International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Severe Tibial Plateau Fracture Treated with Ilizarov and Minimal Internal Fixation

TMF Tuan Ismail[1], Nazari AT[2], NA Yacob[3]

[1]Orthopaedic Department, Hospital Sultanah Nur Zahirah, Kuala Terengganu, Malaysia.
Email: *drfairuzismail[at]gmail.com*

[2]Orthopaedic Department, Hospital Umum Sarawak

[3]Orthopaedic Department, Hospital Sultanah Nur Zahirah

Running Title: SEVERE TIBIAL PLATEAU FRACTURE TREATMENT

Abstract: ***This retrospective study is to evaluate the outcome of severe tibial plateau fracture treated with Ilizarov external fixation with minimal internal fixation. It encompasses all cases of severe tibial plateau fractures treated with Ilizarov and minimal internal fixation (3.5 mm cortical rafting screws or rim plating) from Jan 2019 till June 2022 in Sarawak General Hospital, with a minimal follow - up of 1 year. The study included 13 patients; 10 males and 3 females - with a mean age of 50.4 years. Among them, 5 cases were open fractures.6 were Schatzker V and 7 were Schatzker VI.10 patients presented with grade II Tscherne soft tissue injury, while 3 had grade III injuries. To maintain articular reduction and congruity, at least 2 rafting screws or rim plating were employed. All fractures achieve union without any cases of deep - seated infection or septic arthritis. Mean duration for the Ilizarov External Fixator was 17.5 weeks. Pin tract infections were observed in 3 patients and there were no iatrogenic peroneal nerve injuries. The mean range of motion was 105.3 degrees and the mean Rasmussen radiological score was 15.2. In conclusion, Ilizarov with minimal internal fixation provide good outcome with low morbidity for severe tibial plateau fracture.***

Keywords: External fixator, Ilizarov frame, Tibial plateau fracture

1. Introduction

Severe Tibial Plateau Fracture Treated with Ilizarov and Minimal internal fixation

Tibial plateau fractures account for 9.2% of all tibial fractures (Barbary et al., 2005) and are recognized as one of the most challenging types to treat (Barbary et al., 2005; Ali et al., 2001) due to the concomitant soft tissue involvement. In addition to the compromised soft tissue envelope, these fractures often exhibit poor bone quality or severe comminution, posing a challenge for achieving rigid fixation (Ali et al., 2001). A severe tibial plateau fracture is defined as bicondylar tibial plateau or high - energy tibial plateau fracture (Schatzker V or VI) with significant Tscherne soft tissue injury graded as II or III (Tscherne et al., 1993).

While dual plating is preferred by many, it may not be the optimal choice for all tibial plateau fractures and is associated with high rate of complications (Watson & Coufal, 1998; Young & Barrack, 1994; Weiner et al., 1995; Jensen et al., 1990) due extensive soft tissue dissection required for inserting these plates into already compromised soft tissue.

In the case where internal fixation is not feasible, Ilizarov presents itself as an alternative treatment worth considering. The Ilizarov method allow us to circumvent the need for generous incisions typically required in internal fixation.

In traditional Ilizarov treatment, where only wires are used, the nearest wire must be at least 16 mm away from joint (Nayagam, 2007; Reid et al, 2001) to prevent capsule penetration, which could lead to septic arthritis if the wire becomes infected. This presents a challenge in tibial plateau fracture with articular depression, as the wire may not be close enough to support the depressed articular fragment adequately. Additionally, due to limited safety window around the knee, it is also not always possible to orientate the olive wire perpendicular to the fracture line. This orientation, crucial for providing the strongest interfragmentary compression and stability, is essential for achieving union (Ali et al., 2001).

At our center, in addition to employing wires in classical Ilizarov method, we have incorporated the use of rafting screws (cortical screw 3.5 mm) or 1/3rd tubular plate as a rim plate. This approach helps to maintain and support depressed articular fragment while providing interfragmentary compression (Ali et al., 2001). This is done in conjunction with the standard Ilizarov fixation in the treatment of tibial plateau fractures.

2. Methodology

This is a retrospective study involving patients with tibial plateau fracture classified as Schatzker V and VI, presenting with soft tissue injury (Tscherne) of at least grade II or III. The inclusion criteria required a minimum 1 - year follow - up, and the patients were treated with Ilizarov and minimal internal fixation (cortical screw 3.5 mm/rim plate) from Jan 2019 till June 2022. Patients who defaulted or had less than a 1 - year follow - up were excluded.

Rasmussen's radiologic assessment (Figure 6) was employed to evaluate the radiological results after the removal of the Ilizarov fixator (Barbary et al., 2005; Shimizu et al., 2016).

3. Surgical Technique

To enhance soft tissue conditions, cross knee external fixation is performed in emergency settings. Each patient undergoes CT scans for analysis, and the best reduction strategy is formulated to achieve articular congruity. During surgical planning, the reduction technique, the positioning of screws and the potential required mini - incisions are planned to address articular depression or achieve fracture reduction, especially if closed reduction is not feasible.

During operation, the joint is prioritized for reconstruction.2 or three 3.5 mm cortical screws are used to provide interfragmentary compression and/or to raft depressed articular fragment. Mini open reduction was performed in cases where close reduction failed. Following joint reconstruction, the fracture is then neutralized with Ilizarov ring, specifically one ring at the tibial plateau level, and two rings distal to the fracture level.

Proximal horizontal referencing wire is inserted above the tip of fibula ensuring it is at least 16 mm distal from articular surface to avoid penetration of the joint capsule (Ali et al., 2001). This wire is nearly parallel to the knee joint (3 - degree varus) (Ali et al., 2001).

The distal referencing wire is inserted at the level of the distal most ring, and alignment is verified under I/I in AP and lateral views. Any malalignment is corrected before inserting the medial face wire for each ring. The medial face wire is inserted postero - medially (parallel to the medial subcutaneous surface of the tibia) or antero - laterally, ensuring a minimum crossing angle of 60 degrees. Alternatively, additional half pin can be inserted over the subcutaneous surface of the tibia to enhance the rigidity of the construct.

Stability is assessed under I/I fluoroscopy, specifically in the lateral view, during knee flexion. If the fracture site exhibits movement during flexion, a temporary above - knee construct is applied for six weeks. Postoperative care includes 24 - hour antibiotic administration, early range of motion exercises for the knee joint, and initiation of partial weight - bearing as tolerated by the patient.

Figure 1 to 5 illustrates how one of our cases wase done (Case number 6).

Figure 1: X - ray image of the tibial plateau fracture
Note: Cross knee External fixation applied to correct alignment and reduce swelling over the injured limb.

Pre - op planning which involved CT scan evaluation and fracture reduction strategy. For this case, the plan was to open the anterior split with laminar spreader (Figure 2). The depressed intraarticular fragment (as shown in Figure 3) is then identified through this split. The depressed articular fragment was elevated with osteotome or small periosteal elevator. The reduced fragment is then reduced and hold with K - wire before 2 rafting screws were inserted at subchondral level, about 1.0 - 1.5 cm from the articular surface.

Figure 2: 3D reconstructed image of the tibial plateau fracture
Note: Red arrow is pointing towards the place where anterior split was planned with laminar spreader.

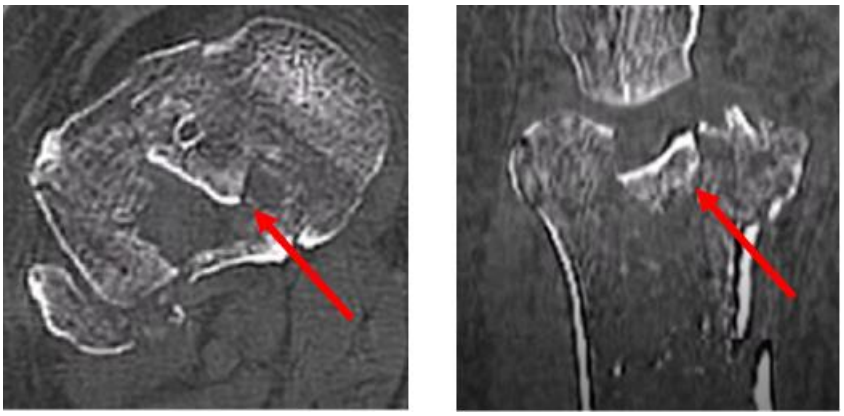

Figure 3: Axial cut (picture on the left) and coronal cut (picture on the right) of CT scan image of the tibial plateau fracture
Note: Red arrow pointing towards depressed intraarticular fragment that need to be identified from the anterior split.

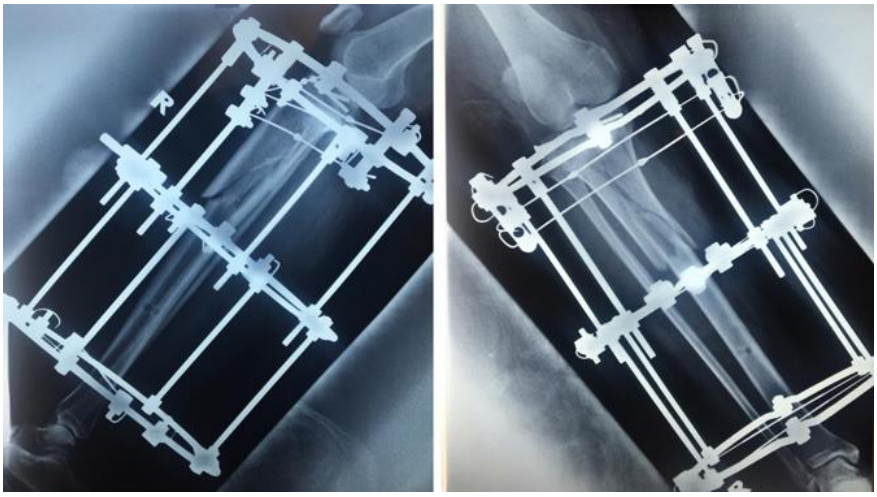

Figure 4: Post Ilizarov X - ray image

Figure 5: Post Ilizarov removal X - ray
Note: Rafting screws not routinely removed

Table 1: Box summary of patients in this study

Case Number	Age	Sex	ROM	Time on Frame (days)	Rasmussen x - ray score	Soft tissue score
1	47	M	120	173	16	II
2	57	M	130	124	14	II
3	37	M	90	138	18	II
4	54	M	100	123	15	II
5	42	M	110	78	14	II
6	52	F	130	95	16	III
7	37	M	110	105	16	III
8	57	F	90	133	16	II
9	75	M	90	125	14	II
10	54	M	100	144	14	II
11	55	M	110	92	16	II
12	32	F	90	122	14	II
13	56	M	100	149	16	III

Figure 6: Criteria for Rasmussen radiologic assessment

Subjective	Points
A. Articular depression	
Not present	6
< 5 mm	4
6 – 10 mm	2
> 10mm	0
B. Condylar widening	
Not present	6
< 5 mm	4
6 – 10 mm	2
> 10mm	0
C. Angulation (valgus/varus)	
Not present	6
< 10º	4
10 – 20º	2
> 20º	0
Maximum	18
Excellent	18
Good	12 – 17
Fair	6 – 11
Poor	< 6

4. Results

All fractures achieved union without any cases of deep infection or septic arthritis. The mean duration of external fixation was 17.5 weeks (ranging from 13 to 24 weeks), a duration consistent with findings in other studies (Dendrinos et al., 1996). The mean range of motion was 105.3 degrees, also in line with results from comparable studies (Barbary et al., 2005; Dendrinos et al., 1996). Twelve patients were classified as having a 'Good' Rasmussen's score, with one achieving an 'Excellent' score (Table 1). The mean Rasmussen's score was 15.3. Pin tract infections were observed in 10 patients, effectively managed with oral antibiotics and local dressing. No cases of iatrogenic peroneal nerve injury were recorded.

5. Discussion

Management of tibial plateau fracture is complex and challenging (Barbary et al., 2005). The treatment goal is to stabilize fracture and restore joint congruity (Barbary et al., 2005; Ali et al., 2001). Soft tissue management is equally important as the bone, due to concomitant severe soft tissue injury associated with it (Ali et al., 2001).

Ilizarov with minimal internal fixation, in our opinion is a good technique to consider when internal fixation is not advisable due to severe soft tissue condition (Buckle et al, 1993; Young & Barrack, 1994). The Ilizarov method allows us to avoid the generous incision generally required in internal fixation (Ali et al., 2001; Watson & Coufal, 1998).

In traditional Ilizarov treatment, where only wires are used, the nearest wire must be at least 16 mm away from joint (Nayagam, 2007) to prevent capsule penetration, which can lead septic arthritis. This is unfavourable in the case of tibial plateau fracture with articular depression, as the wire is not close enough to support the depressed fragment. However, screws do not face this issue, being internal implants not connected to the external environment, allowing them to be inserted into the subchondral bone of the tibial plateau. This is certainly important in anatomical restoration, which is crucial to prevent later osteoarthritis (Moore et al., 1987). In this study, we have managed to get an average of 15.3 points which falls under 'Good' category in Rasmussen radiologic assessment.

With limited safety window around the knee, it is not always possible to orientate the olive wire perpendicular to the fracture line. This orientation provides the strongest interfragmentary compression, which is essential for stability and periarticular fracture union (Ali et al., 2001), can be achieved with screws.

6. Conclusion

In general, this study emphasizes the benefit of severe tibial plateau fracture treated with Ilizarov technique and minimal internal fixation and its associated low morbidity.

Conflict of Interest

We have no conflict of interest to disclose.

References

[1] El Barbary, H., Abdel Ghani, H., Misbah, H., & Salem, K. (2005). Complex tibial plateau fractures treated with Ilizarov external fixator with or without minimal internal fixation. *International orthopaedics*, *29*, 182 - 185.

[2] Ali, A. M., Yang, L., Hashmi, M., & Saleh, M. (2001). Bicondylar tibial plateau fractures managed with the Sheffield Hybrid Fixator: biomechanical study and operative technique. Injury, 32, 86 - 91.

[3] Tscherne, H. A. R. A. L. D., & LOBENHOFFER, P. (1993). Tibial plateau fractures: management and expected results. *Clinical Orthopaedics and Related Research®*, *292*, 87 - 100.

[4] Watson, J. T., & Coufal, C. (1998). Treatment of complex lateral plateau fractures using Ilizarov techniques. *Clinical Orthopaedics and Related Research (1976 - 2007), 353*, 97 - 106.

[5] Nayagam, S. (2007). Safe corridors in external fixation: the lower leg (tibia, fibula, hindfoot and forefoot). Strategies in trauma and limb reconstruction, 2, 105 - 110.

[6] Buckle, R., Blake, R., Watson, J. T., Morandi, M., & Browner, B. D. (1993). Treatment of complex tibial plateau fractures with the Ilizarov external fixator. *Journal of Orthopaedic Trauma*, *7* (2), 167.

[7] Young, M., & Barrack, R. L. (1994). Complications of internal fixation of tibial plateau fractures. *Orthopaedic review*, *23* (2), 149 - 154.

[8] Watson, J. T., & Coufal, C. (1998). Treatment of complex lateral plateau fractures using Ilizarov techniques. *Clinical Orthopaedics and Related Research (1976 - 2007), 353*, 97 - 106.

[9] Reid, J. S., Van Slyke, M. A., Moulton, M. J., & Mann, T. A. (2001). Safe placement of proximal tibial transfixation wires with respect to intracapsular penetration. *Journal of orthopaedic trauma*, *15* (1), 10 - 17.

[10] Shimizu, T., Sawaguchi, T., Sakagoshi, D., Goshima, K., Shigemoto, K., & Hatsuchi, Y. (2016). Geriatric

tibial plateau fractures: clinical features and surgical outcomes. *Journal of Orthopaedic Science*, *21* (1), 68 - 73.

[11] Dendrinos, G. K., Kontos, S. A. V. A. S., Katsenis, D. E. M. E. T. R. I. O. S., & Dalas, A. T. H. A. N. A. S. I. O. S. (1996). Treatment of high - energy tibial plateau fractures by the Ilizarov circular fixator. *The Journal of Bone & Joint Surgery British Volume*, *78* (5), 710 - 717.

[12] Weiner, L. S., Kelley, M., Yang, E., Steuer, J., Watnick, N., Evans, M., & Bergman, M. (1995). The use of combination internal fixation and hybrid external fixation in severe proximal tibia fractures. *Journal of orthopaedic trauma*, *9* (3), 244 - 256.

[13] Jensen, D. B., Rude, C., Duus, B., & Bjerg - Nielsen, A. (1990). Tibial plateau fractures. A comparison of conservative and surgical treatment. *The Journal of Bone & Joint Surgery British Volume*, *72* (1), 49 - 52.

[14] Moore, T. M., Patzakis, M. J., & Harvey, J. P. (1987). Tibial plateau fractures: definition, demographics, treatment rationale, and long - term results of closed traction management or operative reduction. *Journal of orthopaedic trauma*, *1* (2), 97 - 119.