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ORIGINAL ARTICLE

The Role Of The Jess (Joshi's External Stabilization System) Fixator In The Management Of Tibial Plateau Fractures Which Are Associated With Severe Soft Tissue Injuries

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ABSTRACT

OBJECTIVES: The treatment of high-energy tibial plateau 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 for managing high-energy tibial plateau fractures which were associated with severe soft tissue injuries.

MATERIAL AND METHODS: Between July 2007 and June 2009 (24 months), 21 consecutive patients who were aged 21–50 (mean, 26) years, underwent the JESS fixation for high-energy tibial plateau fractures which were associated with severe soft tissue injuries. 13 of them had injured the right knee and 8 of them, the left knee. 14 were closed and 7 were open injuries (compound grade II-4 cases; compound grade III-3 cases). The closed fractures were associated with bruising and marked swelling in 8, blebs formation in 5 and compartment syndrome in one. The injury mechanisms were motor vehicle accidents (n=15) and fall from a height (n=6). The fractures were classified according to Schatzker's classification system.

RESULTS: There were 9 type-VI and 12 type-V Schatzker's tibial plateau fractures. The mean interval between the injury and surgery was 4 (range, 0–14) days. The mean hospital stay was 13 (range, 7–22) days. The mean interval between the surgery and full weight bearing was 16 (range, 13–19) weeks. The mean range of knee flexion was 130º (range: 100-140). The normal extension of the knee was observed in 16 patients, and an extensor lag of 5-10º was noted in five patients. The complications included superficial infections (n=3), pin tract infections (n=2), the restricted range of knee movement (n=1) and non-union (n=1).

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 plateau fractures which are associated with severe soft tissue injuries.

Key words: *JESS fixator; tibial plateau fractures; severe soft tissue injuries.*

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INTRODUCTION

Tibial plateau fractures present a wide spectrum of injuries with a range of fracture patterns involving varying degrees of joint surface depression and displacement [1]. High-energy tibial plateau fractures are difficult to manage, as they are often associated with severe soft tissue injuries (open wounds, crushing, marked swelling, bruising, blebs formation and/or compartment syndrome). The mechanisms of injury involve a combination of axial loading and valgus/varus forces [1]. The ultimate aim is to prevent the occurrence of late degenerative arthritis. The outcome is usually poor, with high rates of wound problems, infections, varus collapse, knee stiffness, and articular malreduction [2]. The treatment goals are to minimize further morbidity to an already traumatized soft tissue envelope [3], in addition to the anatomical restoration of the articular surface and axial limb alignment. Numerous varieties of treatment options are available, depending on the type of the injury. Several studies have shown that the more the complex the fractures are, the more are the complications if anatomical reduction is not achieved [4],[5]. The last two decades have seen the techniques of management evolving from extensive open reduction and rigid internal fixation to arthroscopy-assisted minimal invasive surgery (MIS) and biological internal fixation.

Minimally invasive techniques by using periarticular cancellous screws along with Kirschner wires, allow the rigid fixation of small pieces of cancellous bone and intra-articular fractures, easy wound surveillance, early joint mobilization and weight bearing, and minimal soft tissue disruption [6]. Therefore, in this study, we evaluated the clinical results in 21 patients with high energy tibial plateau fractures which were associated with soft tissue injuries, treated with Joshi's External Stabilization System (JESS), by using the ligamentotaxis technique and additional stabilization with cancellous screws.

MATERIALS AND METHODS

Between July 2007 and June 2009, 21 consecutive patients (15 males) underwent Joshi's External Stabilization System fixation (JESS fixation) for high-energy tibial plateau fractures which were associated with severe soft tissue injuries. All patients with high-energy tibial plateau fractures which were associated with severe soft tissue injury were included in the study [Tab/Fig 1]. These injuries were defined as communicating open wounds, or in cases of closed fractures, the presence of a compartment syndrome, abrasion, contusion, crushing, or marked swelling [7].

Tab/Fig 1]: Clinical photograph of patient showing severe soft tissue injury associated with tibial plateau fracture, precluding routine plate osteosynthesis.

The associated soft tissue injuries did not affect the timing of the percutaneous procedures, while limited open reduction was done only after the soft tissue injuries were resolved. Calcaneal traction was used for preoperative immobilization. Prophylaxis with a cephalosporin and an aminoglycoside antibiotic was given regularly.

The mean patient age was 26 (range: 21–50) years. 13 injured the right knee and 8, the left knee. 14 were closed and 7 were open injuries (compound grade II-4 cases; compound grade III-3 cases). The closed fractures were

associated with bruising and marked swelling in 8, blebs formation in 5 and compartment syndrome in one. The injury mechanisms were motor vehicle accidents (n=15) and fall from a height (n=6). Anteroposterior and lateral radiographs were used to determine the extent of medial and lateral plateau involvement, the extent of the posterior displacement of the condyles, articular comminution, and articular depression [Tab/Fig 2] and [Tab/Fig 3]. The fracture patterns were classified according to Schatzker's staging system [5].

Tab/**Fig 2] and Tab/Fig 3]: Anteroposterior and lateral radiograph of patient showing Schatzker's type VI tibial plateau fracture**

All fractures were managed with JESS fixator application under image guidance. The compound fractures were debrided prior to the JESS fixator application. Patients with the compartment syndrome underwent fasciotomy along with JESS application. The patients were positioned on a traction table. The principle of ligamentotaxis was used to achieve metaphyseal reduction. An articular incongruity of ≥3 mm indicated open reduction with limited incisions. After achieving adequate reduction, 2 cannulated cancellous screws were placed in the juxta-articular bone which was supporting the soft cancellous bone fragments which were parallel to the knee joint. The juxta-articular screws were placed centrally in the midportion of each condylar fragment and perpendicular to the major fracture lines, so as to act in a lag fashion and to provide maximal inter-condylar compression [Tab/Fig 4] and [Tab/Fig 5]. K-wires were then passed through these screws. 3 or 4 K-wires were passed in the distal fragment, and the proximal and distal wires were then connected with link joints to form the JESS assembly.

Tab/Fig4and Tab/Fig 5]: Immediate postoperative antero-posterior and lateral radiograph showing restoration of alignment, compression of inter-condylar area with two lag screws and stabilization with JESS frame.

Care was taken to restore the mechanical axis with respect to the condyles. Isometric quadriceps exercises and hip raising exercises were started from the 1st post-operative day and knee mobilization was initiated on the 7th post-operative day, depending on patient tolerance.

Partial weight bearing was started at 12 weeks and it was advanced to full weight bearing at 16 weeks. Serial radiographs were taken at 4-week intervals to detect any deviation of the mechanical axis during external fixation. Radiographical healing was defined as an obliteration of the major fracture line in both views [Tab/Fig 8]. Clinically, healing was defined as the ability to bear full weight with a varus and valgus stress to the injured tibia without pain. After radiographical healing, the frame was removed [Tab/Fig 6] and [Tab/Fig 7], and full weight bearing ambulation was advised with or without the PTB caliper. None of the patients required bone grafting to achieve the union.

Tab/Fig 6] and Tab/Fig 7]: Range of knee movement (0 to 130º) after removal of JESS frame.

Tab/Fig 8]: One year postoperative antero-posterior and lateral radiograph showing complete healing of fracture with maintained axial alignment

RESULTS

There were 9 type-VI and 12 type-V Schatzker's tibial plateau fractures. The mean interval between the injury and surgery was 4 (range, 0–14) days. Impending compartment syndrome

(n=5) and delayed presentation (n=4) were the most common causes for the delay in surgery. None of the patient required blood transfusion. The mean hospital stay was 13 (range, 7–22) days. The mean interval between the surgery and full weight bearing was 16 (range, 13–19) weeks. The mean follow-up period was 14 (range, 8–24) months. Although varus or valgus instability was noted in 5 patients, none of them complained of functional instability. The mean range of knee flexion was 130º (range: 100-140). Normal extension of knee was observed in 16 patients, and an extensor lag of 5-10º was noted in five patients. Two patients complained of mild discomfort around the knee on exertion. 19 of the 21 patients were able to carry out the tasks which were associated with their pre-injury occupation. The remaining 2 had to change their occupation. There was no case of peroneal nerve palsy, osteomyelitis, myositis ossificans, pulmonary embolism or deep venous thrombosis. Neither was there soft tissue necrosis or wound breakdown. The complications included superficial infections (n=3), pin tract infections (n=2), the restricted range of knee movement (n=1) and non-union (n=1).

DISCUSSION

The treatment of high-energy tibial plateau fractures which are associated with severe soft tissue injuries remains contentious and challenging. Traction followed by cast or bracing provides unfortunate results [8]. Open reduction and internal fixation with double plating requires large amounts of soft tissue mobilization and stripping to achieve satisfactory results. This devitalizes the soft tissues and hinders wound healing. A 23% infection rate was reported with dual plating of the bicondylar fractures [9]. An 87.5% deep infection rate and a 100% complication rate were reported with dual plating for comminuted or bicondylar fractures [10]. Hybrid fixation by using a lateral open reduction and internal fixation, combined with unilateral external fixation, does not address medial condylar comminution, because of the larger diameter of the half pins and the poor purchase in the metaphyseal bone [11]. Limited internal fixation or lateral open reduction and internal fixation alone incompletely address the meta-diaphyseal dissociation, resulting in a collapse beneath the unsupported plateau [12]. Knee spanning external fixation does not allow an early range of movement, thus impairing articular fracture healing [13]. Less-invasive stabilization systems confer a higher risk of implant-associated pain than the conventional plates [14]. Kataria H et al [15] used a small wire external fixation for high-energy tibial plateau fractures and showed the anatomical reconstruction of the articular surface, a stable fixation of the fracture fragments, the early rehabilitation of the joint, and the care of associated soft tissue injuries, without much complications.

Closed reduction or limited open reduction by using JESS and cancellous screws prevents further iatrogenic soft tissue damage and minimizes further devitalisation of the bone and the periosteal and the endosteal blood supplies. The juxta-articular screw, placed in a lag fashion, offers superior metaphyseal purchase, supports the subchondral bone thus preventing collapse, fixes the small cancellous fracture fragments, and allows for early rehabilitation (physiotherapy and weight bearing). This reduces hospital stay and the costs. The principle of ligamentotaxis was used to achieve metaphyseal reduction. 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, the measurement of compartment pressure, and in monitoring of the neurovascular status. Thus, this technique may be used in periarticular fractures with a metaphyseal/subchondral comminution that precludes routine plate osteosynthesis. It may also be used in plateau fractures that present with a metaphyseo-diaphyseal comminution, as well as in fractures with soft tissue compromise (open wounds, compartment syndrome, abrasion, contusion, crushing, or marked swelling).

Ligamentotaxis can be best utilized for achieving anatomical reduction when surgery is performed early. Severe soft tissue injuries which are associated with tibial plateau fractures preclude early surgical intervention. JESS with

lag screw fixation is a feasible option for early surgical intervention, whenever severe soft tissue injuries are present. In cases of delay, the patients must be maintained in calcaneal traction to avoid additional trauma to the soft tissues and to enhance soft tissue healing.

In each of the 21 patients, 1 or 2 cancellous screws were used for the repair of the articular surface. At the final follow-up, in 3 of them, the correction which was achieved peroperatively was lost by 3 mm (depression). The adequacy of reduction is the most important factor which can be used to predict outcome.
Good intraoperative radiographs are needed to decrease the incidence of mal-reduction while learning. We enjoyed a short learning curve on the use of JESS frames. The results improved with experience, careful preoperative planning, and a thorough knowledge of the neurovascular anatomy. Pin tract infection is a potential problem despite the use of the K-wires.

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, the 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 plateau fractures which are associated with severe soft tissue injuries.

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