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Computed Tomographic (CT) Assessment Of Distal Tibia Intra-Articular Fractures Managed By Locking Plate - A Prospective Study

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Abstract

Background - Distal tibia fractures accounts for 7 to 10 % of all tibia fractures. The intra articular part of this fracture is named as plafond/pilon fracture. CT scan also plays an important role in accurately assessing the intraarticular steps and their reduction in post-surgery, determining the direction of the fracture line, the size and the displacement of articular fragments, and the extent of articular comminution and impaction. the present study was planned to evaluate computed tomographic mediated assessment of distal tibia intra-articular fractures managed by locking plate.

Material and Methods -This was a prospective study of 30 patients of distal tibia intraarticular fracture managed by locking plate, analysed by CT scan preoperatively and postoperatively during the period of January 2018 To December 2019 in a tertiary care hospital. Fractures were classified according to AO classification and functional outcome assessed by using AOFAS scoring system.

Results- Most patients had reduced post-operative articular congruity. No significant difference was seen in the post-operative articular congruity in medial, anterolateral, and posterolateral fragments. The average range of dorsiflexion and plantar flexion was 16.16 ± 4.29 and 33.33 ± 7.58 degrees respectively. The AOFAS score was 88 ± 3.44. The average time of clinical union and radiological union was 13.4 ± 2.88 and 14.86 ± 3.42 weeks respectively. No significant difference was seen in the clinical and radiological union.

Conclusion- Preoperative 2D CT and 3D CT play an important role in the analysis of fracture anatomy, geometry and hence give a proper plan for approach, reduction and fixation thereby reduces intraoperative time. A post-operative CT Scan is the better tool to assess the articular reduction which in turn helps in initiating early mobilisation. Anatomical restoration of joint congruence both on post-op X-ray and CT are important predictors of better functional outcome, followed by near anatomical reduction.

Keywords: Distal tibia intraarticular fracture, locking plate, CT scan assessment, functional outcome

Introduction

Distal tibia fractures accounts for 7 to 10 % of all tibia fractures. The intra articular part of this fracture is named as plafond/pilon fracture. Most of these fractures are high-energy injuries caused by road traffic accidents, seen in young individuals of age between 30 to 40 years. Low energy injuries like falls from standing height are seen in elderly patients with osteoporosis. distal tibia fractures are rare in children [1], most of these fractures are associated with a fibula fracture in about 85% of the patients [2]. The distal tibia, due to its subcutaneous location and poor blood supply poses a challenge to treating surgeons in terms of choosing an appropriate implant to achieve adequate union and to achieve a good functional outcome. Radiology X-ray of the Ankle along with

distal tibia has been commonly used for diagnosis and post-operative monitoring of distal tibia fracture management. The X-rays can better appreciate rotation, angulation, and extraarticular comminution. However intraarticular anatomy of treated distal tibial is very difficult to appreciate due to the limitation of x-ray radiology. The advent of computed tomography (CT) with three-dimensional reconstruction improves the identification and visualisation of fracture patterns which helps in decision making and identifying the location of fracture fragments intraoperatively which helps in the reduction of operative time and blood loss. CT scan also plays an important role in accurately assessing the intraarticular steps and their reduction in post-surgery, determining the direction of the fracture line, the size and the displacement of articular fragments, and the extent of articular comminution and impaction. It can also guide one to choose fragments for fixation which cannot be guided by x-rays. Intraarticular restoration can be better planned with Computed Tomography involving 2 D slices and 3 D reconstruction images.

Fixation of distal tibia intraarticular fracture by locking plate, The goal of this technique is to provide stable fracture fixation while maintaining the fracture biology and minimizing the soft tissue problem [3,4]. Recently there has been an increasing trend towards the use of a locking plate for the treatment of complex fracture of the distal part of the tibia. Compared with conventional plates, locking plates impart a higher degree of stability and provides better protection against primary and secondary losses of reduction and minimisation of bone contact [5,6]. Locking plates have the biochemical properties of internal and external fixator, with superior holding capacity because of fixed angular stability through the head of the locking screw, and independent of friction fit [7]. Assessment of articular comminution, injury pattern, availability of implants, internal fixation after reduced swelling, and early postoperative mobilisation all improve functional outcome of distal tibia fracture managed by locking plate [7]. Therefore, the present study was planned to evaluate computed tomographic mediated assessment of distal tibia intra-articular fractures managed by locking plate.

Material and Methods

This observational prospective study of 30 patients was conducted at Tertiary care hospital from January 2018 to December 2019, over a period of 2 years. Fractures were classified according to AO classification and functional outcome assessed by using AOFAS scoring system. The collected data was entered in MS excel and then was analysed and statistically evaluated in the statistical package for the social science-17 chi-square/Fischer test for qualitative and student test was performed for quantitative data.

Inclusion Criteria

All patients age group of 20 to 60 years both male and female and closed distal tibia intra-articular fracture are included.

Exclusion Criteria

Patients <20 and >60 years of age, Patients with comorbidity, extra-articular, pathological fracture, peri-prosthetic fracture, patients with vascular injury, and with open wound fracture are excluded.

Protocol

On admission of the patient with a distal tibial intra-articular fracture, a careful history was elicited from the patient and/or attenders to reveal the mechanism of injury and the severity of the trauma. Antero-posterior and lateral radiographs of the ankle and the tibia were taken, and the fracture was classified based on the AO/OTA classification. The limb was then immobilised in an ABOVE KNEE SLAB and limb elevation was given over BB splint. Patients were analysed for fracture morphology, comminution, primary fracture fragments using CT scan /3D CT. Axial 2 D cuts were evaluated thoroughly for better planning by AO principles for the surgical approach, lag compression of far fragments tangentially across fracture line, choosing fragment for better purchase, and achieving primary stable fixation for early mobilisation and till union.

Surgical procedure - Patient was placed in the supine position with the application of the tourniquet in the upper thigh with placing of sandbag under ipsilateral buttock to correct external rotation of the limb in the minimally invasive anterior approach. Approaches used were Anteromedial for medial fragment, anterolateral for chaput and Volkmann's fragment and posterolateral for posterior fragment. Temporary

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fixation of the articular fragments done by using k wire and pointed tip instruments like towel clip.

The final fixation done with a lag screw using 3.5 cortical screws and the fracture was fixed with medial or anterolateral plate depending on the fracture morphology.

Associated fibula fractures managed with fibula plating and RUSH nail.

Associated calcaneum fracture managed conservatively.

Post-operative management

Limb elevation to reduce swelling and active toe movement were started immediately after surgery. Intravenous antibiotics were continued for 3 to 5 days, postoperative physiotherapy started depending upon the stability of fracture fixation. Suture removal is done on day 10 -14 days.

Follow-Up

The patient was discharged after the suture removal, partial toe-touch weight-bearing was started after pain relief. Post operatively patients were evaluated by computed tomography. CT analysis was done to assess restoration of joint congruency and intraarticular step or intraarticular osseocartilaginous loose fragment within the joint and reduction in fracture fragments. The initiation of ankle range of motion was initially started after CT scan evaluation. The first follow-up was at 3 weeks and subsequent follow-ups were at 8 weeks, 3months, 6 months, and 9 months. In every visit of the patient, the AOFAS score was used to evaluate the functional outcome at follow-up.

Results

In this study, 30 adult patients with distal tibia intraarticular fracture were enrolled and were evaluated. In our study male preponderance was seen, male to female ratio was 6:1. The average age of patients in our study was 45.23 ± 11.40 years (range 21-59) (table 1). Most of the patients were in the age group of 51-60 years (36.66%) followed by those in 41 to 50 years. 26 patients in our study had a right-side fracture, Bilateral fracture was seen in 1 patient. A road traffic accident was the major cause (63.33%) of fracture in our study the other causes fell from a height and direct trauma. Fracture to fibula was the most common associate fracture in our study followed by that calcaneum. 6 patients had no associated fracture. The average duration of trauma and operation was 9.06 ±1.57 days to reduce the swelling. Anteromedial type of plate (22 patients) was most used in our study. Anterolateral was used in 8 patients. The average blood loss among our study population was 170 ± 46.60 ml. Most patients had 150 ml blood loss. Most patients had no complications during surgery. Among those in complication was seen, difficulty in reduction while operative procedure was the common complication followed by unstable fixation. Most patients had no early complications after surgery, among those who reported complications, wound infection (3 patients) was the common complication followed by skin necrosis (2 patients). Most patients had no late complications following surgery, among those who reported complication, implant prominence, and screw back-out were the common complication followed by malunion and stiffness. Implant removal of one patient has been done after the plate is exposed. Majority of patients had fracture which belonged to C1 type of AO/OTA classification C3 and C2 was seen in 8 and 5 patients respectively. Most patients had reduced post-operative articular congruity (table 2 and 3). No significant difference was seen in the post-operative articular congruity in medial, anterolateral, and posterolateral fragments. The average range of dorsiflexion was 16.16 ± 4.29 degrees. The average range of plantar flexion was 33.33 ± 7.58 degrees. The AOFAS score was 51.06 ± 5.59 in the first follow-up visit and 88 ± 3.44 last follow-up visit.

The average follow up was 25.2 weeks. The AOFAS score was significantly better in every follow-up visit as compared to the previous visit (table 4). The average time of clinical union was 13.4 ± 2.88 weeks. The average time of radiological union was 14.86 ± 3.42 weeks. No significant difference was seen in the clinical and radiological union.

Discussion

Fractures of the tibia are among the most difficult fractures to treat effectively. The status of the soft tissues, the degree of comminution and articular damage sustained at the time of injury affect the long-term clinical results. Most of the distal tibia fracture in our study were due to road traffic accident (RTA) (63.33%) and fall from height (33.33%). The

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direct injury was very less (3.33 %) in our study. RTA and fall from height are considered high-energy impact injuries. Cory Collinge et al [8] in 2010 observed 100% high energy fractures in their study. Shrestha D et al [9] reported that half of the patients (50%) in their study were injured due to RTA, and 40% were due to fall. A study on similar fractures conducted by Ch. Banikanta Sharma et al [10] reported 81% of injuries were due to RTA. Reddy M [11] reported 80.8% of patients had high energy trauma. Majority of patients had C1 type of AO/OTA classification. This can be comparable to a study conducted by Reddy M [11] where the majority were found to be of AO type 43A-1 (62%), 11% of patients had AO type 43 A-2 and 27% had AO type 43 A-3. This was almost like the study conducted by Someshwar [12] where the majority were found to be of AO type 43A-1 (75%), 20% of patients had AO type 43 A-2 and 5% had AO type 43 A-3. Most patients had reduced post-operative articular congruity with no significant difference seen in the post-operative articular congruity in medial, anterolateral, and poster lateral fragment.

The distal tibia articular surface is divided into fragments like medial, anterolateral, and posterolateral, and its reduction was seen over post-operative 3D and 2D CT scans, similar study by Dhar A [13] reported anatomic reduction achieved in 20% cases, good reduction in 60%of cases, fair in 20% cases. Fracture of fibula was the most common (73.33%) associate fracture in our study followed by calcaneum (6.66%). 6 patients (20%) had no associated fracture. Mallikarjuna Reddy [11] in his study reported 44 (84.6%) among 52 patients with ipsilateral concurrent fibula fracture at different levels, of which 36 (81.8%) fractured at the level of tibial fracture. Fibula fracture associated with distal tibia fractures aid in the reduction of tibia fracture, especially when the fracture is at the same level as the tibia [14]. Some authors recommend fixing the fibula before tibia fixation to achieve better tibial alignment and to prevent valgus malalignment but the clear consensus for fibula fixation is still lacking and remained controversial. Effects of an intact fibula associated with a tibial fracture were studied by Teitz et al [15], They found that distal tibial fractures in patients aged 20 years or older with an intact fibula are associated with complications at the rate of 61%, which includes, 4% non-union, 22% delayed union, and 26% varus malunion. The average duration from trauma and operation was 9.06 ±1.57 days, with most of the case operated 6-10 days after obtaining fitness, treating the primary morbid condition and reduce swelling. This was high in comparison to a study conducted by Shrestha D et al [9]. reported average injury-surgery interval was 4.45 days. This was like a study conducted by Reddy M [16] where the average duration of delay in surgery, after injury was 4.27 days. Choudhari P [17] in his study reported average delayed time was six days in the case of low energy trauma whereas in high energy trauma it was 8.43 days (range: 4-18 days). The average blood loss during surgery in our study was 170 ± 46.60 ml. This was relatively high as compared to a study conducted by Hong J [18] where the mean intraoperative blood loss volume was 86.4 ± 17.3 mL (range, 50-150 mL). one of the most effective strategies tried in past to decrease blood loss in major lower limb orthopaedic surgery is the use of Tranexamic acid [19]. Yashwant D et al [19] demonstrated that the administration of tranexamic acid given preoperatively reduces the blood loss in the first 24 h by a highly significant degree as well it causes a significant reduction in postoperative anaemia and the need for transfusion among patients with major lower limb orthopaedic surgeries.

Intraoperative and postoperative complications were less in our study, while difficulty in fracture fragment reduction was the intraoperative complication followed by unstable fixation, wound infection, and skin necrosis were immediate post-operative complications. The common late postoperative complications were implant prominence and screw back out followed by malunion and stiffness. Shrestha D et al [20]. reported superficial infection in 4 (10%) cases, ankle stiffness in 2 cases (5%) among twenty patients in their study. Abdulla S et al [21]. reports 10 % of cases in their study developed ankle stiffness. Shikhar D Singh et al [22] reported rate of superficial wound infection was 10%. Reddy M [22] reported 4 (7.7%) cases of superficial infection in the immediate postoperative period and 4 patients (7.7%) with ankle stiffness in the follow-up period. A study by McFerren et al [24] showed the complication rate of 55% that comprises wound breakdown, deep soft tissue infection, osteomyelitis, and superficial wound infection. Vasantharaman R [25] reported 35 % complication 15% of patients with implant loosening.

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The average clinical and radiological union was seen in 13.4 ± 2.88 weeks and 13.4 ± 2.88 weeks respectively in our study. Reddy M [26] reported the average time for radiological union of dia-metaphyseal fractures of the distal tibia as 19.6 weeks. This can be compared to studies conducted by Lau TW et al. [27] who reported 18.7 weeks for the radiological union, Ronga M et al. [28] reported an average radiological union of 22.3 weeks, VK Kumar et al [29] in 2014 reported average radiological union time in their study on similar fractures was 16.1 weeks (range from 13-22 weeks). In the present study no difference between clinical and radiological union due to good joint reduction, early mobilisation, using locking plate, and good postoperative protocol.

AOFAS score was 51.06 ± 5.59 in the first follow-up visit and improved significantly in every follow-up visit with a score being 88 ± 3.44 in the last follow visit. Unlike other outcome measures which fall into a single category, AOFAS is a clinician reporting tool that requires both patient and provider participation to be fully complete and hence is a widely used tool for functional assessment of ankle or hindfoot injury. The average AOFAS score in our study was comparable to the study conducted by Collinge et al. [30] where the average AOFAS score was 85 at the end of the 24th week or last follow-up visit. Someshwar et.al.[31] reported an average AOFAS score of 88. Zhang J [32] reported an AOFAS score based on the AO/OTS fracture type, where he reported at the end of the last follow up, the mean AOFAS score was 96.11 ± 2.32, 92.67 ± 1.80, and 92.00 ± 2.06 ($p > 0.05$) in type A1, A2, and A3 fractures respectively.

Conclusion

Preoperative 2D CT and 3D CT play an important role in the analysis of fracture anatomy, geometry and hence give a proper plan for approach, reduction and fixation thereby reduces intraoperative time. A post-operative CT Scan is the better tool to assess the articular reduction which in turn helps in initiating early mobilisation, reduces time in plaster, and nearly eliminates the apprehension about rehabilitation protocol. Anatomical restoration of joint congruence both on post-op X-ray and CT are important predictors of better functional outcome, followed by near anatomical reduction. However lesser for non-anatomical ones.

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Tables

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Table 1: Age wise distribution of patients

Age (years)	No of patients	Percentage
20-30	**4**	**13.33**
31-40	**7**	**23.3**
41-50	**8**	**26.66**
51-60	**11**	**36.66**
Average age	**45.23 ± 11.40**	
Median age	**1. 21-59)**	

Table 2: Post-Operative Articular Congruity On 2D CT

Post-operative articular congruity	Medial	Anterolateral (Chaput Fragment)	Posterolateral (Volkmann Fragment)
Reduced	20	23	22
Not reduced	10	07	8
P value (Chi square)	0.91		

Table 3: Post-Operative Articular Congruity On 3D CT

Post-operative articular congruity	Medial fragment	Anterolateral (Chaput Fragment)	Posterolateral (Volkmann Fragment)
Reduced	21	22	22
Not reduced	9	8	8
P value (Chi square)	0.94		

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Table 4: AOFAS score

AOFAS score	Score	P value
1.5 month	51.06 ± 5.59	<0.0001 Friedman non parametric ANOVA
3 months	59.06 ± 5.10	
6 months	82.36 ± 4.67	
9 months	88 ± 3.44	

Figures

FIGURE 1: Post-Operative Articular Congruity On 3D CT

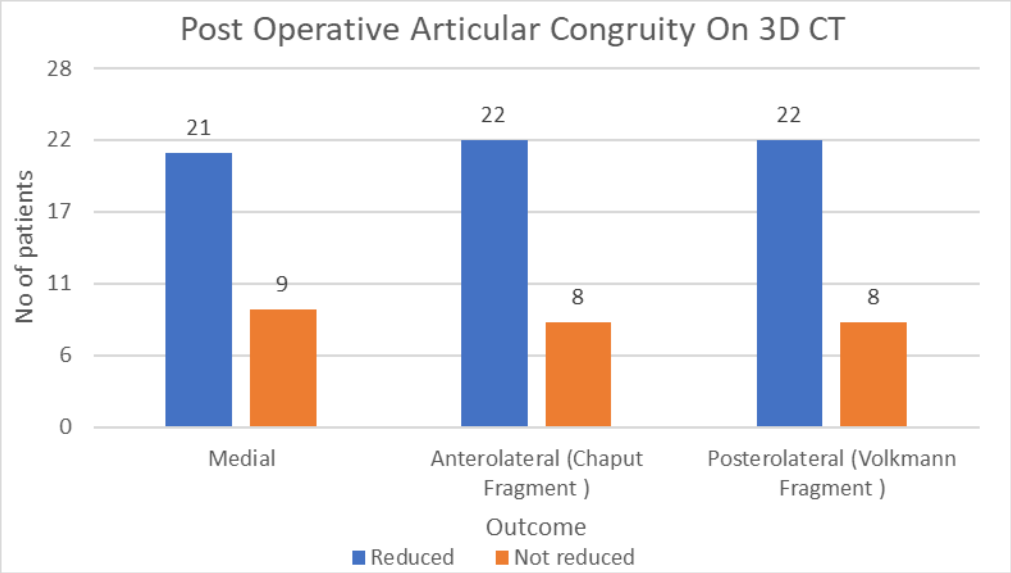

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Figure 2: Preoperative X-Rays Of Distal Tibia Fracture

Figure 3: Postoperative Xrays Of Distal Tibia Fracture

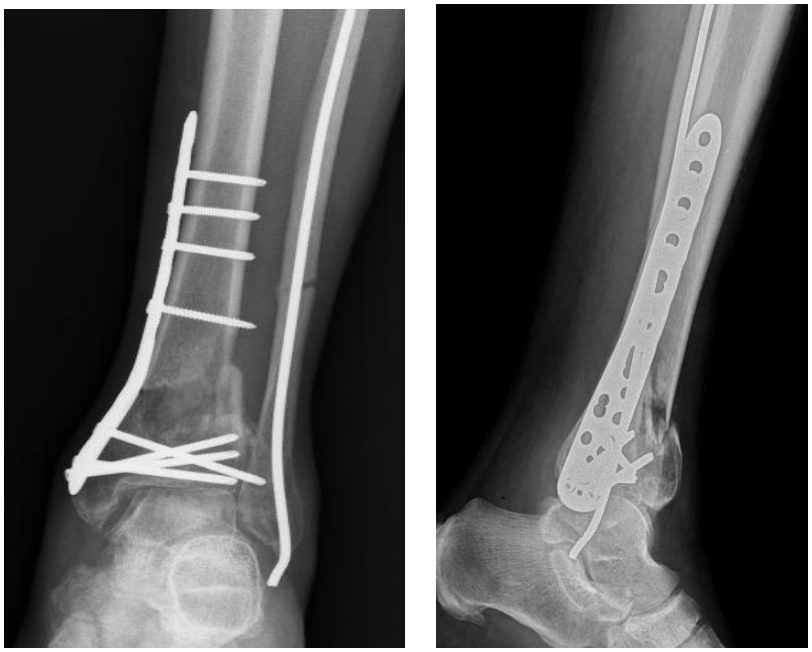

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Figure 4: Posterolateral Fragment Involvement

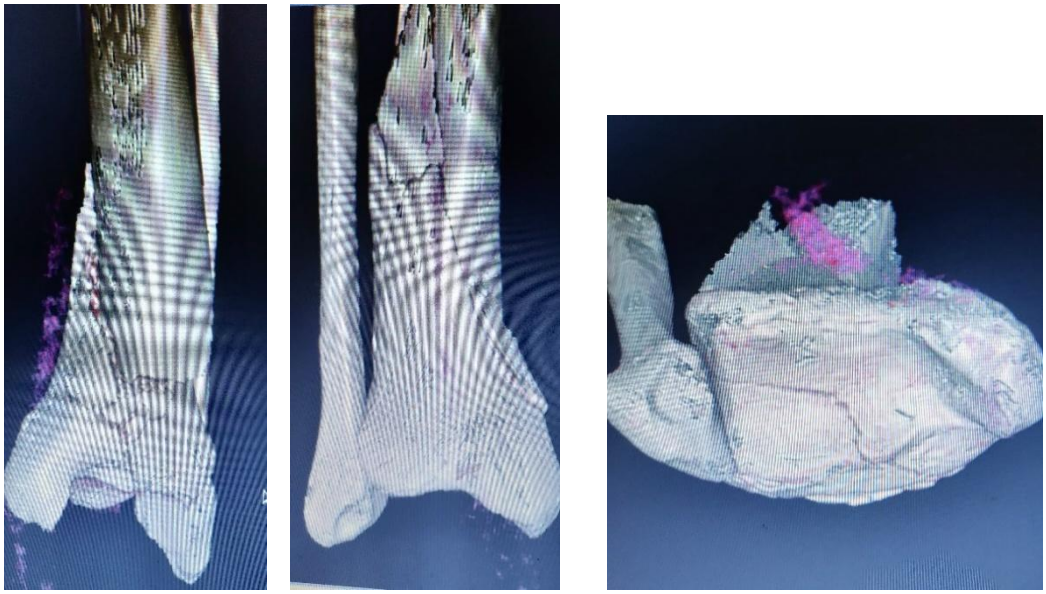

Figure 5: Posterolateral Fragment Reduced

Figure 6: Functional Outcome

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