OUTCOMES OF TIBIAL PLATEAU FRACTURES IN CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL: A RETROSPECTIVE REVIEW

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ABSTRACT

Background: Peri-articular injuries to the proximal tibia are difficult to manage. Various treatment modalities have been used with mixed results.
Objective: The aim of this study was to report on short-term outcomes of patients treated for tibial plateau fractures at a South African tertiary hospital.
Methods: This was a retrospective study conducted from January 2018 to December 2020. This study aimed to evaluate short-term outcomes with a required minimum follow-up of 18 months.
Results: Forty-six patients (23 males and 23 females) met the inclusion criteria. Twelve (26.09%) patients developed early complications within 6 weeks following surgery while 5/46 (10.87%) developed late complications. Four of the 5 patients that had late complications also had early complications. Two (4.35%) patients had prominent hardware, 7/46 (15%) met the suggestive criteria for Fracture-Related Infection (FRI), 2/46 (4.35%) met the confirmatory criteria for FRI, 3/46 (6.52%) developed knee stiffness and 1/46 (2.17%) had Loss of Reduction (LOR). Five patients (11.87%) could not be fitted into any criteria for FRI as record charts were inadequate and only labelled these as Surgical Site Infection (SSI). The mean pain VAS was 2.7 (SD: 2.1). When reviewing the post-operative Range of Motion (ROM), the average knee extension was 8.910 (range 00 – 350) and 109.240 (range 700 – 1300) for flexion.
Conclusion: The short-term outcomes of treatment of tibial plateau fractures is favourable but could be improved. Bicolumnar fixation is associated with early complications compared to the anterolateral approach. With appropriate time interval from injury to definitive surgery, the rate of FRI after ORIF is low.

Key words: Tibial plateau, Complications, Outcomes, Fracture-related infection

INTRODUCTION

Peri-articular injuries to the proximal tibia are difficult to manage (1). Various treatment modalities have been used with mixed results (2). These fractures account for 1% of all fractures in adults (3). The different modalities of treatment come with both advantages and disadvantages. One has to choose the appropriate modality meticulously. The best time to operate on these injuries is within 4 hours after trauma, when no obvious swelling is apparent (4). However, in resource- restricted centres one is often not able to have these patients operated within that time frame. According to one systematic review, clinical and radiological results of more than 85% of patients were good to excellent according to the Rasmussen scoring system (5). This systematic review was evaluating treatment by Percutaneous Reduction and Internal Fixation (PRIF). The Schatzker classification was based on a two-dimensional representation of the fracture (6). This is the commonly used classification system in training institutions. With the advent of three dimensional imaging this classification has been modified. Authors have added a new set of modifiers, "A" (anterior) and "P" (posterior) to denote the quadrants involved in the six principle types (6). Hap *et al.* (7) concluded that the outcome of tibial plateau fractures is satisfactory, with poorer functional outcome being associated with higher energy fractures. The aim of our study was to do a retrospective review of short-term outcomes on the patients that were treated for tibial plateau fractures at a South African tertiary hospital. A local study evaluated high energy tibial plateau fractures treated with a circular fixator. The authors concluded that this was safe and effective, and with limited complications (8). The circular fixator is modular and specific to each fracture configuration (1).

MATERIALS AND METHODS

This was a retrospective study conducted from January 2018 to December 2020 at a South African tertiary hospital. We included patients with tibial plateau fractures that received treatment during the study period and met the inclusion criteria. This included patients older than 18 years, patients that presented within 1 week of the injury and non-poly trauma patients. We excluded patients with open fractures, delayed presentation beyond 1 week, previous tibia fracture on the involved limb, incomplete records and pathological fractures. This study aimed to evaluate short-term outcomes with a required minimum follow-up time of 18 months.

Hospital records were reviewed with particular interest in patient demographics, Mechanism of Injury (MOI), smoking and HIV status, diabetes, time to first presentation, Oestern and Tscherne classification, Schatzker grade, time to definitive surgery, type of surgery/treatment instituted, and documented complications post-treatment. We also analysed the Visual Analogue Scale (VAS) for pain and Range of Motion (ROM) post-operatively. On the VAS score, 0 represented no pain and 10 represented maximum pain. The study was granted ethical approval. Fracture-related infection was defined using the diagnostic criteria as described by Metsemakers *et al.* (9). This description has two sets of criteria, suggestive and confirmatory. Using the description by Kalson *et al.* (10), stiffness was defined as flexion range of 900 – 1000 and extension range of 110 – 200. An arbitrary definition of early and late complications was used. The cut-off used was 6 weeks, with complications occurring within 6 weeks post-operatively labelled as early complications and those occurring 6 weeks post-operatively labelled as late complications.

Loss of reduction was defined as a joint depression of 2mm or more or a malalignment of more than 50 from the immediate post-operative radiograph.

All patients were evaluated by a senior registrar on presentation. A decision was made about the use of a temporizing joint spanning external fixator based on the severity of the bony and soft tissue injury. This was in conjunction with the consultant on call. All definitive surgeries were performed by a senior orthopaedic trauma surgeon or under their supervision, by a senior registrar. Surgical approaches were dictated by the fracture classification and CT scan findings. If circular fixators were used, the Illizarov frame was chosen. Decisions on definitive treatment were individualised and did not follow any predefined protocol. Post-operatively, patients that underwent Open Reduction and Internal Fixation (ORIF) were protected in an above-knee back-slab for 2 weeks until wound review. Knee ROM was started at this point but partial weight bearing was only introduced 6 weeks post-operatively. Circular fixator patients had their pin sites reviewed 10 days post-operatively and they were allowed to weight bear immediately.

Statistical analysis

Stata 14.0 software was used to analyse data. The patients' demographic characteristics, outcome variables (pain, ROM & FRI), patients' time to definitive surgery, external fixation done, patients' CT scan done, type of fixation applied, presence of FRI were summarised as appropriate; categorical variables are reported as frequency and percentage. While the continuous variables are reported in terms of mean and standard deviation.

For inferential analysis, a Pearson Chi-square test was performed to determine association between:

(i) Schatzker grade and confirmed FRI
(ii) Smoking status and confirmed FRI
(iii) Diabetes mellitus and confirmed FRI
(iv) HIV status and confirmed FRI
(v) Tsherne grade and confirmed FRI
(vi) Type of fixation and ROM
(vii) Type of fixation and complication at more than 6 weeks
(viii) Type of fixation and complication at less than 6 weeks

A logistic regression analysis was carried out to ascertain the strength of association between type of fixation and complication at less than 6 weeks. Level of significance was taken as $p < 0.05$.

RESULTS

A total of 46 patients (23 males and 23 females) met the inclusion criteria (Table 1). The mean follow-up time was 20.31 months. According to the Schatzker classification there were 3/46 (6.52%) type I, 15/46 (32.61%) type II, 2/46 (4.35%) type III, 12/46 (26.09%) type IV, 5/46 (10.87%) type V and 9/46 (19.57%) type VI. Eleven (23.91%) patients were HIV positive, 26/46 (56.52%) were non-reactive and 9 (19.57%) unknown. Only 6/46 (13.04%) patients had a temporary joint spanning external fixator and 40/46 (86.96%) patients had a CT-scan done. The average duration from injury to definitive surgery was 19.07 days (range 2 – 44 days). All fractures united at a mean time of 16

weeks. Twelve (26.09%) patients developed early complications within 6 weeks following surgery while 5/46 (10.87%) developed late complications (Table 2). Four of the 5 patients that had late complications also had early complications. Two (4.35%) patients had prominent hardware, 7/46 (15%) met the suggestive criteria for FRI, 2/46 (4.35%) met the confirmatory criteria for FRI, 3/46 (6.52%) developed knee stiffness and 1/46 (2.17%) had loss of reduction (LOR) (Table 2). Five (11.87%) patients could not be classified under the definition of FRI as the chart records were inadequate and simply labelled them as having a SSI. The mean pain VAS was 2.7 (SD: 2.1) (Table 3). When reviewing the post-operative ROM, the average knee extension was 8.910 (range 00 – 350) and 109.240 (range 700 – 1300) for flexion (Table 3). The distribution of the type of fixation used is shown in Table 4. There was no statistically significant relationship between Schatzker grade and confirmed FRI (p = 0.427). This was also true for smoking status (p = 1.00), diabetes (p = 1.00), HIV status (p = 1.00) and Oestern and Tscherne grade (p = 0.909). Relationship between the type of fixation and ROM showed no statistical significance (p = 0.692). Using the chi-square test, a statistically significant relationship was noted between type of fixation and complications at less than 6 weeks post-operatively (p = 0.007). Further analysis using logistic regression demonstrated a statistically significant relationship between bicolumnar plating and complications at less than 6 weeks after surgery (p = 0.005). Patients who had bicolumnar plating were 20.4 times (95% CI: 2.5 – 169.7) more likely to develop complications within 6 weeks of surgery compared to anterolateral plating.

There was no statistically significant relationship between type of fixation and development of complications after 6 weeks of surgery (p = 0.614). Perhaps a longer follow-up time could have uncovered complications that had not arisen at the time of this review. The time interval between

Table 1

Patient demographics

	Frequency	
	No.	(%)
Age mean=40.8 years, SD=11.9		
Gender		
Female	23	50.0
Male	23	50.0
Side involved		
Left	36	80.0
Right	8	17.8
Bilateral	1	2.2
Mechanism of injury		
Gate fell on leg	2	4.4
Jumped off wall	1	2.2
MBA	1	2.2
MVA	5	10.9
PVA	10	21.7
Fell	24	52.2
Soccer injury	3	6.5
Smoker		
No	31	67.4
Yes	14	30.4
Diabetes		
No	43	93.5
Yes	3	6.5

Table 2
Complications

	Frequency	
	No.	(%)
Early complications	12	26.09
Late complications	5	10.87
Prominent hardware	2	4.35
Suggestive FRI	7	15
Confirmed FRI	2	4.35
Knee stiffness	3	6.52
LOR	1	2.17

FRI: Fracture Related Infection; LOR: Loss of Reduction

Table 3
Functional outcomes

	Mean	Standard deviation	Frequency
Pain VAS	2.7	2.1	46
ROM			
Extension	8.91	0 - 35	46
Flexion	109.24	70 - 130	46

VAS: Visual Analogue Scale; ROM: Range of Motion

Table 4
Type of fixation

	Frequency	
	No.	(%)
Type of fixation		
Anterolateral	19	42.2
Anteromedial	8	17.8
Bicolumnar	7	15.6
Conservative	1	2.2
Lateral plate	2	4.4
Medial plate	4	8.9
Posteromedial plate	2	4.4
Posteromedial plate + AL	1	2.2
Ring fixator	1	2.2

AL: Anterolateral

the outpatient review in these is wider after the 6th week review and so maybe some complications presented outside of this period.

DISCUSSION

Tibial plateau fractures are a common injury. These injuries make up 1% of all fractures (11). Their treatment is controversial and multiple surgical options exist. Their treatment is generally surgical however, poor outcomes are common (12). The ideal surgical fixation technique remains a matter of debate (13).

Some authors still report a good to excellent outcome as high as 90% (14). Rohra *et al.* (15) reported an excellent knee society score in 85% of their study population. The same authors had only three cases of knee stiffness throughout follow-up.

In our study the average ROM was 109.240 (range 700 – 1300) for flexion and 8.91 0 (range 00 – 350) for extension post-operatively.

Another study also found that bicondylar fractures treated with dual plating did significantly better (P = 0.045) (16). The index study showed no statistically significant relationship between type of fixation and ROM (p-value = 0.692).

We recorded an infection rate of 19.6% (9/46) in this study. This includes both cases of suggestive and confirmed FRI. Five patients could not be fitted into the definition of FRI because of incomplete records. Looking at the study period, this could be explained by the fact that the criteria for FRI was not as popularised at the time and surgeons were still using old terms. This certainly means that the infection rate is underestimated and is definitely higher than reported. Though this is particularly high, our centre treats these injuries largely by Open Reduction and Internal Fixation (ORIF) and so such is anticipated. Serious infection developed in only two patients and was successfully managed with debridement and metal ware removal. The patients with suggestive FRI all had erythematous wound swelling that resolved with oral antibiotics. One study looked at the use of vancomycin powder intra-operatively and reported 46 of 499 patients developed infection in the control group (17). Wang *et al.* (18) compared unilateral locking plate versus unilateral locking plate combined with compression bolt for Schatzker I–IV tibial plateau fractures and reported a 5% sepsis rate. Milenkovic *et al.* (19) had an infection rate of 12.9%. A surgical site infection rate of 5.7% and 1.6% deep infection rate was found by Li *et al.* (20). In another meta-analysis, a 9.9% incidence of infections was recorded (21). A meta-analysis comparing single locking plate to dual plating for bicondylar tibial plateau fractures found no difference between the two groups (22).

In their prospective study, Rohra *et al.* (15) had three patients who developed superficial infection within 6 months of surgery with Aghamiri *et al.* (23) reporting only one infection.

The mean Visual Analogue Scale (VAS) was 2.7 (SD 2.1) in this study. Bicolumnar plating had the highest mean VAS (4; SD 2) compared to the other approaches. Twenty-five to 45% of patients treated by ORIF developed post-traumatic osteoarthritis (2,24-25) however, only 15% had severe symptoms to warrant a Total Knee Replacement (TKR) (26). Significant differences were observed in the WOMAC score (pain, P = 0.008) when comparing unilateral locking plate versus unilateral locking plate combined with compression bolt for Schatzker I–IV tibial plateau fractures, favouring the addition of the compression bolt (18). In our study, the only patient treated definitively with a circular fixator had the lowest mean VAS (1; SD 2). One is unable to come to any conclusion regarding this as there were not many patients treated with this modality. A Randomized Controlled Trial (RCT) did however find the illizarov frame to be associated with shorter hospital stay and overall function to be similar to that of ORIF (27). In their study, Oguzkaya *et al.* (28) concluded that patients with bicondylar tibial plateau fractures treated with both modalities had similar WOMAC. Another RCT reported the highest VAS (4.8) day 1 post-operatively, subsequently this reduced (29).

The best time for ORIF is within 4 hours of injury or 1 week after the injury (15). The mean time to definitive surgery in our study population was 19.07 days (2 – 44 days). Average time from injury to surgery was 4.78 days (range 1 to 16) in a study by Milenkovic *et al.* (19). The longest waiting time from injury to surgery was in the ORIF group (3.69 ± 2.29 days) in a study by Oguzkaya *et al.* (28). In our study, the impact of a long waiting time from injury to surgery was not particularly studied.

One patient was treated conservatively in this study. This was a 33 year old female who presented 7 days after a Motor Vehicle Accident (MVA) with a Schatzker type I fracture and refused surgery. The fracture went to union with a ROM of 00 – 1200 and a VAS of 5 points. Conservative treatment is only restricted to undisplaced fractures, often not the case with these fractures (30). It is well documented that because of articular surface involvement, poorly managed fractures lead topain, limited range of motion and osteoarthritis (31). Type I – III injuries show significantly higher Short-Form 36 (SF-36) scores than type IV – VI (32). The concern with these injuries is the development of osteoarthritis. Even with surgery, progression to osteoarthritis occurs in 59.5% of patients older than 55 years at a mean follow- up of 2.54 years (33). One study also found that 5.3% and 7.3% of patients who had ORIF for tibial plateau fracture had TKA at 5 and 10 years, respectively (34). Bäumlein *et al.* (35). (not only showed that OA grading of all three compartments increased significantly in comparison to the pre-operative state ($p \leq .04$), they found a significantly higher OA grading in the lateral compartment compared to the medial and patella-femoral compartments ($p = .01$) (35).

In this study we found a statistically significant relationship between type of fixation used and development of complications at less than 6

weeks post-operatively (p = 0.007). Further logistic regression analysis showed a significant relationship between bicolumnar plating and complications within 6 weeks of surgery (p = 0.005). Patients who had bicolumnar fixation were 20.4 times (95% CI: 2.5 – 169.7) more likely to develop complications at less than 6 weeks compared to anterolateral plating. This is unsurprising as it is the high energy fractures that receive this type of fixation and these are anticipated to do worse than their low energy counterpart.

The limitation of this study is that it is a retrospective review. The rate of FRI is underestimated due to different reporting in the medical records. Also a large majority of the patients were treated with ORIF and this makes it impossible to compare this treatment with the only one patient that was treated with a circular fixator. The sample size was small and also patients were operated by surgeons with different experience levels.

CONCLUSIONS

The short-term outcomes of treatment of tibial plateau fractures is favourable but could be improved. There is remarkable improvement in the pain VAS and the ROM is moderately improved. Bicolumnar fixation is associated with early complications compared to the anterolateral approach. With appropriate time interval from injury to definitive surgery, the rate of confirmed FRI after ORIF is low.

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