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Complex tibial plateau fractures treated with Ilizarov external fixator with or without minimal internal fixation

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Abstract We treated 30 tibial plateau fractures (Schatzker Type VI) in 29 patients, with a mean age of 41.4 (20–76) years, with the Ilizarov fixator. In 18 fractures, we combined the treatment with minimal internal fixation. All fractures were the result of high-energy trauma, and 20 patients had associated injuries. Twenty-eight fractures were available for follow-up after 27 (16–36) months. Using The Knee Society clinical rating system, 18 knees were rated as excellent, seven as good, one as fair, and two as poor. There was a direct correlation between the presence of associated injuries and the final outcome. The most significant concomitant injuries were distal femoral fractures and extensive soft-tissue injury. This study emphasizes the clinical success and low morbidity associated with the use of external fixation and minimal internal fixation.

Résumé Nous avons traité chirurgicalement 30 fractures du plateau tibial (Type Schatzker VI) chez 29 malades—âge moyen de 41,4 ans (20–76)—avec un fixateur d’Ilizarov. Pour 18 fractures nous avons combiné le traitement avec une fixation interne légère. Toutes les fractures étaient le résultat d’un traumatisme à haute énergie et 20 patients avaient des lésions associées. Après un suivi de 27 mois (16–36) 28 fractures étaient étudiables. Avec le score de la Knee Society, 18 genoux ont été estimés comme excellents, sept comme bons, un comme moyen, et deux comme mauvais. Il y avait une corrélation directe entre la présence de blessures associées et le dernier résultat, le plus significatif étant l’existence d’une fracture fémorale distale et l’importance des lésions des parties molles. L’étude met en relief le succès clinique et la basse morbidité associés à l’usage du fixateur externe et de la fixation interne légère.

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Introduction

Complex tibial plateau fractures are one of the most challenging problems in orthopaedic surgery. The Ilizarov technique solves many of the problems encountered in management of such fractures and provides a method for closed reduction and fixation that does not necessitate excessive soft-tissue stripping [2, 4, 7, 8, 21]. Combining this technique with minimal internal fixation provides better radiological and functional results [15, 22]. In this study, we report the outcome of treatment of complex tibial plateau fractures using the Ilizarov technique in combination with limited internal fixation.

Materials and methods

Thirty tibial plateau fractures (Schatzker type VI [19]) in 29 patients (26 men and three women) with a mean age of 41.4 (20–76) years were included in the study. There were 21 closed and nine open fractures. Soft tissue injury for the closed fractures was classified according to Tscherny and Gotzen [20], and open fractures were classified according to Gustilo and Anderson [6] (Table 1). All fractures were the result of high-energy trauma. Twenty patients had associated injuries.

Surgical technique

The technique used was a combination of techniques, which have been described before [2, 4, 7, 12, 21]. The objective was to accurately reduce the condyles in relation to one another and to reduce and stabilize the tibial shaft beneath the reduced condyles. Anatomical reduction of the joint surface was a secondary goal that was often accomplished percutaneously or through limited approaches. Condylar reduction was assisted by longitudinal traction on the fracture table with application of varus or valgus forces. Large, pointed reduction forceps applied percutaneously helped to obtain accurate condylar reduction and compression. Sometimes, bony fragments were manipulated with large-caliber

Table 1 Grading of soft-tissue injuries for closed and open fractures

	Closed fractures (Tscherne–Gotzen)				Open fractures (Gustilo–Anderson)					Total
	0	1	2	3	I	II	IIIA	IIIB	IIIC	
Cases	3	6	9	3		3	2	2	2	30

K wires to assist reduction. In five cases, bone grafting was used. After reduction of the condyles, counter-opposed olive wires through the fragments were used to achieve interfragmentary compression. Three-to-four wires at least 14 mm from the joint line, with an overall divergence of at least 60°, were usually required for stabilization of the condylar and metaphyseal fragments. Minimal internal fixation was used in 18 fractures (Fig. 1). In six cases, limited incision over the major fracture line or area of comminution was performed to assist in reduction of the articular surface.

The preassembled frame, consisting of three appropriately sized rings connected to each other by threaded rods, was then secured to the already inserted olive wires. The middle ring was positioned just distal to any shaft fracture component, and the distal ring was placed at a lower level and secured to a transfixion reference wire positioned parallel to the ankle joint to ensure restoration of the mechanical axis of the tibia. A femoral frame was applied in five cases to treat an associated femoral fracture (Fig. 2) and in two other cases for marked fracture comminution necessitating distraction over the knee.

All patients started gentle exercises on the second post-operative day. Weight bearing was increased as tolerated. Patients with marked articular comminution were kept non-weight bearing for 6 weeks. Radiographic, clinical, and functional evaluation was done using the method of Rasmussen [18] and the Knee Society clinical rating score [9].

Results

All fractures united, except one with varus malunion. The frame was removed at an average of 16.3 (range 14–24) weeks. Only 27 patients with 28 fractures were available for follow-up. The average follow-up was 27 (range 16–36) months.

Fig. 1 Closed right tibial fracture in a 41-year-old man treated with closed reduction, minimal internal fixation, and fixation with Ilizarov's apparatus.



Clinical and radiographic outcome

The radiographic reduction of the fractures was rated as excellent in 17 and good in 11, according to Rasmussen's criteria [18]. Using the Knee Society clinical rating system, 18 knees were rated as excellent, seven as good, one as fair, and two as poor. The average total range of knee flexion was 112.5° (range 0–170°), but three patients had a total arc of motion less than 60°. In cases treated with knee distraction, the average knee flexion was 83° (range 0–145°) whereas cases with ipsilateral femoral fractures had an average knee flexion of 55°. Five patients had clinically demonstrable grade 2+ medial–lateral instability. Only two were symptomatic but had no functional handicap. Eleven patients had no pain while the remaining 18 had mild or occasional pain. In eight patients, walking was limited, and six needed walking aids.

Variables influencing the clinical outcome

There was a direct correlation ($P < 0.005$) between the presence of associated injuries and the final outcome, the most significant being a concomitant distal femoral fracture, but the magnitude of soft-tissue injury also influenced the final outcome. Of 18 cases treated with supplementary minimal internal fixation, 12 were finally rated as excellent, five as good, and one as fair. Of ten cases treated without minimal internal fixation, five were rated as excellent, four as good, and one as fair. The quality of reduction increased the functional score, as shown in Table 2.

Complications

Pin-tract infection was mild and common but controlled by local dressing and antibiotics.

Fig. 2 Left distal femoral fracture and ipsilateral tibial plateau fracture in a 20-year-old man treated with minimal internal fixation and cross-knee Ilizarov fixator.

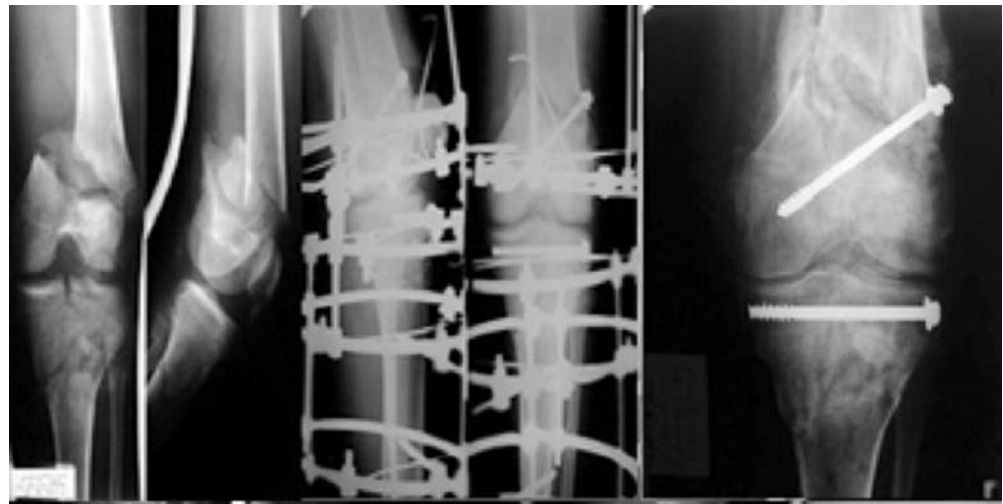


Table 2 Relationship between the quality of reduction and the functional outcome

Functional outcome	Quality of reduction				Total
	Anatomical	Good	Fair	Poor	
Excellent	9	8	–	–	17
Good	7	2	–	–	9
Fair	1	1	–	–	2
Poor	–	–	–	–	–
Total	17	11	–	–	28

Discussion

The management of intraarticular fractures in the tibial plateau is inherently complex [3, 4, 7, 8]. Restoration of articular congruity is mandatory, and careful treatment of soft tissues is as important as the bone [11, 12]. Not all fractures will reduce with ligamentotaxis alone, and a limited open reduction with minimal periosteal stripping is sometimes necessary [1]. Use of Ilizarov fixation allows a better choice of incision since internal fixation will not be used. Morandi and Pearse [17] reported elevation and bone grafting in 26% of cases in a series of 50 complex plateau fractures treated with Ilizarov fixation. Marsh et al. [15] were able to reduce 16 of 21 plateau fractures treated with half-pin fixation either closed, percutaneously, or through open wounds. In this study, closed reduction was effectively achieved in 24 cases. In our study, limited open reduction through a 5- to 6-cm incision was needed in six cases whereas bone grafting to support the elevated articular surface was needed in five cases. This ratio was much lower than that reported by Watson and Coufal [21] (79% open reduction and 57% grafting), Weiner et al. [22] (60% open reduction), and Dendrinis et al. [4] (50% open reduction). Minimal internal fixation using percutaneously inserted lag screws was used in 18 plateau fractures (60%). This contrasts with Weiner et al. [22] who used screw fixation in all of their intraarticular fractures and Dendrinis et al. [4] who used only external fixation wires with no screws.

The average duration of fixation in our group was relatively long, only exceeded by that reported by Kumar and Whittle [12] (24.7 weeks) because four cases of delayed/non-union were included. With their exclusion, this period fell to 16 weeks, which is comparable to the mean time to union reported in other series [7, 15, 21, 22].

Using Rasmussen criteria for radiographic assessment, excellent to good reduction was achieved in all our cases, which is superior to all similar series [4, 21, 22]. The mean range of movement (ROM) reported by Guadinez et al. [5] was 85° and by Morandi and Pearse [17] was 113°. All patients reported by Zecher et al. [24] achieved at least 90°. The average knee ROM in our study was greater than comparable studies, despite the presence of three cases of knee stiffness. When applying the Knee Society rating system, the average knee score in our study was 87.7, the average functional score was 87.2, and the average knee rating was 87.4. Mikulak et al. [16] reported a mean knee score of 78.5, a mean functional score of 81.9, and an average knee rating of 80.2 in their 24 patients. Kumar and Whittle [12] reported a mean knee score of 83 and a mean functional score of 69 in 45 patients (79%) with anatomical reduction. In nine patients (21%) with nonanatomical reduction, the mean knee score was 52 and the mean functional score was only 19.

Several authors have identified factors that maximize the chances of a favourable outcome [15, 17, 22]. Most of the reports include only low-energy or very few high-energy fractures. There is little reported information that focuses on the results of treatment of high-energy fractures. The difference in osseous and soft-tissue injury patterns between these two categories suggests that the outcome achieved and the treatment required might well be different.

In the current study, two variables had a direct correlation with the final ROM: knee distraction and associated distal femoral fracture. Fair and poor results were solely present in polytrauma patients, mainly those with concomitant ipsilateral femoral fractures. This was also the case in Mikulak et al. [16] and accords with the findings of Lobenhoffer et al. [13].

The magnitude of soft-tissue injury was also an important predictor of functional outcome. In our study, open injuries were responsible for 45% of the unsatisfactory results.

Mallik et al. [14] found infection complicating four of five bicondylar fractures treated with plates, and Young and Barrack [23] reported deep infection in seven of eight fractures treated with double plates. Given its devastating nature, one of the goals of management must be to keep the incidence of infection absolutely as low as possible. In the current study, pin-tract infection did not affect the final outcome [12, 14, 22].

Some authors have stated that anatomical restoration of the plateau surfaces is essential to prevent later osteoarthritis [10, 19, 23]. Others have reported good functional results after conservative treatment or after operative treatment that did not restore the anatomy perfectly [4, 7, 8, 15, 21, 22]. One explanation for these contradictory opinions is lack of a uniform classification and method of evaluation. In addition, the criteria for an acceptable result may not have been sufficiently stringent for differences between the fracture and treatment groups to appear. It is uncertain, however, whether these poorer results were related to the severity of the initial articular injury or to the quality of articular reduction. Clinical–radiological correlation in our study demonstrated that the quality of articular reduction was less influential in deciding the final outcome since there was only a minor difference in knee scores for patients with anatomical and nonanatomical results. It appeared that severe initial comminution produced the worst outcome.

In general, this study emphasizes the clinical success and low morbidity associated with the Ilizarov method. The technique is well suited to the management of complex tibial plateau fractures where comminution would require extensive dissection and internal fixation with plates and screws, leading to further compromise of the soft tissue. The results of this study corroborate those of several predecessors. Decreased incidence of soft tissue complications, early range of motion, early weight bearing, and good functional recovery all compare favourably with other reported results and substantiate the recommendation that external fixation should be the treatment of choice for such injuries.

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