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Original Article,

Treatment Outcomes of Delayed Definitive Surgery of Tibial Plateau Fractures

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Abstract:

Background: Low energy tibia plateau fractures can be treated with definitive surgery within 48 hours. High energy tibia plateau fractures require a staged treatment plan that allows healing of the soft tissue envelope, with avoidance of devastating complications such as compartment syndrome and chronic infection. The aim of this study was to compare outcomes of definitive tibial plateau surgery performed within 21 days from the date of injury to those done after 21 days in a resource-restricted center.

Methods: A retrospective cohort study was conducted. Group A consisted of patients that received their definitive surgery within 21 days of the injury. Group B were those who had definitive surgery after 21 days from the injury. Outcomes of interest included infectious complications (suggestive- and confirmed-fracture related infection (FRI)) and clinical outcomes (pain and range of motion). All patients were treated in one center between June 2018 and June 2020.

Results: Forty-four (44) patients were included in the study. Twenty-three patients (23) were in group A while 21 were in group B. The median age was 40 (Inter quartile range [IQR]: 36 - 49) years in group A and 37 (IQR: 30 - 49) years in group B. Group A consisted of 15 males and 8 females while group B had 8 males and 13 females.

Suggestive FRI rate in group A was 26% compared to 33% in group B. Confirmed FRI occurred in 2% of patients in group A compared to none in group B. The pain visual analogue scale (VAS) in group A had a median of 2 (IQR: 0 - 4) and 3 (IQR: 1 - 3) in group B. Range of motion was found to be 94.13 (range: 40 - 130) degrees on average for group A and 99.5 (range: 70 - 120) degrees for group B.

Conclusion: Outcomes of surgeries performed after a delayed period of 21 days still were comparable to those performed before 21 days.

Keywords: Tibial plateau; Fracture-related infection; Outcomes; Range of motion

Introduction:

Tibial plateau fractures (TPFs) should be considered as complex injuries that can present with soft tissue compromise, neurovascular damage, compartment syndrome, deep vein thrombosis, and ligamentous and meniscal tears (1). TPFs can have a severe impact on function in the injured knee, lead to early post-traumatic arthrosis and result in long-lasting subjective symptoms for the patients (2). Low energy tibia plateau fractures can be treated with definitive surgery within 48 hours (3). High energy tibia plateau fractures require a staged treatment plan that allows healing of the soft tissue envelope, with avoidance of devastating complications such as compartment syndrome and chronic infection (1,4). Goals of treatment of tibia plateau fractures are to restore joint congruency, joint stability, and mechanical axial alignment while allowing early range of motion and prolonged non weight bearing (5). Odds of achieving anatomical reduction of the articular surface decreases by 17% with each day after injury (6). Restoring joint congruency may not be possible in severely comminuted fractures and old fractures in which the healing process has commenced. Schatzker and Kfuri have found that restoring the joint stability is the most critical step in the management of these challenging injuries (7).

According to their findings joint stability is most dependent on restoring the continuity of the articular rim by anatomic reduction of the split wedge fragments (7). A stable and well-aligned joint is key to early mobilization and rehabilitation of the soft tissue envelope (7,8). Immobilization of the knee for 6 weeks or longer seem to affect the knee range of motion and arthrokinematics adversely (9). The principle of stable fixation and early movement is of particular importance in tibial plateau fractures to regain range of motion and prevent arthrofibrosis (10). Polat et. Al, found that the use of bone graft, early knee motion, and early started full weightbearing is essential for favourable outcome (11). They also noted that osteoarthritis on radiographs was not related to poor functional outcome at the mid- to long-term follow up of surgically treated tibial plateau fracture patients (11). According to Mehin et. al. the 10-year Kaplan-Meier survival of patients with operatively treated tibial plateau fractures was 97%, meaning that the incidence of end stage post-traumatic osteoarthritis necessitating reconstructive surgery is only 3% (12). It is only recently that the Fracture-related Infection (FRI) Consensus Group published the initial definition criteria, and adopted the term 'fracture-related infection' to encompass all infections which occur in the presence of a fracture (13).

In our resource-limited environment patients can wait for prolonged periods to have their definitive surgery for tibial plateau fractures. This raises big concerns about the outcome of these surgically challenging injuries in our setting.

Aim

To determine the clinical and functional outcomes of patients treated with delayed definitive surgery for tibial plateau fractures.

Materials & Methods:

This study was approved by our institutional Human Research Ethics Committee **(M220128)** and Hospital Chief Executive Officer (CEO) of the tertiary referral public hospital.

Prospectively collected data were retrospectively analyzed for patient demographics (age, gender). Parameters evaluated include days to definitive surgery post injury, Schatzker grading, co-morbidities (diabetes mellitus and human immunodeficiency virus infection), pre-injury smoking status, pain VAS, knee range of motion (ROM) and wound status.

Data were collected prospectively of patients with tibial plateau fractures that had surgery from June 2018 to June 2020. All patients with tibial plateau fractures that received surgery during the study period and met the inclusion and exclusion criteria were included.

The following was the inclusion criteria: patients older than 18 years, patients that presented within 1 week of injury, non-polytrauma patients and patients had to be followed up for a minimum period of 18 months. Patients were excluded if they had a delayed presentation beyond 1 week of injury, those with mangled extremities, if they had a previous fracture on the involved limb and if they had incomplete records.

At our institution, a preference is made for earlier surgical intervention; however, a number of factors may cause delays. As a tertiary referral centre for a wide geographical area with a high population rate, the burden is large and the availability of theatre and staff limited. Additional reasons for delay in surgical fixation included emergency surgeries taking preference and the soft tissue envelope not being amenable to internal fixation. Whilst awaiting surgery, patients where admitted to an inpatient ward with immobilisation and elevation. Fracture type, date of injury, Schatzker grading and date of surgery where recorded.

Patients were divided into 2 cohorts, group A if they received their definitive surgery within 21 days of the injury and group B if they had definitive surgery at 21 days and beyond. Outcomes of interest included suggestive- and confirmed fracture related infection, pain score according to the VAS and range of motion. Follow-up review was scheduled at 2 weeks, 6 weeks, 12 weeks, 6 months, 12 months and 18 months. The patients were examined at an orthopaedic outpatient clinic and the clinical examinations was performed by registrars.

Statistical analysis

Stata 14.0 statistical software was used to analyse data. The patients' demographic characteristics, outcome variables (pain, ROM & FRI), patients' time to definitive surgery and presence of FRI were summarised as appropriate; categorical variables are reported as frequencies and percentages, 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 the association between the outcome and independent variables. Significance was determined at $P<0.05$.

Results:

A total of 44 patients were treated at the same institution during the study period. Twenty-three patients received their definitive surgery <21 days (52.3%), with the remaining patients having definitive surgery ≥21 days after their injury (47.7%). Follow-ups were performed for at least 18 months after definitive surgery. No statistical significant differences were found among the two groups in terms of age, sex, co-morbidities, smoking status and fracture type for the patients (all P values > 0.05) (*see* Table 1).

In group A four out of the twenty-three patients had suggestive FRI (17.4%). Group B had 7 patients with suggestive FRI (33.3%) with a p-value of 0.579 for this variable. There were two patients with confirmed FRI in group A (8.7%) and none in group B (0%), p-value = 0.489 (*see* Table 2).

Group A had an average of 2 (IQR: 0 – 4) according to the pain visual analogue scale compared to 3 (IQR: 1 – 3) for group B (P = 0.115) (*see* Table 3).

The average range of motion in group A was 94.1° with a range of 40° to 130°. Group B had an average of 99.5° and a range of 70° to 120°. P-value for range of motion was 0.444 (*see* Table 4).

Table 1: Summary statistics by time, N=46

	Group A N = 23)	**Group B** N = 21)	**Total** N = 44)	**P-value**
Age (years)				1.000
Below 40	11 (47.8%)	11 (52.4%)	23 (50.0%)	
40-49	7 (30.4%)	6 (28.6%)	14 (30.4%)	
50 and above	5 (21.7%)	4 (19.0%)	9 (19.6%)	
Gender				0.227
Female	9 (39.1%)	13 (61.9%)	23 (50.0%)	
Male	14 (60.9%)	8 (38.1%)	23 (50.0%)	
Smoker				0.752
No	15 (65.2%)	15 (71.4%)	31 (67.4%)	
Yes	8 (34.8%)	6 (28.6%)	15 (32.6%)	
Diabetes				1.000
No	21 (91.3%)	20 (95.2%)	43 (93.5%)	
Yes	2 (8.7%)	1 (4.8%)	3 (6.5%)	
Schatzker grade				0.978
1	1 (4.3%)	1 (4.8%)	3 (6.5%)	
2	7 (30.4%)	7 (33.3%)	15 (32.6%)	
3	1 (4.3%)	1 (4.8%)	2 (4.3%)	
4	7 (30.4%)	5 (23.8%)	12 (26.1%)	
5	2 (8.7%)	3 (14.3%)	5 (10.9%)	
6	5 (21.7%)	4 (19.0%)	9 (19.6%)	

Table 2: Summary of FRI by time to definitive surgery

	Group A N = 23)	**Group B** N = 21)	**Total** N = 44)	**P-value**
Suggestive fracture related infection				0.579
No	15 (65.2%)	15 (71.4%)	30 (67.4%)	
Stiff knee	2 (8.7%)	0 (0.0%)	2 (4.3%)	
Yes	6 (26.1%)	6 (28.6%)	12 (26.1%)	
Confirmed fracture related infection				0.489
No	21 (91.3%)	21 (100.0%)	42 (93.5%)	
Yes	2 (8.7%)	0 (0.0%)	2 (4.3%)	

Table 3: Summary of pain visual analogue by time to definitive surgery

	Group A N = 23)	Group B N = 21)	Total N = 44)	P-value
Pain (1-10)				0.115
0	6 (26.1%)	1 (4.8%)	8 (17.4%)	
1	2 (8.7%)	2 (9.5%)	4 (8.7%)	
2	6 (26.1%)	6 (28.6%)	12 (26.1%)	
3	3 (13.0%)	7 (33.3%)	10 (21.7%)	
4	1 (4.3%)	4 (19.0%)	5 (10.9%)	
5	3 (13.0%)	0 (0.0%)	4 (8.7%)	
8	2 (8.7%)	1 (4.8%)	3 (6.5%)	

Table 4: Summary of range of motion by time to definitive surgery

	Group A N = 23)	Group B N = 21)	Total N = 44)	
ROM Knee				0.444
0-100	1 (4.3%)	0 (0.0%)	2 (4.3%)	
0-110	1 (4.3%)	1 (4.8%)	2 (4.3%)	
0-115	0 (0.0%)	1 (4.8%)	1 (2.2%)	
0-120	2 (8.7%)	6 (28.6%)	9 (19.6%)	
0-130	2 (8.7%)	0 (0.0%)	2 (4.3%)	
0-90	1 (4.3%)	1 (4.8%)	2 (4.3%)	
10-100	0 (0.0%)	1 (4.8%)	1 (2.2%)	
10-110	3 (13.0%)	0 (0.0%)	3 (6.5%)	
10-120	0 (0.0%)	1 (4.8%)	1 (2.2%)	
15-100	1 (4.3%)	1 (4.8%)	2 (4.3%)	
15-110	0 (0.0%)	1 (4.8%)	1 (2.2%)	
15-115	1 (4.3%)	0 (0.0%)	1 (2.2%)	
15-120	0 (0.0%)	1 (4.8%)	1 (2.2%)	
20-100	1 (4.3%)	2 (9.5%)	3 (6.5%)	
20-105	0 (0.0%)	1 (4.8%)	1 (2.2%)	
20-90	1 (4.3%)	0 (0.0%)	1 (2.2%)	
25-100	1 (4.3%)	0 (0.0%)	1 (2.2%)	
25-95	0 (0.0%)	1 (4.8%)	1 (2.2%)	
30-70	1 (4.3%)	0 (0.0%)	1 (2.2%)	
30-95	1 (4.3%)	0 (0.0%)	1 (2.2%)	
35-105	0 (0.0%)	1 (4.8%)	1 (2.2%)	
5-115	2 (8.7%)	1 (4.8%)	3 (6.5%)	
5-120	3 (13.0%)	1 (4.8%)	4 (8.7%)	
5-90	1 (4.3%)	0 (0.0%)	1 (2.2%)	

Discussion:

This study demonstrated comparable outcomes between patients that received definitive surgery for TPFs within 21 days to those having surgery after 21 days from injury. Group A had eight patients with a low VAS score of zero or one, compared to three patients in group B with the only distinguishing factor being time to definitive surgery. The function in terms of range of motion was comparable in the two groups with the association that patients with higher Schatzker grades had an increase in loss of range of motion in both groups.

The most common reasons to postpone surgical management of TPFs in our setting include soft tissue swelling, lack of theatre availability, team availability and delayed referral from peripheral centres.

The influence of articular fracture reduction on outcomes in TPFs is still a matter of debate. Adequate reduction of TPFs is poorly defined in literature. Literature also does not put emphasis on condylar width and the reduction of the articular rim. It is shown that patients with smaller amounts of residual articular depressions have better functional outcomes (14). Biomechanically, patients with articular step and mechanical axial malalignment are at increased risk of posttraumatic osteoarthritis, but this is a late occurrence with low rates of reconstructive surgery (12).

There are a few possibilities for the comparable outcomes between these two groups. Firstly, only five patients received their definitive surgery within seven days. As seen in literature every day leads to a reduced chance of reducing these fractures anatomically as the healing process has already settled in by then. Secondly, reduction of the three dimensional split fragment and restoration of mechanical axial alignment is still possible at a delayed stage of definitive surgery and so might be why the two groups had comparable outcomes.

This study has several limitations, including the retrospective assessment of data.

There also was no use of specific patient reported outcome measures (PROMs) , the only subjective measure was pain score according to the VAS. The study did not look at radiological evidence of joint congruency, mechanical axial alignment or articular rim reduction to correlate with treatment outcomes. The sample size for this study was small and future work should aim for a larger cohort.

Conclusions:

Patients receiving delayed definitive surgery for tibial plateau fractures after 21 days have comparable outcomes to patients operated before 21 days.

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