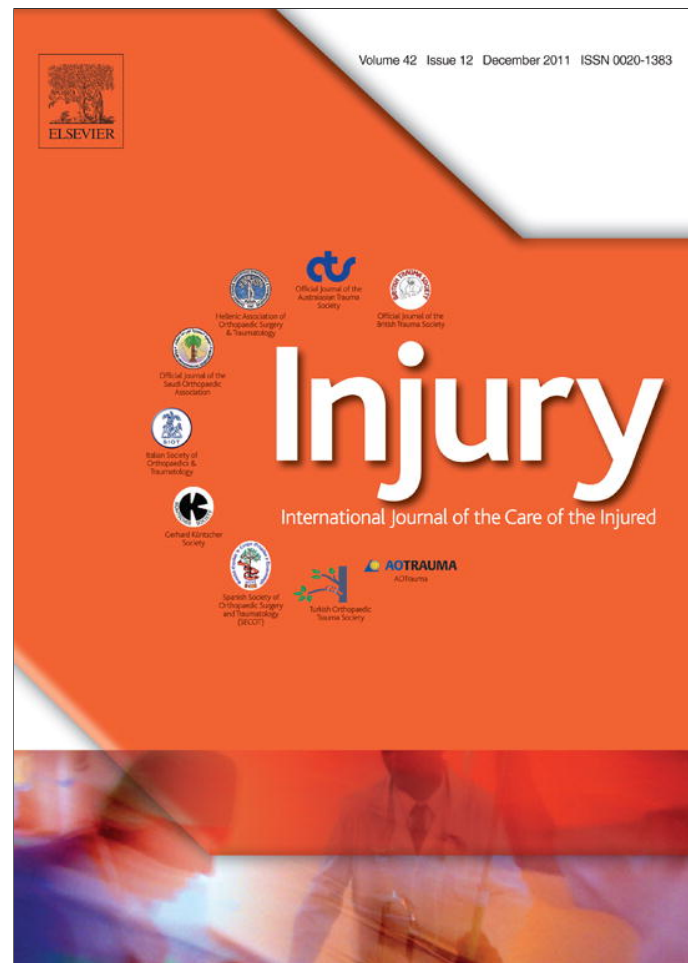


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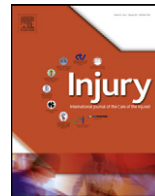


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Operative management of Hoffa fractures—A prospective review of 18 patients

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ABSTRACT

Objectives: Hoffa fractures represent coronal fractures of the femoral condyles. Isolated Hoffa fractures are rare and current management of these fractures is based on a few descriptions in literature. The goal of the study was to prospectively analyse the clinico-radiological and functional outcome following open surgical treatment.

Patients and methods: A total of 18 isolated Hoffa fractures were identified during the study period spanning 29 months. All fractures were treated by open reduction through a medial parapatellar approach. Internal fixation was performed with screws in the anteroposterior/posteroanterior (AP/PA) direction. Immediate active mobilisation with restricted weight bearing was instituted postoperatively. Radiological and functional outcome analysis using Knee Society scores and International Knee Documentation Committee scores were performed at follow-up visits until 1 year.

Results: Union was achieved in all patients. The articular surface was reduced anatomically in all but one patient. There was no loss of reduction or fixation. Functional outcome measures showed a continuous significant improvement in function over the 1-year follow up period. Complications include stiffness and pain in one patient, collateral laxity in two patients and progression of arthritis in one patient.

Conclusion: Hoffa fractures are intra-articular and are best treated by anatomical reduction and rigid fixation followed by early mobilisation. Open reduction increases the chances of achieving anatomical reduction and gives satisfactory functional results when coupled with aggressive rehabilitation.

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Coronal fractures of the distal femur, commonly referred to as 'Hoffa' fractures,¹ represent coronal fracture lines in the lateral or medial femoral condyle. Isolated Hoffa fractures are rare but they occur commonly with intercondylar and supracondylar fractures.² There is a clear preponderance for the lateral condyle and bicondylar involvement has also been described.³ These fractures are usually seen in the setting of high-velocity injuries and other associated fractures especially in the same femur may be present. The mechanism of violence is unknown but both direct impact and vertical shear with twisting mechanism have been postulated.^{4,5} The fractures are classified by OTA as 33-B3. The coronal orientation of the fracture lines makes it difficult to diagnose in the initial X-rays, especially if the fracture is undisplaced. Displaced fractures can be seen clearly in lateral views. The stability of the knee may be compromised if the fracture involves the ligamentous attachments. These fractures are intra-articular and anatomic reduction and stable fixation is advisable to enable early mobilisation and to prevent arthrofibrosis.⁶

There is very little evidence in literature on results following surgery for these fractures and most of them are isolated case reports. With this background, we performed a prospective trial to evaluate the results of surgical management of isolated Hoffa fractures.

Materials and methods

Between June 2007 and October 2009 (29 months), 25 patients with Hoffa fractures were identified out of 193 patients admitted at our institution with distal femur fractures. Isolated Hoffa fractures (OTA type 33-B1) without associated supracondylar and intercondylar fracture components were included in the study. Patients with open physes, concomitant proximal injuries in the same femur, pathological fractures, polytrauma and patients with pre-existing arthritis compromising knee function (Kellgren–Lawrence (KL) grade IV and above) were excluded. After exclusion, 18 patients with isolated Hoffa fractures (accounting for 9.3% of all distal femur fractures in our institution) were enrolled into the study. Informed consent was obtained from all patients for participating in the trial and the Institutional Review Board approved the study.

Preoperative assessment includes clinical examination, anteroposterior (AP) and lateral X-rays of the involved knee. A three-dimensional computed tomography (CT) scan was taken to assess

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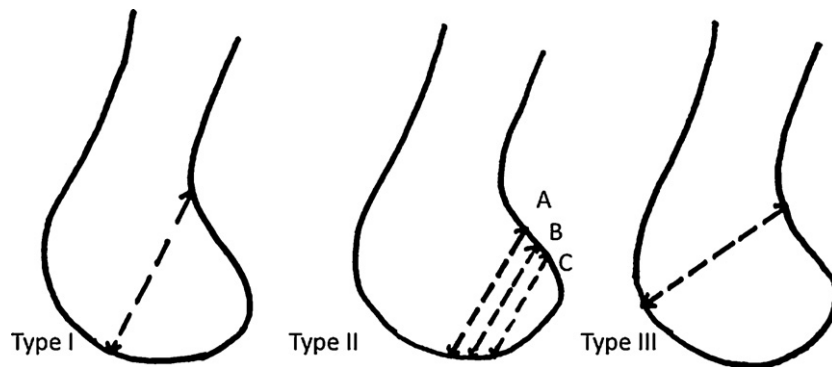


Fig. 1. Letenneur classification of coronal femoral condyle fractures.

the fragment size and plan fixation. Fractures were classified into three sub-types on X-rays based on fracture location as described by Letenneur et al.⁷ in 1978 (Fig. 1). There were eight type 1 fractures, four type 2 fractures and six type 3 fractures. Two of the 16 fractures were undisplaced. Eleven fractures involved the lateral condyle and seven fractures involved the medial condyle. The fracture involved the right knee in eight patients and the left in 10 patients. Anterior subluxation/dislocation of the knee joint was present in two patients. All fractures were closed and there were no associated neurovascular injuries. The mean age was 33 years (22–47 years). There were 10 males and eight females. The mode of injury was motor vehicle accidents in 15 patients and high-velocity falls in three patients. Surgery was performed with a mean delay of 2 (0–7 days) days after the injury.

An open approach was adopted for all fractures (displaced/undisplaced). A midline incision with a medial parapatellar arthrotomy was used for open reduction and internal fixation (ORIF), irrespective of the condyle involved. Four-millimetre fully/partially threaded cancellous screws with or without washers were used for AP fixation. Headless screws (2.4 mm) were used when the PA direction was used. The screw direction and type of screws used were left to the discretion of the treating surgeon. The starting point for AP screw insertion was just proximal to the patellofemoral joint or on either side of the femoral trochlea. Screws were placed perpendicular to the fracture line with maximal spread, as possible. A maximum possible screw length was used to optimise purchase. A minimum of two screws was used to provide rotational stability. PA screw insertion was performed with the knee was hyperflexed ($>120^\circ$). Care was taken to protect the fat pad and meniscal attachments. Headless screws (2.4 mm) were used for fixation. Bony sleeve avulsions involving collateral attachments were fixed with 6.5 mm cancellous screws with washers.

Active range of motion exercises were started from the first postoperative day and a supervised home physiotherapy programme was initiated after discharge. Initially, patients were kept non-weight bearing but progressed to full weight bearing by 10 weeks. Patients were discharged at a mean of 6 days after surgery (4–10 days). Follow-up visits conducted at 3, 6, 9 and 12 weeks, thereafter at 6 and 12 months. Knee Society clinical score (KSS) and International Knee Documentation Committee (IKDC) subjective scores were obtained at 3, 6 and 12 months.

Statistics

Statistical analysis was performed with Statistical Package for Social Sciences (SPSS) 16. Continuous data were described as means and standard deviation, whilst the categorical data were tabulated as absolute and relative frequencies. The changes in continuous variables between follow-ups were assessed using a series of paired *T*-tests. The influence of categorical factors (gender, condylar involvement, fracture subtypes and fixation methods) on the continuous variables (KSS and IKDC scores) was assessed by the Kruskal–Wallis test. The level of significance was set at $p < 0.05$ (Fig. 2 and Table 1).

Results

All patients were followed up for 1-year post injury. The mean surgical time was 75 min (45–100 min). The mean blood loss was 200 ml (150–300 ml). There was no evidence of deep infection but two patients had superficial skin infection, which was treated with antibiotics. AP screws were used in six patients and PA screws in the remaining 12 patients. All type 2 fractures were fixed with PA screws. Articular reductions were classified as anatomical, acceptable (<2 mm step) and poor (>2 mm) on the immediate



Fig. 2. Type 3 Hoffa fracture of the lateral condyle with anterior dislocation. Follow up X-rays show anatomical articular reduction using headless screws. A 6.5 mm cancellous screw is used to fix the avulsed LCL attachment.

Table 1
Summarised results of the study.

No	Age/sex	# subtype	Fixation method	KSS (1 year)	IKDC (1 year)	Remarks
1	33/M	Type 1/LC	AP screws/3.5 mm	80	86.2	
2	22/M	Type 1/LC	PA screws/headless	82	85.1	
3	37/F	Type 2/MC	PA screws/headless	78	83.9	
4	47/M	Type 3/LC	AP screws/4 mm	75	79.3	1 grade progression of arthritis
5	43/F	Type 3/MC	AP screws/4 mm	80	82.8	
6	36/M	Type 1/LC	PA screws/headless	80	80.5	
7	34/F	Type 1/LC	PA screws/headless	85	81.6	
8	38/M	Type 3/MC	PA screws/headless	85	87.4	
9	29/M	Type 2/LC	PA screws/headless	78	79.3	Grade II LCL laxity
10	26/F	Type 3/LC	AP screws/4 mm	57	60.9	Stiffness, underwent arthroscopic scar excision
11	27/M	Type 1/MC	AP screws/3.5 mm	80	81.6	
12	30/F	Type 2/MC	PA screws/headless	80	81.6	
13	33/F	Type 1/LC	PA screws/headless	80	80.5	<2 mm articular step off, Superficial infection
14	38/F	Type 3/MC	AP screws/4 mm	82	80.5	Superficial infection
15	34/M	Type 2/LC	PA screws/headless	78	79.3	
16	31/M	Type 3/MC	PA screws/headless	80	81.6	
17	30/F	Type 1/LC	PA screws/headless	80	79.3	Grade II LCL laxity
18	32/M	Type 1/LC	PA screws/headless	80	85.1	

M, Male; F, female; LC, lateral condyle; MC, medial condyle; and LCL, lateral collateral ligament.

postoperative radiographs. Seventeen of the 18 fractures were classified as anatomically reduced and one fracture had a <2 mm step off. AP and lateral X-rays were taken during each follow up visit to assess progress in union, loss of reduction and fixation. Union was defined clinically as ability to weight bear without pain and radiologically as obliteration of the fracture line and evidence of bridging trabeculae across the fracture lines. Union was achieved in all patients. There was no loss of reduction or fixation at follow-up. There was no evidence of osteonecrosis or development of degenerative arthritis at final follow-up. The mean KSS and IKDC scores at 12 months were 78.8 ± 5.9 and 80.9 ± 5.5 , respectively (Fig. 3). The scores at 12 months showed a significant improvement over the scores at 3 and 6 months ($p < 0.05$). Gender, fracture of the medial or lateral condyle, fracture sub-types and method of fixation had no influence on the functional outcome ($p > 0.05$).

Complications

One patient developed stiffness and pain following AP screw insertion. He underwent arthroscopic excision of scar tissue in the supratrochlear region with manipulation under anaesthesia at 5 months. Lateral collateral ligament laxity ($5-10^\circ$) compared with the opposite side was seen in two patients after fixation of lateral condyle fractures. Radiological progression of osteoarthritis was seen in one patient by 1 grade (KL grade II to III) at 12 months.

Discussion

'Hoffa' fractures are a rare entity and treatment methodologies are based on a few reports in literature. A high index of suspicion is required for diagnosis on X-rays and preoperative CT scans can help in doubtful cases and in planning definitive treatment. These fractures are intra-articular and non-operative treatment can result in stiffness and poor joint function.⁸ Anatomical reduction is the goal and fixation is generally achieved using screws in varying configurations.

A midline incision with a medial/lateral parapatellar arthrotomy is the most common approach reported.⁹ Direct lateral approach with or without osteotomy of the Gerdy tubercle and posterior-based approaches have also been described.^{10,11} We feel that the medial parapatellar arthrotomy is reproducible, provides good access even on the posterolateral aspect and is familiar to all surgeons with the advent of total knee replacement.

In spite of the popularity of minimal access techniques, open approaches are preferable in Hoffa fractures for the following reasons: (1) chances of displacement after initial evaluation is possible and subtle displacements may not be appreciated intra-operatively, (2) assessment of fracture reduction with conventional fluoroscopy is difficult and (3) assessment of optimal screw length without intra-articular penetration is best done under vision. Arthroscopy-assisted reduction and fixation of Hoffa fractures have been reported recently.^{12,13} The authors

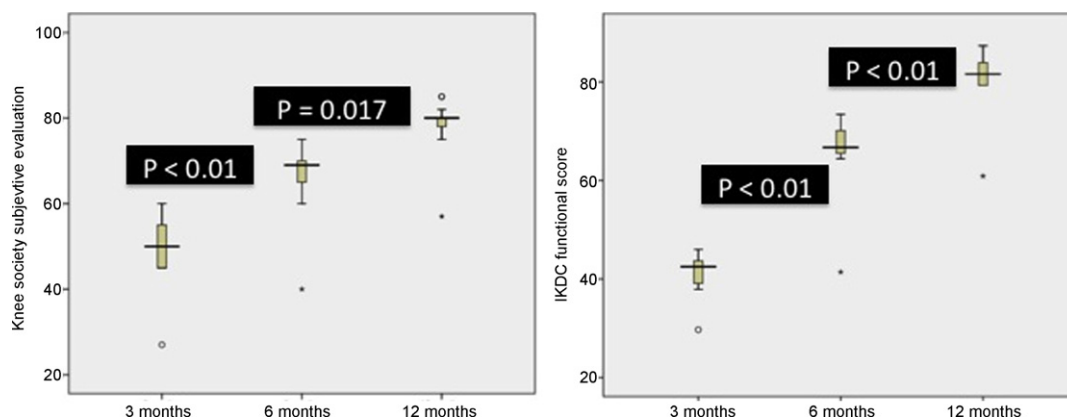


Fig. 3. Boxplots show follow up KSS and IKDC scores. *p* values indicate the level of significance between contiguous follow up scores.

claim it is technically difficult but the technique may hold future promise.

A few reports have previously recommended prolonged immobilisation in flexion or cylinder casts after AP screw fixation. This is to minimise high shear stresses especially in extension and subsequent loss of fixation.¹⁴ Jarit et al. reported that PA screws showed less displacement than AP screws when subjected to vertical loads.¹⁵ The PA screws need to be countersunk, which causes cartilage damage. This was addressed in the current study using headless screws. The use of headless screws for Hoffa fractures has been described previously in a case report.¹⁶ The drawback with the headless screws is their small size and length and more than two screws are required for stable fixation. All type II fractures in the study were addressed with PA screws, as we felt that the fragments are too small for the AP screws to get a secure purchase.

Following cadaveric studies, Letenneur et al.⁷ classified fractures based on the integrity of soft-tissue attachments in an attempt to predict the occurrence of avascular necrosis (AVN). Types I and III have residual soft-tissue attachments, whilst type II fractures are more posterior and have minimal or no attached soft tissues. They proposed higher rates of AVN in type II fractures, but it has not been translated in clinical studies. The absence of AVN in the current series refutes it further but the sample size is small and the follow-up period is short.

In summary, Hoffa fractures are intra-articular and anatomical reduction with stable fixation may provide the best possible long-term outcome. This study is unique in being the first prospective trial on the topic, to the best of our knowledge. Its other strength is the use of validated objective and subjective scores to evaluate the results. The limitations of the study are short follow-up and the use of non-homogeneous fixation techniques. The lack of controls and small sample size are difficult to overcome due to the rarity of the fracture.

Conflict of interest

The authors declare no conflict of interest.

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