (1 January 2001–31 December 2010) and the prospective cohort of 29 patients managed over a 1-year period (1 June 2011–31 May 2012). Follow-up was at least 1 year in all patients. The medical record data and the pre-operative and post-operative radiographs were entered into an online database, as well as the computed tomography (CT) scans obtained in 39% of patients. The data were used initially to validate the classification of the fracture in the AO system [5].

The treatment type and modalities were at the discretion of the surgeon, who could choose between non-operative treatment and operative treatment via an anterior or posterior approach with internal screw or plate fixation. Immediate mobilisation was an option, with no more than 60° of flexion for the first 45 days. Resumption of weight bearing was allowed of the radiographs taken after 2 months showed that the fracture was healed.

Fracture site deformities after treatment were assessed on antero-posterior and lateral radiographs and classified as malunion with more than 2° of angulation, a greater than 2 mm articular surface step-off, or tibio-femoral malalignment exceeding 5°. Congruity of the lateral or medial tibio-femoral compartment and patello-femoral compartment was assessed. The International Knee Society (IKS) knee and function scores were determined at last follow-up [11]. Clinical and radiographic follow-up was provided for at least 1 year, and the data at last follow-up were recorded.

Statistical comparisons relied on the Chi<sup>2</sup> test, non-parametric Fisher test, and non-parametric Mann-Whitney test. Values of  $P \leq 0.05$  were considered significant.

## 3. Results

### 3.1. Epidemiology

The study population was composed predominantly of males, with an active lifestyle and no history of knee abnormalities (95%)

<sup>1</sup> Presented at the symposium on the treatment of supra-condylar, intercondylar, and unicondylar fractures of the distal femur at the 88th annual meeting of the SoFCOT held in Paris in November 2013.

**Table 1**  
Epidemiological data.

<i>n</i> = 163	
Age (years), mean ± SD	50,9 ± 24 [17–93]
Male/Female ratio	1,6
Side: Right/Left (%)	51/49
Compound fracture (%)	17
Multiple fractures (%)	44
Knee osteoarthritis (%)	5
<i>Type of trauma (%)</i>	
Fall from standing height	42
Fall from high place	8
2-wheel motor vehicle accident	23
Car accident	11
Pedestrian-motor vehicle accident	5
Sports accident	4
Other	7
<i>AO-33 B Fracture type (%)</i>	
66 B1	40
68 B2	42
29 B3	18
<i>Treatment (%)</i>	
Surgical/non-surgical	95/5

(Table 1). Mean age was 50.9 ± 24 years (range, 17–93 years). The fracture was due to a high-energy trauma in 51% of cases. In addition, 17% of patients had compound fractures and 44% had multiple fractures or injuries.

Of the 163 fractures, 134 (82%) were sagittal, including 66 lateral B1 fractures and 68 medial B2 fractures. The remaining 29 (18%) lesions were coronal B3 fractures.

### 3.2. Treatments

Non-surgical treatment was chosen in 9 (5%) patients. These patients were young individuals with non-displaced fractures, or patients with very limited functional demands, elderly patients with osteoporosis, or patients with B3 posterior unicondylar fractures. The treatment consisted only in a very short period of immobilisation, followed promptly by mobilisation of the knee.

Surgical treatment was performed in 154 (95%) patients. Table 2 lists the intra-articular lesions documented during surgery. Of the patients with B1 fractures, 5% had damage to the lateral meniscus and 8% to the cruciate ligaments. Of patients with B2 fractures, 2% had lesions of the medial meniscus and 9% of the cruciate ligaments. Finally, among patients with B3 fractures, 12% had meniscal lesions and 23% lesions of the cruciate ligaments.

Table 3 shows the approaches and internal fixation methods used in the 154 surgically treated patients. The approach was antero-lateral for B1 fractures and antero-medial for B2 fractures. Among B3 fractures, 78% were managed via an antero-lateral or antero-medial approach and 22% via a postero-lateral or postero-medial approach. Fixation of B1 and B2 fractures was usually achieved using screws or buttress-plates (Fig. 1a and b) (95%); in a few cases (5%), staples or pins were used. Fixation of B3 fractures relied on screws in 93% of cases; in 78% of cases, lag screws were inserted anteriorly (Fig. 2a) and in 15% screws were inserted directly via a posterior approach (Fig. 2b). In the remaining 7% of B3 fractures, fixation was with staples or pins.

**Table 2**  
Intra-articular lesions documented during surgery.

AO-33 B type <i>n</i> = 154 (%)	Lateral meniscus (%)	ACL (%)	Medial meniscus (%)	PCL (%)
B1 (40)	5	3		5
B2 (42)		6	2	3
B3 (18)	8	15	4	8

ACL: anterior cruciate ligament; PCL: posterior cruciate ligament.

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