Management of Tibial Plateau Fractures in Patients Having Compromised Soft Tissue Envelope Using Ilizarov External Fixator

MOOTAZ F. THAKEB, M.D.; IBRAHEM S. HANTERA, M.Sc. and AHMED EL-GENDY, M.D.

The Department of Orthopedics, Faculty of Medicine, Cairo University

Abstract

Background: Complex fractures of the tibial plateau are associated with considerable displacement of the articular surface together with either open wounds or severe soft tissue injury. Adequate condition of the soft tissue is an important prerequisite before reconstruction of the tibial plateau. Conventional treatment by open reduction and internal fixation by plate and screws necessitates extensive dissection through compromised soft tissue with high rates of skin necrosis and infection.

Patients and Methods: Twenty-three patients with tibial plateau fractures having compromised soft tissue envelope were treated using the Ilizarov method with or without minimal internal fixation. There were nineteen male (82.6%) and four female (17.4%) patients with average age 39.4 years (range 22 to 65 years). The mechanism of injury was road traffic accident in seventeen patients (73.9%), fall from height in five patients (21.7%) and one patient (4.4%) injured by wall collapse.

Results: Using the criteria of Honkonen and Jarvinen as regard functional results, fifteen patients (65.2%) were considered to have excellent results, six (26.1%) good and two (8.7%) fair.

Conclusion: The Ilizarov method for treatment of tibial plateau fractures with or without minimal internal fixation is considered a minimally invasive procedure with low morbidity for a fracture that would otherwise require an extensive dissection and internal fixation with plates and screws with further soft tissue compromise and high rate of complications.

Key Words: Tibial plateau – Ilizarov – Soft tissue.

Introduction

COMPLEX fractures of the tibial plateau are associated with considerable displacement of the articular surface together with either open wounds or severe soft tissue injury [1]. Adequate condition of the soft tissue is an important prerequisite before reconstruction of the tibial plateau [2]. If the skin is contused or overridden with blisters, then surgery should be postponed until the soft tissue has recovered, meanwhile a skeletal traction or temporary knee spanning external fixator is used to maintain length and alignment of the limb [3]. Both the complexity of these types of fracture and the soft tissue disruption contributes to the high rate of unsatisfactory results that follow either nonsurgical or surgical management [4-6]. Conventional treatment by open reduction and internal fixation by plate and screws necessitates extensive dissection through compromised soft tissue with high rates of skin necrosis and infection [4,7-9].

The optimal treatment of high energy tibial plateau fractures frequently is not limited to purely internal or external fixation but commonly combines elements of both [3]. The Ilizarov technique with or without minimal internal fixation provides a good solution for these fractures especially when associated with compromised soft tissue envelope [10-13].

Patients and Methods

Between November 2001 and May 2004 twenty-three patients with tibial plateau fractures having compromised soft tissue envelope were treated using the Ilizarov method with or without minimal internal fixation. There were nineteen male (82.6%) and four female (17.4%) patients with average age 39.4 years (range 22 to 65 years). The mechanism of injury was road traffic accident in seventeen patients (73.9%), fall from height in five patients (21.7%) and one patient (4.4%) injured by wall collapse. According to Schatzker [14] classification, there were nine type II (39.1%) Fig. (1), four type V (17.4%) and ten type VI (43.5%) Fig. (2). Closed soft tissue injury was classified according to Tscherene and Gotsen [15] (Table 1), and open injuries were classified according to Gustillo and Anderson [16]. Eighteen patients (78.3%) had frac-
ures with closed soft tissue injury; three were Grade 1, five Grade 2 and ten Grade 3. Five patients (21.7%) had open fractures; one Grade 1, three Grade II and one Grade III B. Ligament injury was present in ten patients (43.5%).

Nine patients (39%) had associated major skeletal injuries.

Patients with open fractures were operated upon within the first 12 hours after injury. Three patients with Grade 1 soft tissue injury were operated upon within the first 48 hours. The other patients with Grade 2 and 3 soft tissue injuries had their surgery delayed between 10 to 14 days till soft tissue recovery, meanwhile a calcaneal traction was done for eleven patients (47.8%) or a temporary knee spanning external fixator done in four patients (17.4%) to maintain length and alignment of the limb. Ten patients (43.5%) had their fracture reduced by ligamentotaxis, eleven patients (47.8%) required open reduction through limited approach and two patients (8.7%) required extensile exposure for reduction. Thirteen patients (56.5%) required autogenous bone graft. Twelve patients (52%) had minimal internal fixation with screws.

Surgical technique:

Patient is positioned on the orthopaedic table to facilitate longitudinal traction and condylar reduction. Reduction is completed either by closed or open means. Large pointed reduction clamp help to obtain accurate condylar reduction and compression. Our objective was to accurately reduce the condyles in relation to each other and maintain their anatomical relation to the tibial shaft. Then anatomical reduction of the articular surface was a secondary concern that may be completed through limited approach to elevate the depressed articular segments. Bone graft was applied to fill the defect under the elevated segment and support reduction that was further maintained by olive wires together with screws in twelve patients, fixation is then completed by insertion of a number of wires enough to maintain and protect the reduction (usually 4 wires). The Ilizarov frame was then applied with three ring construct, the proximal wires maintaining reduction was secured to the proximal ring, the middle one positioned just distal to the most distal extension of the fracture, and the distal one secured by supra malleolar wires. All wires were tensioned to 110kg. The next step was to assess the knee ligamentous laxity; ten patients had medio-lateral laxity not severe enough to require ligament repair or reinforcement, in these patients a femoral ring was applied and connected to the tibial frame by hinges that was locked temporary in the first two weeks then patients were encouraged to actively flex and extend the knee, the femoral ring was usually removed after six weeks. All patients without a femoral ring were encouraged to start mobilization of the knee on the second postoperative day. Patients then progressed from partial to full weight bearing between 8 and 12 weeks postoperative, except nine patients with associated major skeletal injuries weight bearing was delayed according to the type of their injury and the method of its treatment. The frame was removed after full consolidation of the fractures with an average of 16 weeks (range 12 to 20 weeks).

Results

All fractures united and the frame was removed at an average of 16 weeks (range 12 to 20 weeks). The average follow-up period was 27.8 months (range 12 to 40 months).

The clinical, functional and radiological evaluations were done using the criteria of Honkonen and Jarvinen [17]. Grading of clinical criteria depends on the amount of extension lag, flexion range, thigh atrophy and knee stability. The functional criteria were done in relation to patient ability to walk, squat and stair climbing. Grading of radiological criteria consider the degree of plateau tilting, articular step off and condylar widening.

Clinical evaluation: Fifteen patients (65.2%) were able to fully extend the knee, six patients (26.1%) had 5 degrees lag of extension and two patients (8.7%) had 10 degrees. Ten patients (43.5%) had flexion more than 130 degrees, eleven patients (47.8%) had flexion to 110 degrees and two patients (8.7%) had flexion to 90 degrees. At the last clinical evaluation two patients had thigh atrophy more than 1cm, all patients had their knees stable both medio-lateral and antero-posterior.

Functional results: Nine patients had associated major skeletal injuries but we were concerned about the disability caused by the tibial plateau fracture. Fifteen patients (65.2%) had normal walking; slight limp in six patients (26.1%) and two patients (8.7%) used a stick. Stair climbing was normal in fifteen patients (65.2%), six patients (26.1%) had mild difficulty and two (8.7%) had to do it one at a time. All patients except two were able to squat although with some difficulty. Normal squatting was normal in eleven patients, limited to 90 degrees in ten patients. As regard functional results fifteen patients (65.2%) were considered to have excellent results, six (26.1%) good and two (8.7%) fair.
Radiographic outcome: There is no agreement on the amount of articular depression that can be accepted. Ranges from 4 to 10mm have been described as tolerable [4,5,7,18-20]. Mechanical studies indicated that an articular step-off or incongruency of more than 4mm is associated with increase joint contact pressure. For an incongruency of less than 1.5mm, there is no significant increase in the contact pressure occurs. Therefore, the joint may have some ability to compensate for a limited degree of depression [21].

For radiological assessment failure of fixation was defined as loss of reduction exceeding 5mm of redisplacement or more than 10 degrees angulation [17].

All except two patients had no or less than 4mm articular step-off. Fifteen patients (65.2%) had no tibial plateau tilting; six (26.1%) had tilt less than 5 degrees and two (8.7%) patients had tilt between 6 and 10 degrees. Condylar widening was estimated in comparison to ipsilateral femoral condyles. Widening less than 5mm was present in eight patients (39.1%).

Complications: At least one attack of superficial pin tract infection occurred in almost all patients and responded well to oral antibiotics, none progressed to deep infection. One patient with associated multiple skeletal injuries developed deep venous thrombosis. All patients received low molecular weight heparin from admission. Superficial wound infection occurred in two patients one of them had open Grade III B soft tissue injury, both resolved by debridment and intravenous antibiotics without further soft tissue management was needed, none of the patients developed skin necrosis or osteomyelitis.

Fig. (1 A-D): Schatzker type II fracture treated by elevation of the articular surface through minimal incision and bone graft followed by fixation with olive wires through Ilizarov frame together with minimal internal fixation, with excellent result.
Figure Number (1 A-D) Male patient 47 years old road traffic accident with Schatzker type II fracture (a) treated by elevation of the articular surface through minimal incision and bone graft (b) followed by fixation with olive wires through Ilizarov frame together with minimal internal fixation (c), with excellent result (d).

Figure Number (2 A-C) Male patient 32 years old fall from height with Schatzker type VI fracture (a) and grade 3 closed soft tissue injury, with good reduction of the articular surface and stabilization by olive wires only through the Ilizarov frame (b), with excellent final result (c).

Table (1): Grading of closed soft tissue injuries [15].

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Little or no soft tissue injury.</td>
</tr>
<tr>
<td>1</td>
<td>Significant abrasion or contusion.</td>
</tr>
<tr>
<td>2</td>
<td>Deep contaminated abrasion with local contusion and damage to skin or muscle.</td>
</tr>
<tr>
<td>3</td>
<td>Extensive contusion or crushing of skin or destruction of muscle; also subcutaneous avulsions, decompensate compartment syndrome, or rupture of a major blood vessel.</td>
</tr>
</tbody>
</table>

Discussion

Satisfactory results have been reported with the use of fine wire ring fixators with or without internal fixation as minimally invasive technique in the management of complex tibial plateau fractures especially those patients having compromised soft tissue envelope [6,11,13,22,23]. These injuries are very unstable and require rigid fixation with minimal soft tissue dissection. The technique of fixation should aim to stabilize the fracture in such a way that allow early mobilization of the knee and weight bearing without endangering the articular reconstruction, the alignment of the leg or the healing time [24,25]. The tensioned wires in the subchondral bone function as a scaffold supporting the tibial plateau, allowing the transfer of load through the device to the distal diaphysis. Furthermore, when wires are used on at least one side of a fracture, self-stiffening occurs during loading which is beneficial for fracture healing [23].

Careful management of soft tissue is vital. The presence of fracture blisters or extensive subcutaneous haemorrhage and bruising does not hinder percutaneous placement of wires which avoids additional devitalisation of bone since the periosteal and endosteal blood supply are not further damaged [26]. Small tensioned wires allow fixation of small bone fragments and olive wires can compress condylar fractures. Maintenance of the mechanical alignment of the limb can be always monitored and adjusted with the frame. Thirteen patients required open reduction, eleven through limited approach. Depressed articular fragments were elevated and autogenous bone graft was used to fill the gap and support the elevated fragments in thirteen patients, together with screws fixation in twelve patients. Fifteen patient had their surgery delayed 10 to 14 days till soft tissue condition improved meanwhile calcaneal traction was applied in eleven patients and a knee spanning external fixator was used to maintain length and alignment of the limb in four patients.

The aim of surgery is the early restoration of movement and function as the value of early movement has been already established [7,27]. The Ilizarov method allows early movement and
weight bearing. In this work; patients with no other associated skeletal injuries progressed from partial to full weight bearing between 8 and 12 weeks, no angulation or significant articular depression occurred.

Ali et al., [23] reported weight bearing progressed from partial to full weight bearing between 4 to 6 weeks with no angulation or depression of the articular surface except two patients that developed angulation which was corrected with the fixator. Other surgeons delayed weight bearing between 12 to 16 weeks [3,11,24].

Using the criteria of Honkonen and Jarvinen (17) as regard functional results, fifteen patients (65.2%) had excellent, six (26.1%) good and two (8.7%) fair results. These were superior to the results achieved by Dendrinos et al., [11], who had eight excellent, nine good and seven fair results.

Patients in this work had a mean range of knee flexion of 115.4 and this was comparable to range of motion reported in the series of Ali et al., [23] who had mean range of knee flexion of 115.5 degrees and to 113 degrees achieved in the work of Morandi and Pearse [28], and also comparable to those achieved by El-Barbary et al., [29] who reported mean range of flexion of 113 degrees.

In tibial plateau fractures, the soft tissue injury usually does not address the intensity of bony problem, some patients has significant soft tissue injury with minimal or no fracture comminution, while others may have good soft tissue cover with massive bone injury. The relation between bony and soft tissue injury depends on the bone quality, magnitude of trauma and mode of injury.

The magnitude of soft tissue injury is an important predictor of functional outcome, infection and skin sloughing were reported as complications in tibial plateau fractures associated with soft tissue injury treated with plates in four of five patients in the work of Mallik et al., [30], and in seven of eight patients in the work of Young and Barrak [31]. In our work, none of the patients developed skin necrosis or sloughing, superficial wound infection occurred in two patients, one of them had open grade IIIB soft tissue injury, both resolved by debridment and intravenous antibiotics. Pin tract infection is a common complication that occurs with external fixation, none progressed to deep infection and it did not affect the final outcome.

There is no correlation between the functional outcome and the anatomical restoration of the articular surface [11-13,29]. This was noticed in our study group since there were minor differences in the knee functional grading for patients with anatomic and non anatomic reduction.

Conclusion:

The Ilizarov method for treatment of tibial plateau fractures with or without minimal internal fixation is considered a mini invasive procedure with low morbidity for a fracture that would otherwise require an extensive dissection and internal fixation with plates and screws with further soft tissue compromise and high rate of complications. Decreased incidence of soft tissue complications, early range of motion, early weight bearing and good functional recovery are factors that favor the use of this method in such complex injuries.

References

Management of Tibial Plateau Fractures in Patients