Nonunion of coronal shear fracture of femoral condyle

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【**Abstract**】Isolated coronal fractures of femoral condyle are rare in adults and nonunion of Hoffa fracture is reported only a few times in the literature. We analyzed six cases of nonunion of Hoffa fractures over a period of three years. Three patients were treated conservatively and three patients had fixation failures. Delay of presentation was 2 months to one year. Treatment protocol consisted of open reduction, excision of pseudoarthrosis, bone grafting and internal fixation along with knee arthrolysis. Union was achieved in all patients at mean 16 weeks. The treatment of nonunion of Hoffa fractures requires careful preoperative planning and meticulous surgical technique. The literature regarding the controversies in fracture management and surgical technique are reviewed.

Key words: ***Femoral fracture; Fracture fixation, internal; Retrospective studies***

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Hoffa fracture is a coronal shear fracture of femoral condyle and is a rare injury.[1] It accounts for less than 1% of femoral fractures and results from high energy trauma.[1,2] These fractures are unstable due to bony instability as well as muscular pull.[2] The recommended treatment is open reduction and internal fixation (ORIF). The nonunion of Hoffa fracture is reported in case reports only.[2-5] We studied six cases of nonunion of Hoffa fracture and discussed their management along with a review of literature.

METHODS

A retrospective record of nonunion of Hoffa fractures between 2006 and 2009 was retrieved from medical records department. Inclusion criteria were coronal fracture of femoral condyle, fractures with duration of more than 3 weeks and fixation failures resulting in nonunion. Eight patients were identified with inclusion criteria and 6 were available for follow-up, hence they were all included in the study. Classification of Letenneur et al[6] was used. The injury mechanism, clinical examination and radiographic data were recorded in each patient. Anteroposterior (AP) and lateral radiographs of knee and CT wherever available were taken for the study. Blood investigations (hemogram, erythrocyte sedimentation rate, C-reactive protein) and knee aspiration were done in all cases to rule out preoperative infection.

Surgical technique

Under regional/general anaesthesia and tourniquet control, lateral or medial parapatellar approaches were used depending on the location of fracture and previous incision was utilized wherever present. Marked patellofemoral adhesions made eversion of the patella difficult. Patella was everted and joint was inspected. Fracture area was exposed by sharp dissection over the condyles after removal of adhesions and fibrosis. The hardware, if any, was removed and the fibrous adherence of the fracture fragments was removed by sharp osteotomes. Knee was flexed and posterior surface of the Hoffa fragment was released of the adhesions. Pseudoarthrosis was excised and fracture ends were debrided until cancellous bleeding edges were visible. The fracture was anatomically reduced and held by pointed reduction clamps. After placing the corticocancellous autologous graft (ipsilateral iliac crest) between the fracture fragments, guidewires for screw placement were inserted just proximal to the patellofemoral joint with direction perpendicular to the fracture line. The wires were taken out at the articular surface of posterior part of the cartilage. Screw length was measured and the screws was made paralleled. The 4.5 mm Herbert screws/cannulated cancellous

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screws (CCS) were used for compression. For smaller articular fragments, 2.7 mm miniscrews/Herbert screws were used. Reconstruction plates contoured on posteromedial nonarticular surface were used in two cases (Figures 1-2). Knee stability and range of motion were checked and wound closure was done on suction drains.

RESULTS

There were five males and one female with mean age of 36 years (range: 18-46 years). There were 3 cases of fracture in medial femoral condyle and 3 in lateral femoral condyle. As for Letenneur classification, four fractures were of type III and two of type II. Three cases were treated by open reduction and internal fixation with Herbert screws/CCS at other institutions. Three cases of primary nonunion were treated by casts and braces. Delay of presentation was 2 months to one year (Table 1). All the patients complained of pain during ambulation and presented with knee deformities. Mean range of motion was 30°-70° with varus deformity of 16° and 20° in two cases of medial Hoffa nonunion. No evidence of infection was found. No intraoperative complications were observed. There were no superficial or deep infections. Union was present clinically and radiologically in all cases at a mean of 16 weeks. Mean follow-up was 2.2 years (1-3 years). Mean extension was 6° (range: 0°-10°) and mean flexion was 115°(range: 100°-125°). There was no varus and valgus instability. Preoperative varus in two cases was corrected, but residual 3° of varus was observed at follow-up. There was no case of avascular necrosis or osteoarthritis.

Figure 1. A and **B:** AP and lateral radiographs of lateral Hoffa fracture at initial injury. **C** and **D:** AP and lateral radiographs after one year of conservative management. The fracture fragment has displaced proximally with sclerosis of fracture ends. Marked varus is seen in AP view. **E:** Clinical picture of the flexion and varus deformities in supine position. **F** and **G:** AP and lateral radiographs after ORIF by 4.5mm Herbert screws and locking reconstruction plate. The varus deformity correction is seen in AP radiograph and clinically.

Figure 2. A and **B:** AP and lateral views of lateral Hoffa fracture. **C** and **D:** AP and lateral radiographs 6 months after ORIF with CCS. The nonunion is seen in lateral radiograph. **E** and **F:** Postoperative radiograph after re-fixation by CCS, locking plate and bone grafting.

Table 1. Demographic data of the patients

No.	Age (years)	Sex	Type of fracture	Delay in presentation (months)	Primary treatment	Implants	Range of motion (°)
1	46	Male	III, medial condyle	12.0	Conservative	Herbert screw and plate	6-100
2	32	Male	III, lateral condyle	6.0	Cancellous screws	CCS+ plate	6-96
3	34	Male	III, lateral condyle	5.0	Conservative	CCS	0-100
4	18	Male	II, medial condyle	3.0	ORIF by CCS	Herbert screws	10-100
5	44	Male	III, lateral condyle	2.5	Conservative	CCS	15- 98
6	42	Female	II, medial condyle	2.0	Herbert screws	CCS	10-100

DISCUSSION

Hoffa fractures are uncommon injuries with lateral condyle more commonly affected than the medial condyle.[3] They usually occur as isolated injuries but have been reported to be associated with 17% of supracondylar and intercondylar fractures.[7] Mechanism of injury postulated is a shear force on the posterior femoral condyle. Hoffa fracture effectively separates the patellofemoral joint from the tibiofemoral joint, thus weight bearing and knee movements lead to high shear forces along the fracture line.[3] The pull of the gastrocnemius and popliteus also contributes to the instability. It is an unstable intraaticular fracture configuration as it is subjected to shear stresses in both coronal and sagittal planes.[2] Thus nonoperative management in displaced Hoffa fracture is unpredictable and surgical treatment is warranted. The rate of nonunion of Hoffa fracture is not known because only four cases of primary nonunion are reported till date. [2-5]

Letenneur classified these fractures into three types: I, II and III, with three subtypes of type II.[6] Type II fractures are completely free in joint without any soft tissue attachment, thus making this fracture susceptible to nonunion.[5] Type III fractures respond poorly to conservative management because of displacement of the fracture as the fracture line runs obliquely to the femur. [4] In our series, primary nonunion occured in three cases of type III. They were treated conservatively by bone setters, resulting in subsequent nonunion. Fixation failures happened in type II (*n*=2) and type III (*n*=1) fractures due to poor surgical technique. The treatment is still controversial in view of the surgical approach, osteosynthesis, direction of implants and postoperative rehabilitation. [3, 8-10]

Hoffa fracture, as an articular fracture, requires open reduction, stabilization with good exposure of the fracture fragments posteriorly. In cases of nonunion, standard lateral and medial approaches are used. For a lateral condyle Hoffa fracture, the lateral approach can be used to gain access to the posterior portion of the lateral femoral condyle between the iliotibial band and the biceps femoris tendon, but this has the risk of damaging the common peroneal nerve running along the posterior border of the biceps. The posterior approach puts the popliteal vessels at risk.[10] We used standard approaches with arthrotomy and patellar eversion for complete exposure of the joint. Wide exposure was required due to fibrosis and adhesion. The fracture fragments were markedly osteoporotic in two cases due to long-standing neglect. In two cases the fracture fragments were completely devoid of soft tissue attachments. Autologous bone graft was placed between fractured fragments before internal fixation. They united well and the patients had stable, painless knees with

good function. The osteochondral fracture fixation was similar to the reconstruction reported in capitellar fracture and radial head fractures.[11, 12] No signs of avascular necrosis were present at follow-up of these patients. We used autologous bone graft in all cases due to nonunion of fracture fragments.

The direction of screw insertion may also vary; a biomechanical study found the posteroanterior (PA) manner of screw insertion superior to AP insertion.[13] A lateral or posterior surgical approach is necessary when using the PA direction. Countersinking of screws has to be beneath the articular surface with disruption of the cartilage in PA direction of screws. We used AP direction of screws in all cases because it is convenient with standard approaches.

The lag screw provides interfragmentary compression and is reportedly stable enough in normal bone without comminution. The buttressing of the fragment requires screw placement on the posterior aspect just above the fragment to prevent superior migration but the parapatellar approach provides limited access. The fixed fragment is continuously exposed to shear stress in sagittal plane during flexion and extension and varus and valgus stress in coronal plane.[10] Thus a varied period of posterior splintage is reported for 3-6 weeks so as to tighten the posterior capsule to act as splintage for posterior femoral condyle.[14] In osteoporotic fracture fragments, the strength of screw is diminished.[10] Displacement of fracture fragments and reoperation are reported due to poor screw fixation and biplanar stresses during rehabilitation.[15] Thus the stability of the construct should be checked intraoperatively. In two cases, we applied locking reconstruction plate in addition to screw fixation so as to increase the stability of the construct and provide early mobilization.

The second attempts to gain union in these intraarticular fractures are difficult and careful preoperative planning with meticulous surgical technique is required to achieve good functional results. Even if a large defect is created, the bone stock would be available for future replacement surgery. Freshening of the bone ends, bone grafting and stable fixation with early mobilization achieve good results. Though avascular necrosis is a potential complication, one should fix a fracture fragment even if it is devoid of soft tissue attachments.

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