



A STUDY TO CONFIRM OR REFUTE THE SUPERIORITY OF COMPUTED TOMOGRAPHY (CT), IN SURGICAL PLAN OF PROXIMAL TIBIA FRACTURES OVER PLAIN RADIOGRAPHS ALONE

Orthopaedics

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ABSTRACT

The anatomic configuration of the proximal tibia is such that the fractures of these regions are not adequately visualized on conventional radiographs. There has been a conflicted opinion among orthopaedic surgeons worldwide about the need of CT scan in these fractures and its advantages.

Objectives: To classify and decide plan of management of each fracture according to Schatzker's classification in two proformas, first with X-ray alone and then after seeing CT scan, and to assess how the surgical plan changes after introducing CT scans.

Methods: This is a cross-sectional, prospective study of 60 patients diagnosed with proximal tibia fracture from January 2016 to June 2017.

Results: In our study of 60 patients, Schatzker's type 1 (33.33%) was the most commonly encountered fracture type and antero-lateral plating (38.09%) was the most commonly opted treatment modality by the operating surgeon on X-ray. After CT scan, Schatzker's type 5 (40.49%) was most commonly observed and Bi-condylar plating (23.81%) was the most commonly chosen mode of treatment.

Conclusion: CT scan should be used to supplement the plain radiographs for better diagnosis, pre-operative evaluation and management of proximal tibia fractures.

KEYWORDS

Proximal tibial fractures, CT scan, plain radiograph

INTRODUCTION

Proximal tibia is one of the most critical weight bearing part of the human body. Fractures of the tibial plateau affect [knee alignment](#), stability, and motion. Early detection and appropriate treatment of these fractures are critical for minimizing patient disability and reducing the risk of documented complications, particularly post-traumatic [arthritis](#).

The surgical treatment of these fractures is dependent upon several factors, including the type of fracture, the degree of the fracture depression, and fracture fragment separation as well as the patient's age and physical condition. The degree of the plateau depression is a particularly important criteria for surgical-treatment planning. However, the anatomic configuration of the proximal tibia is such that the fractures of these regions are not adequately visualized on conventional radiographs.

There has been a conflicted opinion among orthopaedic surgeons worldwide about the need of CT scan in proximal tibia fractures and its advantages. In developing countries like India, there is always an economic constraint influencing the plan of management of any fracture especially in rural setups where surgeons are not always equipped with these expensive and sophisticated diagnostic technologies. In Indian setups, all fixation modalities (like external fixators, all varieties of plates, CC screws etc.) are usually not available all at once in most OTs. The surgical plan has to be carefully sought out beforehand keeping in mind the difficulties one might face and specific implants have to be ordered for each case.

So there was a need to study the importance of CT scan in diagnosis and preoperative planning of these fractures and to find out whether CT scan should be done mandatorily in all types of proximal tibia fractures or it is just an additional diagnostic tool enabling surgeons to plan better.

AIMS AND OBJECTIVES

- 1) To classify and decide plan of management of each fracture according to Schatzker's classification in two proformas, first with X-ray alone and then after seeing CT scan.
- 2) To assess how the surgical plan changes after introducing CT scans.

MATERIALS AND METHODS

This cross-sectional, prospective study entitled 'A study to confirm

or refute the superiority of computed tomography (CT), in surgical plan of proximal tibia fractures over plain radiographs alone' was conducted at Department of Orthopaedics, Index Medical College, Hospital and Research Centre, Indore (M.P.), from January 2016 to June 2017, and comprised of 60 patients diagnosed with proximal tibia fracture.

INCLUSION CRITERIA

- 1) Traumatic fractures of the proximal tibia.
- 2) Patients of age group 15-65 years.

EXCLUSION CRITERIA

- 1) Those conditions which may require Total Knee Replacement in recent future (like Grade 4 and Grade 5 Osteoarthritis)

APPROACH

The study was explained in detail to the patient and/or his/her legally acceptable representative regarding risks, benefits, surgery, approach etc. After obtaining their verbal consent, a voluntary written informed consent was taken from them, prior to initiation of any study related procedures.

The patient's clinical history and examination findings were recorded prospectively in a case record form. Then radiological investigations like X-ray and CT scan were ordered.

Opinions of operating consultant surgeon were taken in two separate proformas regarding their findings, diagnosis and plan of management. First opinion was taken on the basis of the X-ray alone and second opinion was taken after showing the CT scans. Any change in the plan of management was noted.

INVESTIGATION DETAILS

- 1) Roentgenogram of the involved knee joint with leg (antero-posterior and lateral views) was done. (GE DX 300mA X-ray machine, Carestream Dryview CR system, Carestream Dryview 5950 laser imager were used)
- 2) Computed tomography was done after taking opinion of the operating surgeon on the basis of roentgenogram (Siemens Somatom Definition AS scanner and Carestream Dryview 5950 laser imager were used).

OUTCOME MEASURES

The changes in plan of management of each case were divided into 3

groups:

'No change', 'Subtle change' and 'Drastic change'.

Those cases in which there was no change in the plan of management after seeing X-ray and CT scans were included in '**No change**' group.

Those cases where there was a minor change in management like change in reduction maneuvers, supplementation of fixation with CC screws, immobilization and restriction of weight bearing for longer durations were included in '**Subtle change**' group.

In cases where after seeing the CT scans, operating surgeon advised a major change in the treatment strategy like complete change in modality of treatment, change in method of fixation, change of plate position, addition or removal of one or more plates, change in surgical approach or addition of bone grafting, were included in the '**Drastic change**' group.

STATISTICAL ANALYSIS

The data from proforma was transferred onto Microsoft Excel (Microsoft Office Professional Plus 2013) and then transferred to statistical software package SPSS 20.0.0 for analysis. The mean comparison was done using paired 'T' test. A 'P' value of ... was taken as statistically significant. The data was represented in the form of tables and graphs.

FINANCIAL INPUTS AND FUNDING

The patients were managed according to the protocol of the institution laid down for management of the disease. All the charges as per the institution norms were borne by the patient. All study related expenditures were borne by the investigator himself.

ETHICAL AND LEGAL CONSIDERATIONS

The protocol of present study was approved by the Ethics Committee of Index Medical College, Hospital and Research Centre, Indore. A patient information and consent form was given to the parents in their local language which, when all their queries were satisfactorily answered and when they were willing to participate, signature of the patient and/or his/her legally acceptable representative was obtained and then only study related procedures were initiated.

RESULTS & DISCUSSION

Tibial plateau fractures involve a complex anatomy. They can present as isolated fracture or as a part of polytrauma. Their management is further complicated by the fact that multiple fracture patterns can be seen which usually don't fit into one classification system.

Plain radiographs contribute largely to the primary diagnostic procedure, they are quick and easy to perform, low-cost and widely available. CT scan is a diagnostic modality that every patient can't afford, especially in developing countries like India. These are usually available in tertiary care hospitals and private medical setups. These expose the patients to much more radiation than X-rays but give valuable additional information that cannot be obtained by plain radiographs.

Traditional classification systems like Schatzker, AO and Duparc systems classify them according to the fracture morphology on plain radiographs. Most of them fail to include the vast variety of fracture patterns that are commonly seen in clinical practice. So they don't always contribute in management plan of these types of fractures.

To the best of our knowledge, presently no individual classification system includes all the fracture patterns in a single classification. There have been numerous attempts by different authors to propose new, more detailed and comprehensive classifications.

Luo et al¹ have proposed three-column classification based on fracture patterns in CT axial scans which describes the fracture geometry better and also helps the surgeon in preoperative planning, surgical approach to be taken, choice of implant and expected functional outcome. Krause et al⁴ divided the tibial plateau into ten segments so each fragment can be addressed individually. Recently Dhillon et al⁵ proposed a new simple four segment classification which they insist is better to classify the tibial plateau fractures than the cumbersome ten segment classification system.

In our study, we found that tibial plateau fractures are more common in

males than females. It is commonly found in adults of age group 30-40 years. Most common cause of injury was road traffic accidents. This stands in concordance with the study by Albuquerque et al⁶ which concluded that males are affected more commonly with highest incidence during 5th decade of life. Left side knee is more commonly affected than right. Most common cause of fracture is road traffic accident and 22.6% have associated injuries like meniscal and capsulo-ligamentous injuries, fracture fibula, fracture shaft of femur, fracture supracondylar humerus and calcaneal fractures.^[23]

14 out of 42 cases were diagnosed as Schatzker's type 1 on X-ray. This type showed the highest incidence. Antero-lateral plating was the chosen method for fixation in 09 cases, above knee cast immobilization was suggested in 04 cases and 01 cases were planned to be fixed by cortico-cancellous screws only. Total 02 cases were classified as Schatzker's type 2 on X-ray, out of which operating surgeons planned to fix both cases with antero-lateral plate. The incidence of Schatzker's type 3 pattern was the least in all cases. No cases were diagnosed with this type. Schatzker's type 4 fracture was present in 05 cases. In 01 case of undisplaced medial condyle fracture, the operating surgeon felt that CC screws would suffice to fix the condyle. In 01 case, displacement of the medial condyle indicated that antero-medial plating should be done. 03 cases seemed to require postero-medial plating for satisfactory results. Second most commonly observed fracture on X-ray was Schatzker's type 5 involving both medial and lateral condyles (13 cases). Antero-lateral plating was planned in 03 cases, antero-lateral plate was proposed to be supplemented with CC screws from lateral to medial direction in 01 case. Bi-condylar plating was needed in 07 cases, in 01 case medial plating was planned which would fix the lateral condyle also by long screws passing through the medial plate. 01 fracture had to be fixed with postero-medial plate and CC screw. 6 cases were included in Schatzker's type 6. Antero-lateral plating was planned in 02 cases, bi-condylar plating in 03 cases and 01 case required fixation with CC screws only because of poor condition of skin around the fracture.

When diagnosis was made after seeing CT scans, type 5 fractures were the most commonly seen (17 out of 42) followed by type 1 fractures (12 out of 42), followed by type 6, type 2, type 4 and type 3. The additional information made available by CT scan influenced the surgical plan of some fractures and lead them to revise their line of management for those particular fractures. 02 cases were thought to have no bony injury on X-ray but after seeing CT scans, diagnosis of 01 case was changed to Schatzker's type 01 and another case was placed in type 3 group. Total 14 cases on X-ray were included in Schatzker's type 1. Out of these, diagnosis of 11 cases remained unchanged after CT scan. Diagnosis of 02 cases was changed from type 1 to type 2. 01 case was removed from type 1 and included as type 3 fracture. Out of total 02 cases diagnosed with Schatzker's type 2, diagnosis of 01 case was unchanged while 01 case had a medial condyle fracture which was revealed only on CT scans and thus included in type 5. 05 cases were included in Schatzker's type 4 according to X-ray but after CT scan 03 cases got converted to type 5 because CT scan revealed fractures of medial condyle which was not apparent on X-rays. After CT scan, no change was observed in 13 cases of Schatzker's type 5 fractures. Same was the case with 05 patients diagnosed as Schatzker's type 6.

Antero-lateral plating was the opted for in 16 out of 42 cases. After confirming with CT scan, antero-lateral plating was done in 09 cases, in 02 cases bone grafting was required to elevate the depressed articular fragment, in 03 cases antero-lateral plating had to be supplemented with CC screws and in 02 cases one more plate had to be added to provide the medial support.



Figure Plain radiograph

In 01 case antero-medial plating was recommended on X-ray, which remained unchanged. In 10 cases planned for bi-condylar plating, decision was unchanged in 09 cases but in 01 case CT scan revealed inadequate bone stock of medial condyle for plating. So only antero-lateral plating could be done. 03 cases were planned for fixation with CC screws. This method was finally followed in 02 cases. In 01 case, CT scan showed displaced postero-medial fragment which was then fixed with a postero-medial plate. 03 cases were planned for postero-medial plating after diagnosis on X-ray. Management of only 01 case was unchanged, while 01 case required an additional fixation with lateral to medial CC screws and in 01 case, antero-lateral plate had to be added. In 01 case after seeing the X-ray, operating surgeon expected that postero-medial plating with CC screws would provide adequate fixation but later changed the management to bi-condylar plating.

In our study, we found out that CT scan is a very valuable diagnostic modality than plain radiographs alone, more so in some types of fracture patterns. It provides a better orientation of the fracture morphology which enables the operating surgeon to better diagnose, plan appropriate surgical approach, and decide mode of management and choice of implants best suited for adequate fixation.

This is in concordance with the study conducted by Rao SP⁷ et al who found that inter-observer reliability and intra-observer reproducibility was better in Three-column classification (which is based on CT scan) to characterize and classify tibial plateau fractures than Schatzker's classification (based on plain radiographs). Our study is in concordance with the study by Markhardt et al⁸ where they showed that cross-sectional imaging results change the surgical plans based on plain radiographs by more precisely demonstrating the fracture pattern, depression and displacement. They concluded that CT imaging is more accurate than plain radiography for characterization and classification of tibial plateau fractures.

In our study, diagnosis of 09(21.43%) cases got changed after addition of CT scans. The plan of treatment was changed in 15 (35.71%) cases after seeing CT scans. Similar observations were seen in study by S. H. Chang et al⁹ where classification of fracture got changed in 12% cases and treatment was changed in 26% cases. They concluded that addition of CT scans to plain roentgenograms increases the inter-observer and intra-observer agreement on treatment plan. Similarities exist between our study and an article by Tsifountoudis et al¹⁰. They have shown that surgical plans based on plain radiographs were modified in 6-60% of cases after CT scans. In their opinion, CT scan especially 3D CT images are more accurate for Schatzker's classification, and use of cross-sectional images can improve surgical planning. Our study agrees with Rafi et al¹¹, who found that in 3 out of 20 patients, treatment was changed. And in other 3 cases, classification was changed after seeing CT scans. They also found that the degree of depression and separation are measured more accurately with CT scans.

But newer doesn't always mean better. Doornberg et al¹² in their study concluded that added value of 3D CT after 2D CT is limited and doesn't significantly improve reliability of characterisation and classification of tibial plateau fractures. In 2013, Lopez et al¹³ compared the importance of plain radiographs and computed tomography. They concluded that the use of CT did not give rise to greater concordance between the evaluators regarding Schatzker's classification, nor did it contribute towards changes in preoperative planning in comparison with radiographs.

CT scan helps the operating surgeon in deciding the surgical approach to be followed. This was proved by Luo et al³ in their study of Three-column fixation of tibial plateau fractures.

Additional advantages of CT scan include detection of ligament tear or footprint avulsion which can leave a well-constructed tibial plateau fracture unstable during rehabilitation.

CONCLUSION

CT scan contributes significantly in management of proximal tibia fractures especially in Schatzker's type 1 and type 4. It reveals articular depressions and fracture fragments that are often obscured on X-rays. It helps surgeons to prevent dreadful postoperative complications. Although plain radiographs are indispensable for initial evaluation of patients with acute knee trauma, they should not be replaced by CT scan. Rather CT scan should be used to supplement the plain

radiographs for better diagnosis, pre-operative evaluation and management of proximal tibia fractures.

There is a need for classification systems which could include significant fracture patterns that are not included in traditional systems like Schatzker's, AO, Hohl and Moore classifications.

SUMMARY

- Mean age of the patient was 35.69 years.
- There were 37(88.09%) male and 05(11.91%) female patients in our study. Clear male preponderance was found in the study.
- Schatzker's classification system was used to classify all fractures.
- On the basis of X-ray, Schatzker's type 1 (33.33%) was the most commonly encountered fracture type in our study.
- According to management planned on X-ray, antero-lateral plating (38.09%) was the most commonly opted treatment modality by the operating surgeon.
- After CT scan, Schatzker's type 5 (40.49%) was most commonly observed.
- Bi-condylar plating (23.81%) was the most commonly chosen mode of treatment after CT scan.
- Out of total 42 cases included in this study, some change (Drastic or Subtle) was observed in 19 (45.24%) cases.
- Most frequently changed diagnoses after CT scan were type 1 and type 4.
- Most frequently altered plan of management was antero-lateral plating.
- Most 'Drastic change' in surgical plan was seen in cases diagnosed as Schatzker's types 1, 4, 5 and 6 based on X-ray.
- Antero-lateral plating planned on X-ray had most 'Drastic change' in management plan to include Bone grafting or to undergo Bi-condylar plating after CT scan.

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