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Original article

Role of Joshi's external stabilization system with percutaneous screw fixation in high-energy tibial condylar fractures associated with severe soft tissue injuries

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ABSTRACT

Purpose: The treatment of high-energy tibial condylar fractures which are associated with severe soft tissue injuries remains contentious and challenging. In this study, we assessed the results of Joshi's external stabilization system (JESS) by using the principle of ligamentotaxis and percutaneous screw fixation for managing high-energy tibial condylar fractures associated with severe soft tissue injuries.
Methods: Between June 2008 and June 2010, 25 consecutive patients who were 17–71 years (mean, 39.7), underwent the JESS fixation for high-energy tibial condylar fractures associated with severe soft tissue injuries. Out of 25 patients, 2 were lost during follow-up and in 1 case early removal of frame was done, leaving 22 cases for final follow-up. Among them, 11 had poor skin condition with abrasions and blisters and 2 were open injuries (Gustilo-Anderson grade I & II). The injury mechanisms were motor vehicle accidents ($n = 19$), fall from a height ($n = 2$) and assault ($n = 1$). The fractures were classified according to Schatzker classification system.
Results: There were 7 type-V, 14 type-VI and 1 type-IV Schatzker's tibial plateau fractures. The average interval between the injury and surgery was 6.8 days (range 2–13). The average hospital stay was 13 days (range, 7–22). The average interval between the surgery and full weight bearing was 13.6 weeks (range 11–20). The average range of knee flexion was 121° (range 105°–135°). The normal extension of the knee was observed in 20 patients, and an extensor lag of 5°–8° was noted in 2 patients. The complications included superficial pin tract infections ($n = 4$) with no knee stiffness.
Conclusion: JESS with lag screw fixation combines the benefit of traction, external fixation, and limited internal fixation, at the same time as allowing the ease of access to the soft tissue for wound checks, pin care, dressing changes, measurement of compartment pressure, and the monitoring of the neurovascular status. In a nutshell, JESS along with screw fixation offers a promising alternative treatment for high-energy tibial condylar fractures associated with severe soft tissue injuries.

1. Introduction

The severity of a tibial plateau fracture and complexity of its treatment depends upon energy imparted to the limb.[1] High-energy tibial plateau fractures are characterized by significant fracture comminution and associated soft tissue damage with implications for healing.[2,3] Open reduction and internal fixation of these types of fractures have significant complication rates.[4] Not only is the severity and number of complications high, but the number of repeat surgical interventions and their severity is greater. It requires extensive surgical exposure that leads to problems with wound healing and infection in the compromised soft tissue environment. Also, surgical incision may hamper future total knee arthroplasty, if the need arises.[5]

To overcome the drawbacks of nonoperative and other operative modalities, the minimally invasive technique of closed reduction by ligamentotaxis and fixation with percutaneous screws and K-wires has been developed and practiced. These techniques combine

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attributes of operative and nonoperative philosophies, are more biological and give excellent functional results.[3,6–8]

We reviewed our results with the use of Joshi's external stabilization system (JESS) with percutaneous screw fixation for the treatment of 25 high-energy tibial plateau fractures (Schatzker type IV, V & VI type) to evaluate the outcome and the merits and demerits of this modality of management in tibial condylar fractures. JESS frame provides adequate fixation of fracture in short operative time with no further damage to soft tissue and requires only basic instruments for surgery. Early mobilization of knee is possible with this device. Postoperative control of deformity and fracture is also possible. It also provides good clinical results and patient satisfaction.[9]

2. Materials and methods

Totally, 25 patients with high-energy tibial plateau fractures, treated with JESS Helmet frame and percutaneous screw fixation from June 2008 to June 2010, were reviewed. Patients having high-energy tibial condylar fracture (Schatzker type IV, V &VI type) irrespective of age and sex were included. Open fractures (except Gustilo type I & type II), soft tissue infection at fracture site and patients not willing to take part in the study were excluded. Schatzker classification[10] was used to classify these fractures. Data were collected at the time of admission to elicit age, sex, type of fracture, mode of injury, date of injury and any other associated injuries.

After careful physical examination of the knee and leg, a lower tibial pin was passed and traction was applied on Bohler Braun splint with continuous attention to peripheral circulation of involved limb till definitive fixation.

Initial radiographs included anterioposterior and lateral views of involved knee. Computed tomography with 3-D reconstruction was done to evaluate the degree of displacement.

2.1. Surgical technique

Reduction of the fracture was done by traction ligamentotaxis on a fracture table in supine position under fluoroscopic control. Limited open reduction was done in 10 cases along with bone grafting for restoration of the depressed articular surface and pointed reduction forceps was used to compress the fracture fragments. A 2 mm guide wire was passed 5 mm–10 mm distal and parallel to the joint line across the two displaced major fragment. Tibial condyle was fixed with 6.5 mm cannulated cancellous screw passed over guide wire. Three 2.0 mm K-wires were passed from postero-lateral, postero-medial and transverse direction to the proximal tibia at the level of the guide wire. A 14 inch long and 4 mm thick connecting rod was bent to make 5/8th of a circle and all wires were connected to this rod with 4 × 4 link joint, this helmet frame was reinforced with another connecting rod. Three K-wires each of 3 mm were passed perpendicular to long axis of tibia in diaphyseal region to construct diaphyseal hold. These K-wires connected with 'Z' connecting rods. This diaphyseal hold was connected to the metaphyseal helmet hold with two anterior and two posterior connecting rods to complete the procedure.

2.2. Postoperative period and follow-up

Isometric quadriceps exercise and knee mobilization were started from postoperative day one to achieve full extension and 90° of flexion of knee joint as soon as possible. Partial weight bearing was allowed at 6–8 weeks and was gradually increased as tolerated. JESS helmet frame was removed after 14–16 weeks on evidence of clinical and radiological union and long knee brace was given for support if the patient had gross comminution. Patients were followed at regular interval till last follow–up and evaluated with the Rasmussen's criteria[11] & Iowa knee score.[12]

3. Results

Out of 25 patients, 2 were lost during follow-up and in 1 case early removal of frame was done (case 23), leaving 22 cases for final follow-up. There were 20 males (90.9%) and 2 females (9.09%) patients with a mean age of 39.7 years (17–71 years). Road traffic accidents were the major cause of injury (19 cases, 86.36%), fall from height (2 cases, 9.09%) and assault (1 case, 4.54%) were other culprits. Four patients (18.18%) had other major ipsilateral lower extremity injuries. According to Schatzker classification, there were 14 type VI (63.64%), 7 type V (31.81%) and 1 type IV (4.54%). Out of 22 cases, 11 patients (50.00%) had poor skin condition in form of abrasions or blisters and 2 patients (9.09%) had Gustilo type I and II injury respectively which were immediately irrigated and debrided prior to definitive fixation (Figs. 1 and 2). Patients were operated at a mean interval of 6.8 days (range 2–13 days). The delay in surgery was due to poor skin conditions. Limited open reduction was allowed only after such injuries resolved. Out of 22 cases, 10 cases (45.45%) required additional bone grafting to fill up the gap which was made after elevating and maintaining the articular surface during surgery. Mean interval between surgery and partial weight bearing was 8.9 weeks (range 8–13 weeks). Causes of delayed partial weight bearing ($n = 2$, 9.09%) was mainly other associated injuries which require prolonged nonweight bearing. Mean interval between surgery and full weight bearing was 13.6 weeks (range 11–20 weeks). Most of the patients were allowed complete weight bearing at 10–15 weeks.

Two patients (9.09%) had delayed complete weight bearing because of excessive comminution at fracture site. The JESS helmet frame was retained till the signs of union were seen on X-rays. The mean interval between surgery and removal of JESS frame was 16 weeks (range 10–25 weeks). In one case early removal (at 10 weeks) of frame was done (case 23) because of preoperative peroneal nerve palsy for which patient underwent surgical intervention. The most common complication seen was superficial pin track infection ($n = 4$) which was easily controlled by regular pin track dressing and a course of oral antibiotics. Deep infection, septic arthritis, non union or breakage of wires was not noted in any of the patients.

Patients were followed up for a minimum of 1 year with a mean of 27 months (12–40 months). The mean score according to Rasmussen's criteria at the final follow-up was 42.7. All cases had excellent or good outcome at 1 year follow-up. The mean Iowa Knee score was 91.5. Total range of motion 120° or more was noted in most of the patients. Out of 22 cases 18 patients (81.81%) had total range of motion (ROM) 120° or more. 2 cases (9.09%) had more than 130° range of motion and 2 cases (9.09%) had range of motion up to 105°. Mean range of knee motion was 121° (range 105°–135°). Normal extension of knee was observed in 20 patients (90.9%) and extensor lag of 5°–8° was noted in 2 patients (9.09%, Figs. 3 and 4).

4. Discussion

High-energy tibial plateau fractures are recognized by complex fracture patterns with associated serious soft tissue injury internally and externally, which presents multifaceted problems of difficulty in achieving a stable, aligned congruous joint with painless restoration of motion and function. There is a universal agreement that accurate restoration of joint surface, stable fixation and early knee motion are equally important. To overcome the demerits of both the conventional operative and nonoperative philosophies