Hypothesis

Observational Study to Evaluate an Impact of Intraoperative C-arm Image Based Surgical Path Planning on Improvement of Functional Outcome in Intra-articular Proximal Tibia Fractures

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Abstract

Aim: To study the functional and radiological outcome of intra-articular proximal tibial fracture treated with locking compression plate using C-arm image based surgical path planning method.

Objectives: To compare the functional and radiological outcome of intra-articular proximal tibial fracture managed by conventional method and C-arm image based surgical path planning method.

To study and compare the incidental complications associated with both methods.

Study Methodology: Patients with closed lateral tibial plateau fractures will be taken on to operative table in supine position and induced under desired anaesthesia. We will then take a C-arm shoot of the non-affected knee while the patient is on OT table. We then trace the normal knee anatomy on a tracing paper. The paper will then be flipped and placed on C-arm monitor. The affected knee will then be restored to its normal anatomy using image guidance

Result: - C-arm image based management for proximal tibial fracture surgically led to better functional outcomes on follow-up versus conventional method, as indicated by superior Oxford knee score and range of motion.

- C-arm image-based planning led to no complications and was as safe as the conventional method for managing proximal tibia fractures.

- Future studies from Indian centres can help in validating our study findings.

Conclusion: C-arm image based management for proximal tibial fracture surgically led to better functional outcomes on follow-up versus conventional method, as indicated by superior Oxford knee score and range of motion.

Keywords: Proximal Tibia Fractures, C-arm image based, Schatzkers

Introduction

The tibial plateau is one of the most important critical load bearing areas in the human body. Fractures of this region are a common cause of concern even in the most experienced surgeons as the spectrum of the fractures can range in its severity from a simple injury with predictably excellent outcomes after non-operative treatment to complex fracture patterns. Complex biomechanics of its weight bearing position and complex ligamentous stability and articular congruency are the main reason why these fractures are of concern to surgeon.[1]

Tibial plateau fractures constitute about 1% of all fractures occurring at an incidence of 10.3 per 100,000 annually. The distribution of tibial plateau fractures is bimodal, with men under the age of 50 more likely to sustain this injury via high energy mechanisms and frequently associated with soft tissue

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injuries. Whilst women over the age of 70 more likely to have tibial plateau insufficiency fractures secondary to falls. Most of these injuries (55-70%) affect lateral plateau. Isolated injuries to the medial plateau occur in 10-23% cases, whereas bicondylar fractures are noted in 10-30% cases.[2].Tibia plateau fractures are a result of a combination of axial loading with varus or valgus stress during flexion and extension movements, mostly secondary to high- speed velocity accidents. Extra-articular fractures of the proximal tibia usually secondary to direct bending forces applied to the meta diaphyseal region of the upper leg, older patients with osteopenic bone are more likely to sustain depression type fracture because their subchondral bone is less likely to resist axial directed loads.[3]

The management of tibial plateau fracture encounters a unique challenge despite the advances in the recent times. This is because of the characteristics of the joint[4]

- The small size of the proximal fragment makes the reduction quite challenging, regardless of the choice of management.
- Forces acting on the proximal tibia can create chances of malalignment.
- Closed reduction takes a prolonged time to heal leading to immobilization, stiffness, and poor functioning of the joint.
- With the operative management, loss of fixation in the proximal segment is more common resulting in poor quality.
- The unique cross-sectional anatomy of the tibia makes the intramedullary nailing a challenging technique.
- Open treatment of the fracture has an increased risk of soft tissue complications like wound breakdown, deep infections etc.
- External fixation can also lead to pin track infection and a further risk of septic arthritis of the knee in the susceptible.

In the current medical literature, there are no consensus about the best approach to treat these fractures. The main keys for successful functional outcomes of tibial plateau fractures are the restoration of the axial and rotational alignment of the limb and knee stability. Another crucial aspect is soft tissue management. Non-operative modalities like cast, braces or traction are complicated by intrinsic risks of poor functional results and extended hospital stay. These are indicated in minimally displaced fractures whether it is a split or depression pattern. Among the different operative options available, some are Open Reduction and Internal Fixation (ORIF), External fixation with limited open/ percutaneous fixation of the articular segment, staged or Sequential fixation: Bridging external fixation with delayed ORIF, arthroscopically assisted reduction and internal fixation, Primary Total Knee Arthroplasty. These involve the use of intramedullary implant, half-pin external fixation, hybrid or thin-wire external fixation, plate fixation, or a combination of these techniques. While open reduction and stable internal fixation helps in maintaining the articular surface and restoration of the mechanical alignment which allows early mobilization of knee. Open reduction and internal fixation have its own complications.[5] Closed reduction (with minimally invasive plating) and internal fixation (with percutaneous cancellous screws) is a commonly used strategy for management of these complex fractures.[6]

The use of fluoroscopy during orthopedic procedures has grown over recent years. The intra-operative use of C-arm fluoroscopy in orthopedic surgical practice has become an important part. The utilization of C-arm is an integral part in procedures like intramedullary nailing of long bone fractures, reduction of closed fractures, external fixation of fractures, percutaneous hardware insertion and so on. Their use enhances the surgeon's proficiency, decreases morbidity for the patients due to soft tissue devitalization, early functional recovery is seen in the patient. However, the use of c-arm comes with some challenges. The process requires the surgeon to adjust the projection direction of the C-arm X-ray constantly. Such a method has twofold disadvantages: adjustment of the C-arm projection direction and location continuously can be difficult and time consuming and secondly, a high radiation dosage due to continuous X-ray exposure that is harmful to medical staff and the patient.[7]

Literature search revealed that though there are a few studies from foreign hospitals which have evaluated the C-arm image based surgical path planning method for proximal tibia fractures, such studies are scarce in India. Therefore, in the present study, a unique approach for fracture management using C-arm guidance was proposed, where constant adjustment of the C-arm was not required. Our aim was to evaluate and compare the functional and radiological outcome of intra-articular proximal tibial fracture managed by the conventional method and C-arm image based surgical path planning method. This study will help in adding crucial evidence with respect to this topic, which can help Orthopedic surgeons in better surgical path planning for proximal tibia fractures and produce a better functional outcome than the conventional method.

Conclusion

C-arm image based management for proximal tibial fracture surgically led to better functional outcomes on follow-up versus conventional method, as indicated by superior Oxford knee score and range of motion.

Aims and Objectives

1. To compare functional as well as radiological outcomes for intra-articular proximal fracture of tibia, managed by conventional method and C-arm image based surgical path planning method.
2. To study and compare the incidental complications associated with both methods.

Material And Methods

Study site

Department of Orthopedics Dr D Y Patil Medical college & research Centre, Navi-Mumbai.

Sample population

Cases with closed proximal tibial fracture (Schatzker's type I, II and III).

Sample size

At least ten percent better results are expected in patients with new treatment as compared with control group.

Considering the probability of type I error (α) equal to 0.1 And the probability of type II error (β) equal to 0.2 the estimated sample size is 50.

$n = (Z1+Z2)2\{p1(1-p1)+p2(1-p2)\}$

$(|p1-p2|-I)2$

Where;

- Z1=1.64 and Z2= 0.84
- p1- proportion of recovery in new procedure
- p2- proportion of recovery in traditional procedure
- z1- Area under the normal curve for type I error
- z2- Area under the normal curve for type II error

Thus, a total of 60 consecutive cases with closed proximal tibial fracture Schaztkers type I, II and III were included in the study. A total of 30 cases was managed as per the new management technique i.e., C-arm image based surgical path planning method. While the data of 30 cases managed via conventional technique was retrieved from hospital records.

Design of study

A prospective and Retrospective observational study

Duration of study

Data was collected between August 2022 to December 2022 (4months). The analysis of the parameters was done after the data was collated completely. At any point of time, the patient may opt out of the study. Study was initiated only after institutional ethics committee permission was obtained.

Selection criteria for enrolment of patients

Inclusion criteria

- Patients with a recent history of fall and aged more than 20 years and less than 70 years.
- Patients of closed proximal tibial fracture schaztkers type I, type II and type III requiring surgical intervention and treated by locking compression plate using C-arm guidance.

Exclusion criteria

- Age group less than 18 years and more than 70 years.
- Patients who were medically unfit for surgery.
- Compound fractures (Gustilo Anderson)
- Patients with associated ipsilateral lower limb fractures, spine injury, pelvic fractures, or patients with an associated head injury.
- All pathological fractures, non-union and neglected fractures.

Brief Methodology

The study was initiated after getting permission from the institutional ethics committee. The study was conducted on 60 cases with closed proximal tibial fracture (Schatzker's type I, II and III). The main aim of the study was to evaluate and compare the functional and radiological outcome of intra- articular proximal tibial fracture managed by the conventional method and C- arm image based surgical path planning method.

The demographic details of the patients were noted down at the start of the study. All the necessary clinical details were recorded in the proforma prepared for this study. The general condition of the patient was assessed with regard to hypovolemia and associated orthopaedic or other systemic injuries and resuscitative were measures taken accordingly.

All the patients were given preliminary management by temporary above knee POP slab and required medical management. The patients were taken for definitive fixation after a variable period depending upon swelling and skin condition. Definitive fixation was done in the form of lateral column fixation by raft plate and screws.

Patients enrolled in the study were hen be divided into the 2 study groups using simple randomization method. To summarize the distribution of 60 patients (30 patients in each group):

Group 1 – Patient with tibial plateau fractures (Schatzker type I, II and III) and using intraoperative c-arm image based surgical path planning

Group 2 – Patient with tibial plateau fractures (Schatzker type I, II and III) with routine method

Parameters assessed

o Clinical assessment of range of motion

o Radiological evaluation as by parameters (medial proximal tibial angle, posterior proximal tibial angle

o Progression of healing (union; determined by visibility of fracture lines)

o Post-operative complications (surgical site infection, deep infection, knee stiffness, knee instability)

o Oxford Knee Scores questionnaire (for the functional evaluation)

Follow up

- After the discharge, patients were advised to report for follow up at 1-month intervals.
- The patients were examined clinically and radiologically at each follow up.
- Clinically, the range of motion was assessed and recorded.

Radiological evaluation was done by parameters i.e., medial proximal tibial angle, posterior proximal tibial angle, and progression of healing (union; determined by visibility of fracture line).

• The radiological union was analyzed by the visibility of fracture line, seen on AP and lateral x-ray of knee.

• In each of the follow up visits, surgical wounds were also evaluated, and appropriate required measures were taken.

• The functional outcome evaluation as reported by patient using Oxford Knee Score questionnaire (Appendix I) was done at the end of 1 month of follow up.[39]

Surgical Procedures

• Patient was taken on to operative table in supine position and was induced under desired anaesthesia.

• The image intensifier was positioned so that AP & lateral views of the knee could be taken.

• Pneumatic tourniquet was recommended. A sand bag was placed under the ipsilateral gluteal region for the anterolateral approach.

• Painting and draping of the part were done. Both the iliac crests were also painted and draped.

• Later, with a C-arm, a shot of the non-affected knee was taken while the patient was on OT table. This was done to trace the normal knee anatomy on a tracing paper. The paper was then flipped and placed on C- arm monitor. The affected knee was restored to its normal anatomy using image guidance. In conventional method (taken as controls) the above step was not done.

• Open reduction and internal fixation of the articular surface was performed after elevating the depressed fragments with the help of k wires and reduction clamps to secure reduction.

• Additional, inter-fragmentary screws were used to supplement reduction when required.

• The fracture reduction and plate position below the joint line was confirmed under C-arm.

• After temporary fixation, a lateral tibial locking compression plate was used to fix the lateral column.

• An appropriate length of the plate was selected and placed against the lateral proximal tibia and the position verified with the help of C-arm in both AP and Lateral views. On achieving alignment, the drill sleeve was placed and drilled up to the far cortex and measure was checked using a gauge and appropriate length locking screws were inserted. All the procedure is confirmed on C- arm.

• Tourniquet was then deflated.

• Haemostasis confirmed. Wash with sterile normal saline was given. The wounds were closed in layers and a sterile bulky compression dressing was applied.

Statistical analysis

• All the data was noted down in a pre-designed study proforma

• After data collection, data entry was done in Excel.

• Data analysis was done with the help of statistical software Graphpad InStat v3.0

• All the qualitative data were represented in the form of frequency and percentage.

• Association between qualitative variables was assessed by Chi-Square test with Continuity Correction for all 2 X 2 tables and Fisher's exact test for all 2 X 2 tables.

• Quantitative data was represented using Mean ± SD and Median & IQR (Interquartile range).

• Analysis of Quantitative data between the two groups was done using an unpaired t-test if the data passed 'Normality test' and by Mann-Whitney Test if the data failed 'Normality test'.

• A p-value < 0.05 was taken as the level of significance.

• Results were graphically represented where deemed necessary

Results

1. Demographic details in study groups

A total of 60 patients, 30 patients in C-arm management group and 30 patients in conventional study group, were enrolled in the study. The mean age was statistically comparable between study groups (p>0.05). Majority of cases in both study groups were males (C-arm group: 70%, Conventional group: 73.33%). P value >0.05 considered NOT significant by ^Unpaired t test and $Chi-square test

The commonest age group in both the study groups was 41-50 years' age group, followed by 18-30 years. Complete details of age distribution are noted

2. Tibia fracture laterality in study groups

In C-arm group, there was equal distribution of right side and left side tibia fracture. In the Conventional group, 16 of the 30 patients were left sided fractures.

3. Mode of injury in study groups

Majority of fractures in both the study groups were a result of RTA (90% in C- arm group and 86.67% in the conventional group). Fall was the other mode of injury.

4. Schatzker Classification in study groups

Based on Schatzker classification, Type 1 fracture was noted in 43.33% cases in C-arm group and 40% cases in conventional group. Type 2 fracture was noted in 40% cases in C-arm group and 43.33% cases in conventional group. Type 3 fracture was noted in 16.67% cases in both study groups.

5. Comparison of surgery duration between study groups

The mean operative time was found to be significantly higher in the C-arm group versus the conventional group (p<0.05). P<0.05 considered significant by Unpaired t test

6. Comparison of Oxford Knee score between the study groups at 1-month and

3-months follow-up

The Oxford knee score was noted to be significantly higher in the C-arm group versus the conventional group ($p<0.05$) at both, 1-month and 3-months' follow-up. (Table 7, graph 5.7)

7. Comparison of Range of motion at knee between the study groups at 1-month and 3-months follow-up

The range of motion at knee was noted to be significantly higher in the C-arm group versus the conventional group ($p<0.05$) at both, 1-month and 3-months' follow-up.

$P<0.05$ considered significant by Unpaired t test, values in degrees

8. Functional outcome at follow-up for study groups

The functional outcome grading was done based on last follow-up based on following criteria of Oxford Knee Score:

>40 = Excellent

31-40 = Good

21-30 = Fair

<20 = Poor

At 1-month follow-up, in C-arm group, 96.67% cases showed excellent functional outcome, compared to 66.67% in conventional group, and this was significant finding ($p<0.05$). In C-arm group, 3.33% cases showed good functional outcome, compared to 33.33% in conventional group, and this was significant finding ($p<0.05$). (Table 9)

$P<0.05$ considered significant by Chi-square test

At 3-month follow-up, in C-arm group, all cases showed excellent functional outcome, compared to 86.67% in conventional group, and this finding was statistically not significant ($p>0.05$). In conventional group, 13.33% cases showed good functional outco

Discussion

Over the past few years, fluoroscopy has become increasingly used during orthopaedic surgeries. C-arm fluoroscopy's intraoperative usage in orthopaedic surgical practise has grown in significance. In various kind of management paradigms for the fractures, and others, the use of a C-arm is a crucial component. By using them, the surgeon becomes more skilled, patients have less morbidity from soft tissue devitalization, and the patient recovers functionally more quickly. The employment of c-arm does provide certain difficulties, though. Throughout the procedure, the surgeon must continuously change the C-arm X-projection ray's direction. Such a procedure has two drawbacks: first, it can be challenging and time-consuming to continually alter the C-arm projection direction and position; second, it exposes patients and medical workers to a high dose of radiation.[7] Even though most of the centers with the latest technology in place have a C-arm in operating room, there are still numerous centers in resource-poor nations who lack this capability because to a lack of either the necessary equipment or experienced personnel to operate it.[40] These flaws frequently require surgeons to refuse operating therapy to patients who have the proper surgical justification. Additionally, there are growing worries regarding increased radiation exposure for medical staff working in such settings.[41] There has been some debate whether management of proximal tibia fractures cases can be done without C-arm support, but the data comparing C-arm intervention and without C-arm supported intervention are absent. Hence, present study was done to evaluate and compare the functional and radiological outcome of intra-articular proximal tibial fracture managed by conventional method and C-arm image based surgical path planning method.

The proximal tibia is crucial to the stability and function of the knee because it helps transmit body weight through the knee joint and leg. Historically, it has been challenging to treat proximal tibia fractures due to the anteromedial surface of the tibia's subcutaneous placement.42 The goal of surgical management for proximal tibial fractures is to get normal knee function in the patients. This is usually done by anatomically restoring the articular surfaces, maintaining the mechanical axis, restoring ligamentous stability, and maintaining a functional, pain-free range of motion of the knee. In several documented studies, the prevalence of malunion, non-union, and infections is comparatively high, leading to considerable long-term impairment. For the management of proximal tibial fractures, plate fixation has gained popularity during the past ten years. High union rates have been attained because of this combined with the biological benefit of percutaneous insertion. Comparing the locking compression plate system to other techniques may provide a biomechanical benefit. The capacity to directly manage and decrease the tiny, frequently osteoporotic fracture pieces is an additional benefit of locking compression plates.[43] Hence, in present study, while evaluating the C-arm intervention versus non-C-arm intervention, all the proximal tibia fracture cases were managed by locking compression plates to not only maintain uniformity in study but also provide the best possible surgical care as per protocol of the study centre.

Demographic details of enrolled patients

A total of 60 patients, 30 patients in C-arm management group and 30 patients in conventional study group, were enrolled in the study. The mean age was 38.13 years in the C-arm group and 37.47 years in the conventional group without C-arm usage. The mean age was statistically comparable between study groups ($p>0.05$). The commonest age group in both the study groups was 41-50 years' age group, followed by 18-30 years. These age findings indicate that majority enrolled cases were either middle aged or young adult population. Majority of cases in both study groups were males (C-arm group: 70%, Conventional group: 73.33%).

In the study on proximal tibia fractures by Vadadoriya et

al.,[44] the fractures were noted to be more common in younger (55.8%) and middle aged (30.2%) population with higher incidence in third and fourth decade. These findings were similar to our study. Additionally, the study had 83.7% males and 16.3% females managed by C-arm guided locked compression plate. These findings were again similar to our study. The study mentioned that males being involved in outdoor activities in Indian settings makes them prone to vehicular accidents and hence the higher incidence of fractures was observed in them.

In the study by Reddy et al.,[43] mean age of patients with proximal tibia fractures was noted to be 41 years, with majority cases being in between 18 years to 40 years. The age findings were similar to our study. The proportion of males in the study was 86.7%, indicating male preponderance as noted in our study.

In a similar study by Aseri et al.,[45] proximal tibia fracture cases included in study were mostly males (83.33%) and the mean age was 39.03 years. The commonest age group affected was 31-40 years, a finding identical to our study.

Features of proximal tibia fracture in study

In C-arm group, there was equal distribution of right side and left side tibia fracture. In the Conventional group, 16 of the 30 patients (53.33%) were left sided fractures. The scientific literature does not mention any side being more prone to proximal tibia fractures. Majority of fractures in both the study groups were a result of RTA (90% in C-arm group and 86.67% in the conventional group). Fall was the other mode of injury.

In the study by Vadadoriya et al.,[44] nature of injury was high velocity injury in 38 cases (88.4%) as it is explained by all patients sustaining road traffic accident. 5 (11.6%) cases had sustained injury as a result of fall or trivial trauma. These findings were similar to our study. In the study, 65.1% cases had left sided tibia fracture.

In the study by Reddy et al.,[43] 93.3% of the patients sustained injury secondary to RTA and the rest 6.7% due to fall from a height. These findings were again similar to our study. 73.3% of the patients sustained injury on the right side in this particular study, and 26.7% on the left side.

In the study by Aseri et al., [45] those who were highly associated with road traffic accident accounted for 80% of proximal tibia fracture cases. 56.67% of the patients sustained injury on left side in the study and 43.33% on right side.

Schatzker Classification of enrolled cases

The Schatzker classification defines pathoanatomy in AP radiograph and suggests treatment strategies and this classification remains central to the language of tibia plateau fractures.[46],[47]The Schatzker classification system for tibial plateau fractures, which divides these fractures into six types, is widely recognized and standardized by orthopaedic surgeons while managing the fractures. Schatzker type IV, V and VI fractures are high energy fractures often accompanied by other local and systemic injuries.[48] Based on Schatzker classification, Type 1 fracture was noted in 43.33% cases in C-arm group and 40% cases in conventional group. Type 2 fracture was noted in 40% cases in C-arm group and 43.33% cases in conventional group. Type 3 fracture was noted in 16.67% cases in both study groups. These findings suggest that the patients in our study were not suffering from displaced and unstable fractures in both the study groups.

Duration of surgery in study groups

In the present study, mean operative time was found to be greater statistically in the C-arm group in comparison to the conventional group ($p<0.05$). The mean duration was 115.67 minutes in C-arm group and 102.50 minutes in the conventional group where C-arm was not used. The reason may be the setting up of the C-arm machine and technical finesse may take slightly more time versus free-hand technique. However, the time difference in mean value was just 13 minutes which may be statistically different but may not be clinically meaningful finding.

In the similar study by Rohilla et al.,[49] the duration of surgery was noted to be similar in both the study groups (free-hand versus C-arm assisted). However, another similar study by Prasad et al.[36] had found that using the nail over nail technique for tibia fractures, the surgeons were able to conduct the nailing method in the 28 patients in 65.04 minutes which was significantly higher than C-arm group (54.40 minutes) (p-value < 0.05), a finding which was contrast to our study. However, in the same study the authors mentioned that the reason of higher duration was low confidence in doing procedure without C-arm, and the duration gradually decreased as recruitment of cases were done over study period because of building confidence of surgeons.

Outcome of patients in study groups

The Oxford knee score as well as the range of motion were noted to be significantly higher in the C-arm group versus the conventional group ($p<0.05$) at both, 1-month and 3-months' follow-up. At 1-month follow-up, in C-arm group, 96.67% cases showed excellent functional outcome, compared to 66.67% in conventional group, and this was significant finding ($p<0.05$). At 3-month follow up, in C-arm group, 3.33% cases showed good functional outcome, compared to 33.33% in conventional group, and this was significant finding ($p<0.05$). These findings show that with C-arm, the functional outcomes were better in comparison to the method without C-arm evaluation.

There is a plethora of studies evaluating C-arm assisted locked compression plating outcomes in proximal tibia fractures cases, but comparative study with non-C-arm assisted cases are absent. In fact, on extensive literature search only one comparative study was found in tibia fracture setting conducted by Prasad et al. and published in 2021, but in this study only

duration of surgery was compared. The authors did not compare the functional outcomes of C-arm and non-C-arm group. Hence, our present study holds lots of novelty factor.

The non-comparative studies which have evaluated C-arm assisted locked compression plating outcomes in proximal tibia fractures cases showed excellent outcomes. A study by Aseri et al.45 showed excellent reduction, restoration of articular congruity and provides early motion to attain optimum knee function along with reduction post-traumatic osteoarthritis. The study by Vadadoriya et al. [44] which evaluated functional outcome of tibial plateau fractures managed with C-arm assisted locked compression plate noted early mobilization, good functional and radiological outcomes of tibial plateau fractures. The study by Reddy et al. concluded that surgical management of proximal tibial fractures with locked compression plates will give outstanding anatomical reduction as well as rigid fixation to reinstate articular congruity, help to facilitate early mobilization and reducing post-traumatic osteoarthritis and hence to achieve optimal knee function.

In the field of orthopaedics, fluoroscopy utilisation has greatly grown. By reducing the surgical field and shortening the procedure, image intensifiers have helped orthopaedic surgeons improve their technical proficiency and reduce patient morbidity.[50] The usage and misuse of fluoroscopy have occurred. Others underuse it because of irrational anxieties, while some overdo it while ignoring the fundamentals of radiation safety. In general, orthopaedic surgeons are callous with regard to shielding and are unaware of the exposure to radiation they are receiving and its impact on health.[51] Due to their proximity to the exposure area, operators and surgeons are the OT staff members that are most at danger. However, caution is advised owing to the long-term consequences of even low dosage radiation, according to certain studies, which found that the total body dose received was well within permissible ranges.[52]According to a 2015 study by Mahajan et al.,53 orthopaedic surgeons in Indiawere exposed to a certain level of radiation while practising their profession. The study also aimed to raise knowledge regarding the usage of image intensifier safety in daily practise. Four senior consultants, five junior consultants, and three trainees were among the twelve right-handed male orthopaedic surgeons who participated in a three-month prospective trial for radiation exposure assessment with suitable protective measures in all surgeries requiring C Arm fluoroscopy. Five Thermo Luminescent Dosimeter (TLD) badges, which were tagged at the level of the neck, chest, gonads, and both wrists, were given to each surgeon. Each procedure's operational time and time of exposure were noted. At the conclusion of the trial, the exposure dosage for each badge was measured, and the findings were analysed. The investigation discovered that the average radiation exposure to each component was substantially below the allowable limits. The exposure time and exposure dose for the left wrist were substantially correlated. Overall, the dominant hand had the most exposure. The researchers concluded that orthopaedic surgeons do not fall under the category of radiation workers and that the mean exposure levels to every portion of the body were substantially below the allowable limits. It is essential to adopt radiation safety precautions and to frequently check exposures using at least one dosimeter to measure the dosage received by the entire body. With the findings of present study and other similar studies, it can be noted that C-arm guided proximal tibia fracture management helps in better outcomes in patients.

The study had a few limitations. The sample size was limited, and the study was conducted at only one centre. Additionally, long-term outcomes were not possible to evaluate because of limited study duration. Future studies with larger sample size, multicentre study design and longer follow-up can help in validating our study findings.

Summary

The main objective of the study was to compare the functional and radiological outcome of intra-articular proximal tibial fracture managed by conventional method and C-arm image based surgical path planning method.

The study was initiated after getting permission from the institutional ethics committee. The study was conducted on 60 cases with closed proximal tibial fracture (Schatzker's type I, II and III). All the patients were given preliminary management by temporary above knee POP slab and required medical management. The patients were taken for definitive fixation after a variable period depending upon swelling and skin condition. Definitive fixation was done in the form of lateral column fixation by raft plate and screws.

Patients enrolled in the study were hen be divided into the 2 study groups using simple randomization method. To summarize the distribution of 60 patients (30 patients in each group):

Group 1 – Patient with tibial plateau fractures (Schatzker type I, II and III) and using intraoperative c-arm image based surgical path planning

Group 2 – Patient with tibial plateau fractures (Schatzker type I, II and III) with routine method

The mean age was statistically comparable between study groups ($p>0.05$). The commonest age group in both the study groups was 41-50 years' age group, followed by 18-30 years. Majority of cases in both study groups were males (C- arm group: 70%, Conventional group: 73.33%).

In C-arm group, there was equal distribution of right side and left side tibia fracture. In the Conventional group, 16 of the 30 patients were left sided fractures. Majority of fractures in both the study groups were a result of RTA (90% in C-arm group and 86.67% in the conventional group). Fall was the other mode of injury.

Based on Schatzker classification, Type 1 fracture was noted in 43.33% cases in C-arm group and 40% cases in conventional

group. Type 2 fracture was noted in 40% cases in C-arm group and 43.33% cases in conventional group. Type 3 fracture was noted in 16.67% cases in both study groups.

The mean operative time was found to be significantly higher in the C-arm group versus the conventional group (115.67 + 6.26 mins vs 102.50 + 3.66 mins, $p<0.05$).

The Oxford knee score and the range of motion were noted to be significantly higher in the C-arm group versus the conventional group ($p<0.05$) at both, 1-month and 3-months' follow-up.

Based on Oxford Knee score, at 1-month follow-up, in C-arm group, 96.67% cases showed excellent functional outcome, compared to 66.67% in conventional group, and this was significant finding ($p<0.05$). At 3-month follow-up, in C-arm group, all cases showed excellent functional outcome, compared to 86.67% in conventional group, and this finding was statistically not significant ($p>0.05$).

Conclusion

- C-arm image based management for proximal tibial fracture surgically led to better functional outcomes on follow-up versus conventional method, as indicated by superior Oxford knee score and range of motion.
- C-arm image-based planning led to no complications and was as safe as the conventional method for managing proximal tibia fractures.
- Future studies from Indian centres can help in validating our study findings.

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