ORIGINAL RESEARCH

A demographic analysis of patients with proximal tibia fractures using CT scan-based classification system at a tertiary centre

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ABSTRACT

Background: Proximal tibial fractures in general are one of the most common long bone fractures seen & occur in about 4% of the senior population. We wanted to study the demographic characteristics & the pattern of proximal tibia fractures in patients presenting to our hospital with special reference to the three-column concept based on CT scan. **Methods:** This was a demographic type of study conducted in Tata Main Hospital, Jamshedpur, Jharkhand,India, in the Department of Orthopaedics from October 2018 to September 2020 among patients satisfying the inclusion and exclusion criteria. Approval from the ethical committee of Tata Main Hospital, Jamshedpur was taken before embarking on the study.**Results:** In the present study, male patients were more and right-side fractures were more commonly seen. The study group consisted predominantly of RTA patients. There were statistically significant differences among the patients according to their association of Schatzker type with the mode of injury, with p value=0.0315 ($p<0.05$). There werestatistically significant differences among the patients according to their association of Schatzker type with no columns,with p value ($p<0.0001$). There were statistically significant differences among the patients according to their association of Schatzker type with columns, with p value ($p<0.0003$).**Conclusions:** Adoption of preventive measures such as educational campaigns, surveillance & traffic education can dramatically reduce the number of injuries. The inclusion of sensitive imaging methods in major trauma centres such as CT & MRI can improve patient care for tibial plateau fractures.

Key words: Proximal tibia fractures, CT scan-based classification system, tata main hospital, Jamshedpur

INTRODUCTION

Proximal tibia fractures in general are one of the most common long bone fractures seen & occur in about 4% of the senior population. Patients with these fractures present with the inability to bear weight on the affected limb and deformity. Due to pain, evaluating the range of motion and stability is often difficult.[1-3] In 2010, three-dimensional CT scan was used in three column classification by Luo *et al*. which is reliable in classifying and treating complex fractures because fractures involving posterior columnsare taken into consideration.[4-6]

CT scan is indicated to identify the fracture pattern which is very useful to plan preoperatively for fixing these complex fractures. CT scan also helps in the proper selection of implants.[7-9] Current study analyses the demographiccharacteristics&thepatternofproximaltibia fractures in patients presenting to our hospital with special reference to the three-column concept based on CT scan.

METHODS

This was a demographic type of study conducted in Tata Main Hospital, Jamshedpur, Jharkhand, India, in the Department of Orthopaedics from October 2018 to September 2020 among patients satisfying the inclusion and exclusion criteria. Approval from the ethical committee of Tata Main Hospital,Jamshedpur was taken before embarking on the study. All skeletally mature individuals with either closed or grade 1 open tibial fracture without any neurovascular

deficit were taken into the study. Previously operated proximal tibia fractures with new injuries and associated compartment syndrome were excluded from the study. Patients who were lost to follow up were not included in the study.

SAMPLE SIZE

For calculation of sample size, the formula used is,

$$n = Z2\ x(p)\ x(1\text{-}p)/L2$$

Where n is the sample size, Z is the normal deviate at alevel of significance (Z is 1.96 for a 5% level of significance), L is the relative error, which is taken as 5%, P is the proportion of the population with the disease under study i.e., the incidence of proximal tibia fractures was 9% in the previous study. Thus, sample size was calculated to be n=125 is the calculated sample size. However, considering the previous hospital records & the duration of the study, the required sample size was taken as 90. Hence, 90 patients were recruited for the study.

STUDY PROCEDURE

Upon admission of the patient, a careful history of injury and the severity of trauma were elicited from the patients and/or attendants. The patients were then assessed clinically to evaluate their general condition and the local injury. The general condition of the patient and the vital signs were recorded. A methodical examination was done to check for fractures on the other sides. The local examination of the injured leg was done for swelling, deformity, loss of function, altered attitude, compartment syndrome and any associated nerve injury was also looked for and noted. Anteroposterior & lateral view radiographs of the affected leg with knee and ankle joint were taken. Next, the limb was immobilized in an above-knee pop slab & elevated over a Bohler-Braun splint. Informed consent was taken from the study participants who fulfilled the inclusion criteria for participation in the study. CT scan of the affected knee was done and fractures were classified according to the 3-column classification based on CT scan & Schatzker classification based on X-rays.

STATISTICAL METHODS

The collected data were organized, tabulated and statistically analysed using SPSS IBM version 21.0. The data was analysed by appropriate statistical tests. Quantitative variables were expressed as mean and standard deviationand categorical data were expressed as relative frequency and percentage. Chi square and t-test and ANOVA were applied wherever required. A "p value" was considered significant if <0.05.

RESULTS

DEMOGRAPHY

The age distribution in the study group was even with the patients in the age group 40-59 slightly more than the rest of the cohort. In the present study, male patients were more, and right-side fractures were more commonly seen. The study group consisted predominantly of RTA patients. The (Table 1-4) depicts demographic characteristics of mode of injury, Schatzkers classification, number and name of columns involved in study population. The (Table 1-4) shows dominance of Schatzker type-VI patients was more. A maximum number of patients were bicolumnar type. A maximum number of patients were in group posterior + medial + lateral columns.

Table 1: Mode of injury in study population (n=90)

Mode of injury	N	%
RTA	73	81.11
Slip & fall	10	11.11
Fall from stairs	3	3.33
Fall from height	2	2.22
Fall from train	1	1.11
Fall of heavy object	1	1.11

Table 2: Schatzkers distribution in study population (n=90)

Schatzker type	N	%
I	3	3.33
II	25	27.78
III	4	4.44
IV	7	7.78
V	16	17.78
VI	35	38.89

Table 3: Number of columns involved in study population (n=90)

No. of columns	N	%
1	13	14.44
2	40	44.45
3	37	41.11

Table 4: Column specific distribution in study population (n=90)

Name of columns	N	%
Posterior + Medial	5	5.56
Posterior + Lateral	34	37.78
Medial + Lateral	1	1.11
Lateral	8	8.89
Posterior	2	2.22
Medial	3	3.33
Posterior + Medial + Lateral	37	41.11

Table 5: Incidence of associated skeletal injuries (n=90)

Associated injuries	N	%
2ND Metatarsal LT	1	1.11
Head of LT Fibula	1	1.11
Left Patella	1	1.11
LT Clavicle	1	1.11
3RD-6TH Ribs LT	1	1.11
RT Calcaneum	1	1.11
RT INF Pubic Ramus	1	1.11
RT Clavicle	1	1.11
RT Distal Femur	3	3.33
4TH & 5 TH Metatarsal Neck RT	1	1.11
Lateral Condyle RT Femur	1	1.11
RT Patella	3	3.33
RT Proximal Humerus	2	2.22
RT Volar Barton	1	1.11
Shaft of LT Femur	1	1.11
Both Bone RT Leg	1	1.11
Shaft of RT Fibula	2	2.22
B/L Shaft of Humerus	1	1.11
Facial Laceration	1	1.11
Galeazzi LT	1	1.11
Head Injury	1	1.11
LT DER	1	1.11
RT Proximal ULNA with RT Radial Head	1	1.11
Head Injury with Shaft of LT Fibula	1	1.11
Head Injury, Shaft of RT Fibula	1	1.11
Head Injury, Shaft of RT Tibia & Fibula	1	1.11
Left ACL Tear	1	1.11
LT Shoulder Dislocation	1	1.11
Segmental RT Fibula	1	1.11
LT Proximal Humerus	2	2.22
LT Volar Barton	2	2.22
Neck of LT Fibula	2	2.22
Neck of RT Fibula	6	6.67
Nil injuries	50	55.56

among the patients as per their association with Schatzker type with no. of columns, with $p<0.0001$. As shown in (Tables 6-8), there were statistically significant differences between the patients based on their relationship of Schatzker type with columns, with a $p=0.0003$.

The (Table 9), depicts statistically significant differences among the patients according to their time since surgery, with $p<0.0001$. There were no

statistically significant differences between the patients in regard to the number of columns and time after surgery, as indicated in (Table 10) above, with a p value of 0.184% and a p value >0.05.

DISCUSSION

In a study by Barei *et al*. most injuries were the result of high-energy trauma including falls from a height 25 (30.1%)patients,RTA43(51.8%)andsports-related [10]injury 15 (18.1%) patients.

Luo *et al*. though discussed the various injury mechanisms involved in the TPF but did not brief about the modes of injuries.4-6 The most common mode of injury in our study was road-traffic accidents (81.11%) followed by slips & falls (11.11%) and others (7.78%). In the three-column concept (TCC) study comprising 287 patients by Luo *et al*. mean age of the patients was 46.1 yrs.4-6 The mean age was the same for all the column fractures. In our study, the mean age was 43 (43.14) years. The mean age of patients for all the columns was comparable between the two studies. Usually, one column fractures are more common in old age group patients due to reduced strength of subarticular cancellous bone whereas the two-column and three-column fractures are seen in young and middle-aged patients which are due to high-velocity trauma. In a study of a revised 3-column classification approach by Hoekstra *et al*. for the TPFs extending into the posterolateral corner, the mean age of the patients was 53 yrs.11

The sex distribution of column fractures in the TCC study by Luo *et al*. was 182/95(M/F).4-6 Similarly, in our study, there was a high male predominance 75/15(M/F). However, in the study done byHoekstra *et al*. the distribution was equal (58% females and 42% males).11 The side distribution of proximal tibia fractures in our study was 59/31(R>L) However, in the study done by Hoekstra *et al*. the side distribution was equal (47% right side, 53% left side).11 Luo *et al*. study did not mention the side distribution. The column-wise distribution of proximal tibia fractures based on CT scans in our study was 13/40/37 (one column / two column / three-column). So, there was a dominance of two-column & three columns over one column types with a maximum number of patients being bicolumnar which was comparable to the study done by Luo *et al*. the majority of the bicolumnar.

The (Table 5) show wide variety of associated skeletal injuries. However, more than 50% had isolated TPF. With a p value of 0.0315 and a p value of 0.05, there were statistically significant differences between the patients in terms of Schatzker classification of fracture and Mode of injury.Therewerestatisticallysignificantdifferences fractures on CT scan involved the posterior + lateral columns in our study (34 out of 37) while 5 involved posterior + medial columns & only 1 involved medial + lateral columns. Under the 1 column group, we encountered 8 isolated lateral column fractures, 2 posterior & 3 medial. 37 patients were involving all the 3 columns namely posterior, medial & lateral.

Table 6: Association of Schatzker type with mode of injury

Mode of injury	Schatzker type							
	I	II	III	IV	V	VI	Total	P value
RTA	3	16	1	7	15	31	73	
Slip & fall	0	7	2	0	0	1	10	
Fall from stairs	0	0	1	0	0	2	3	
Fall from height	0	2	0	0	0	0	2	0.0315
Fall from train	0	0	0	0	1	0	1	
Fall of heavy object	0	0	0	0	0	1	1	
Total	3	25	4	7	16	35	90	-

Table 7: Association of Schatzker type with number of columns

Number of columns	Schatzker Type							
	I	II	III	IV	V	VI	Total	P value
1	3	3	2	3	0	2	13	<0.0001
2	0	18	2	3	2	15	40	
3	0	4	0	1	14	18	37	Significant
Total	3	25	4	7	16	35	90	

Table 8: Association of Schatzker type with specific columns

Columns	Schatzker Type							
	I	II	III	IV	V	VI	Total	P value
Posterior + Medial	0	0	0	3	0	2	5	
Posterior+Lateral	0	18	2	0	1	13	34	
Medial + Lateral	0	0	0	0	1	0	1	
Lateral	3	3	0	0	0	2	8	<0.0001
Posterior	0	0	2	0	0	0	2	

Medial	0	0	0	3	0	0	3	
Posterior + Medial + Lateral	0	4	0	1	14	18	37	
Total	3	25	4	7	16	35	90	

Significant

In the study by Luo *et al*., medial + posterior column involvement was slightly more (56) as compared to lateral+ posterior (48) & lateral + medial (16). In the one column group, there was a clear dominance of the lateral column(47) over the medial (13) & posterior column (17) in Luo's study.4-6 Considering the Schatzker classification in ourstudy, most patients (51 out of 90) had Schatzker type V & VI injuries on X-rays which showed that high energy mechanismsofinjuriesweremorecommonwhile25 patients had Schatzker II and only 3, 4 & 7 patients hadSchatzker type I, III & IV injuries respectively.

In the 51 patients consisting of Schatzker type V & VI injuries, majority (46 out of 51) were caused by road traffic accidents (RTA's) thus establishing RTAs as the major cause of high energy injuries while only 1 case had slip & fall, 2 had fallen from stairs, 1 had fallen from train & 1 sustained fall of a heavy object. Considering the low energy injuries i.e., Schatzker type I, II & III, 20 out of 32 injuries were again caused by RTA's while 9, 1 & 2 patients had injuries caused due to slip & fall, fall from stairs & fall from height respectively. So, RTAs emerged as the major cause of proximal tibia fractures amongst both high & low energy injuries. Amongst the 40 patients having bicolumnar fractures on CT scan, most were Schatzker type II (18) followed by Schatzker type VI (15) while most of the 37 patients involving all 3 columns on CT scans had Schatzker type VI (18) & V (14) of patterns on X rays. Amongst the bicolumnar type posterior + lateral column group (34 patients), 18 were Schatzker type II followed by Schatzker type VI (13). In the single column group having isolated lateral column injuries, 3 patients had Schatzker type I, 3 had type II & only 2 had Schatzker type VI injuries while isolated posterior & medial column was only associated with Schatzker type III & IV injuries. In the tricolumnar type of fractures (37), there was the dominance of Schatzker type V (14) & VI (18) injuries. 50 out of 90 patients (56%) included in our study had no associated injuries with proximal tibial fractures while of the rest 40, 9 patients had proximal fibula fractures, 5 patients had shaft fibula fractures, 2 patients had fracture of bone of both legs, 4 patients had concomitant head injuries & 1 patient had facial lacerations, 4 patients had patella fractures, 1 patient had shaft femur fracture, 4 patients had associated distal femur fractures, 2 patients suffered metatarsal fractures and 1 patient had calcaneum fracture.

Table 9: Time of surgery (n=90)

Time to surgery (days)	N	%
2	3	3.33
3	4	4.44
4	9	10
5	17	18.89
6	22	24.44
7	9	10
8	6	6.67
9	8	8.89
10	4	4.44
11	1	1.11
12	3	3.33
13	1	1.11
15	3	3.33
Mean±SD	6.66±2.79	-

Table 10: Relationship between time to surgery with no. of columns

Time to surgery	No. of columns			No. of patient
	1	2	3	
(Days)	(N=13)	(N=40)	(N=37)	s
2	0	2	1	3
3	2	2	0	4
4	3	2	4	9
5	1	8	8	17
6	2	11	9	22
7	1	6	2	9
8	0	3	3	6

9	1	4	3	8
10	2	1	1	4
11	0	0	1	1
12	1	0	2	3
13	0	1	0	1
15	0	0	3	3
Mean±SD	6.38±2.99	6.23±2.17	7.22±3.26	p=0.1184

Considering the associated upper limb injuries, 2 patients had associated clavicular fractures, 4 patients had fracture proximal humerus, 1 patient had bilateral shaft humerus fracture & 1 suffered shoulder dislocation, 1 patient sustained fracture of 3rd-6th ribs, 1 sustained Galeazzi fracture, 1 patient sustained monteggia fracture & 4 had fractured distal end of the radius.

LIMITATIONS

Limitations of current study were; the study has been done in a single centre, The study was carried out in a tertiary care hospital, so hospital bias cannot be ruled out. Another limitation was the inability to search the associated intra- articular lesions of the knee as tibial plateau fractures are associated with a significant risk of meniscal & capsuloligamentous injuries.

CONCLUSION

Utilising preventive strategies including awareness raising campaigns, surveillanceand traffic education can significantly lower the number of injuries. Tibial plateau fracture patient care can be enhanced by incorporating sensitive imaging techniques like CT and MRI at large trauma centres. The columns involvement in their final treatment planning allows surgeon to make better surgical decisions, which should result in superior functional outcomes. We believe that all patients with TPFs should undergo MRI, a recommendation that has been supported by numerous authors despite the cost involved. Associated injuries does affect the rehabilitation and impacts the overall outcome too.

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CONFLICT OF INTEREST: None declared.

ETHICAL APPROVAL: Thestudywas approvedbythe Institutional Ethics Committee.

REFERENCES

1. Sivasundaram L, Trivedi NN, Gatta J, Ning AY, Kim CY, Mistovich RJ. Demographics and risk factors for non-accidental orthopedic trauma. Clin Pediatr. 2019; 58(6):618-26.
2. Stella M, Santolini E, Sanguineti F, Felli L, Vicenti G, Bizzoca D, *et al*. Aetiology of trauma-related acute compartment syndrome of the leg: a systematic review. Injury. 2019;50:S57-64.
3. Kazley J, Jahangir A. Tibia Diaphyseal Fracture. Treasure Island (FL): StatPearls Publishing; 2019.
4. Hohl M, Moore TM. Articular fractures of the proximal tibia. In: Evarts CM, ed. Surgery of the musculoskeletal system. New York: Churchill Livingstone; 1990.
5. Luo CF, Sun H, Zhang B, Zeng BF. Three-column fixation for complex tibial plateau fractures. J Orthop Trauma. 2010;24(11):683-92.
6. Zhu Y, Yang G, Luo CF, Smith WR, Hu CF, Gao H, *et al*. Computed tomography-based three-column classification in tibial plateau fractures: introduction of its utility and assessment of its reproducibility. J Trauma Acute Care Surg. 2012;73(3):731-7.
7. Beris AE, Soucacos PN, Glisson RR, Seaber AV, Urbaniak JR. Load tolerance of tibia plateau depressions reinforced with a cluster of K-wires. Bull Hosp Jt Dis. 1996;55(1):12-5.
8. Chan PS, Klimkiewicz JJ, Luchetti WT, Esterhai JL, Kneeland JB, Dalinka MK, *et al*. Impact of CT scan on treatmentplanandfractureclassificationoftibial plateau fractures. J Orthop Trauma. 1997;11(7):484-9.
9. Wicky S, Blaser PF, Blanc CH, Leyvraz PF, Schnyder P, Meuli RA. Comparison between standard radiography & spiral CT with 3D reconstruction in the evaluation, classification and management of tibial plateau fractures. Eur Radiol. 2000;10(8):1227-32.
10. Barei DP, Nork SE, Mills WJ, Coles CP, Henley MB, Benirschke SK. Functional outcomes of severe bicondylar tibial plateau fractures treated with dual incisions and medial and lateral plates. JBJS. 2006; 88(8):1713-21.
11. Hoekstra H, Kempenaers K, Nijs S. A revised 3-column classification approach for the surgical planning of extended lateral tibial plateau fractures. Eur. J Trauma Emerg Surg. 2017;43(5):637-43.