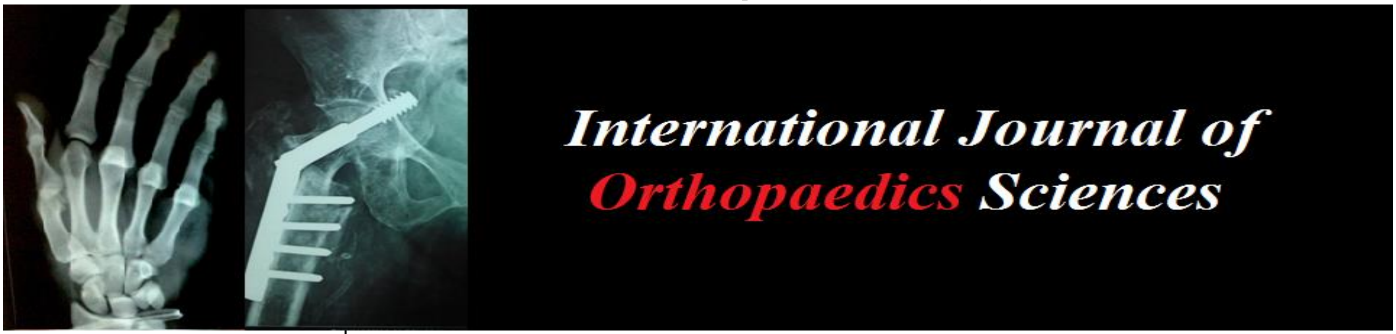

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Analysis of functional outcome of anterolateral plating in tibial pilon fractures

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Abstract
Introduction: Tibial pilon fractures account for 1% to 10% of all lower extremity injuries. The difficulty in managing these injuries is primarily due to the precarious vasculature around the ankle. Medial plating using LCP on the subcutaneous medial border of distal tibia resulted in a significant rate of wound dehiscence and deep infection. Plating on the lateral surface of tibial plafond is a new entity and the anterolateral approach is gaining popularity for the fixation of tibial pilon fractures.
Materials and methods: In our study 20 cases with a minimum follow up of 4 months and maximum of 12 months with an average of 9 months was carried out. Anterolateral approach to ankle was used and anterolateral locking compression plates are placed through the interval between the anterior and lateral compartments of leg. All cases were assessed postoperatively using the Kaikkonen clinical ankle score and Teeny wiss radiological score.
Results: 20 fractures united with a mean duration of 16.9 weeks. In our study we had excellent functional outcome in about 20% of cases, good functional outcome in 60% of cases fair and poor outcome 20% of cases each based on Kaikkonen Ankle Score. In our study the complication we met were 2 cases (10%) of wound dehiscence and superficial infection which healed by secondary intention. One patient had superficial peroneal nerve neurapraxia which improved gradually over time without any intervention. One patient had nonunion which required bone grafting later on for fracture healing. **Conclusion:** Anterolateral approach with anterolateral plating in the distal tibia fractures is safe easy and effective and has excellent to good functional outcome in most of the fracture types.

Keywords: Distal tibia, Pilon, Plafond fracture, anterolateral, plating, LCP

1. Introduction
Tibial pilon fracture was described by the Etienne Destot, a French radiologist in 1911 to describe fracture occurring in distal tibia within 5 cm from the ankle joint line [1, 2]. Tibial pilon fractures account for 1% to 10% of all lower extremity injuries [6]. These are intra-articular fractures involving the ankle joint. These fractures may occur due to high or low energy injuries [3, 4, 5]. The precarious vasculature around the ankle and the subcutaneous location of tibia make these fracture one of the serious injuries challenging orthopaedic surgeons [6].
In the older age group pilon fractures occur due to low energy injuries. Rotation is mainly attributed as the mechanism of the injury [8]. In younger age group whereas axial loading causes high energy pilon fractures. The talus acting as a hammer, impact and injure the distal tibia. The fracture pattern depends upon the foot position during impact. High energy injuries usually have severe soft tissue affections and blisters are commonly seen [8]. The fibula is fractured in 85% of the tibial pilon injuries. Fixation of fibula fracture is crucial to the reduction of pilon fracture [7]. Fibula fractures were fixed using semi tubular or reconstruction plates to achieve length and axial alignment.
Many treatment options emerged over time for treating these injuries. Early open reduction and internal fixation lost its popularity due to wound related complications and external fixation emerged as the definitive fixation which was replaced by hybrid fixators with the advantage of early mobilization of ankle and better stability [9]. Hourglass shape of medullary canal prevents the tight endosteal which compromises stability thus limiting the use of intramedullary nails [9].
AO medial plating although showed promising results has its own drawbacks like wound dehiscence and implant prominence over subcutaneous border of tibia. Also in medial

approach difficulty is encountered in visualization of the Chaput fragment [10, 11]. Plating on the lateral surface of tibial plafond is a new entity and the anterolateral approach is gaining popularity for the fixation of tibial pilon fractures with many studies showing better soft tissue coverage and less chance of wound dehiscence [10, 11]. Management of pilon fractures had shifted from acute to delayed fixation following the understanding that soft tissue healing is of paramount importance in treating these in injuries [12, 13]. In this study, we are evaluating the anterolateral plating through anterolateral approach for distal tibia fractures.

2. Materials & Methods

This Prospective study was conducted from June 2017 to May 2018 at Department of Orthopaedics, Silchar Medical college Hospital, Silchar, Assam. There were totally 20 patients of which 14 were males and 6 were females (range 22–70 years). All the patients were selected based on strict inclusion and exclusion criteria. The inclusion criteria include patients volunteering to participate in this study, skeletally mature patients, AO type 43 A, B and C fractures, Ruedi and Allgower type – I, II, III fractures, closed fractures, minimum follow up of 4 months. Patients having age below 18 years and above 80 years, compound fractures, associated calcaneum fractures and talus fractures, severely mangled extremity and associated spinal and abdominal injuries. minimum follow up of 4 months and maximum of 12 months with an average of 9 months. Plain radiographs of anterolateral, lateral views and mortise were done for assessment. A 3D CT scan may be required to asses any intra-articular fractures. Fractures were classified according to AO/OTA classification (FIG. 1)

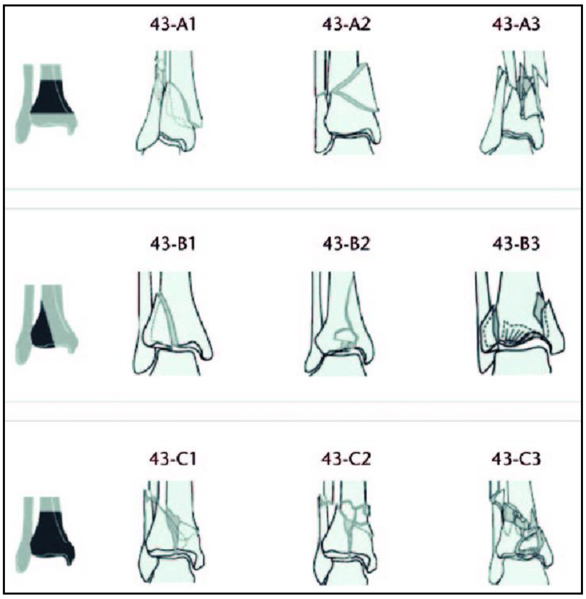

Fig 1: AO/OTA classification of distal tibial fractures. Type A is extra-articular, Type B is partial articular, Type C is complete articular fractures.

Patients were immobilized in a posterior splint and limb elevation and ice pack application were done to reduce the associated soft tissue swelling. Patients were taken up for surgery after the swelling and blisters had resolved and the appearance of 'wrinkle sign' with the average delay of 20.8 days from the date of injury.

2.1. Anterolateral LCP: The 3.5 mm anterolateral system consists of combi holes having dynamic mode and locking mode for screw application. This anatomically precontoured plate is 3.6mm is thick in shaft which tapers to 2.0mm distally, 60º twists in shaft is contoured for the distal tibial anatomy with tapered tip for sub muscular insertion. Distal locking screws provide support for the articular surface, targeted locking for Volkmann's triangle and Chaput fragment.

2.2. Surgical technique: Under regional anaesthesia, all patients were operated in supine position in a radiolucent table. Fibula was fixed in 65% of cases initially with recon plate/ one-third tubular plate to maintain limb length thus indirect reduction of tibia. Posterolateral approach was used and concomitant fibula. The standard anterolateral approach was used for tibia fixation. The skin incision, which is centered at the ankle joint, parallels the fourth metatarsal distally and runs between the tibia and fibula proximally. The skin bridge of 5 to 8 cm was maintained between fibular & tibial incisions. The superficial peroneal nerve is identified, mobilized and retracted. The anterior compartment tendons retracted medially after incising the fascia and extensor retinaculum longitudinally. Throughout the dissection full thickness flaps are maintained to avoid skin necrosis. Anterolateral LCPs are placed through the interval between the anterior and lateral compartments. The articular fragments are reduced in the following order posterolateral, posteromedial, central, anterior and then anterolateral and provisionally fixed with K-wires. Under fluoroscopic guidance, offset checked and anterolateral LCP was fixed by 3.5 mm locking screws. For AO type A fractures we used the technique of MIPPO in 3 cases successfully.

2.3. Post-operative protocol: Short leg plaster cast was applied in all cases immediately post-surgery. Drain removed after 48 hrs. Ankle and knee mobilization exercises were started after drain removal. Non-weight bearing walking with walker support initiated simultaneously. Plaster cast was changed to removable splint, to be worn by patient at bed time. Wound sutures removed on 12th post-operative day. Once signs of radiological union appear, partial weight bearing was allowed. Full weight bearing was allowed after fracture consolidation.

Quality of reduction was assessed using Teeny Wiss scoring and functional outcome was analyzed using Kaikkonen Ankle scores.

3. Results

In our study, maximum number of cases were in the age group of 36 to 50 years (11 cases, 55%) with an average age of 46.6 years. Male outnumbered female by a ratio of 2.33:1 (male – 14, female - 6). High energy mechanism (60%) being more common than low velocity trauma (40%). Fracture of right tibia was more common (70%) than left (30%). In our study AO Type A fractures were found to be more (60%) than Type C (30%) and Type B (10%) (TABLE. 1). There was associated fibula fracture in 80% of cases (16 cases) out of which 65% cases (13 cases) fibula was fixed. All cases were operated with a mean delay of 20.8 days for the soft tissues swelling to settle. The average duration of surgery was 94.75 minutes with shortest duration being 75 minutes and longest 120 minutes. Follow up was done for a minimum period of 4 months and maximum of 12 months. The average duration of radiological union was 16.9 weeks (range 12 to 24 weeks). Two cases went for nonunion. The mean TEENY WISS SCORE for assessing quality of reduction was 10.65.

Anatomic reduction achieved in 20% cases, good reduction in 60%of cases, fair in 20% cases. Functional outcome was assessed using Kaikkonen Ankle Scores with average score being 74.25 (Table. 2). Excellent outcome was found in 20% cases, good in 60% cases, fair results in 15% cases and poor outcome was in one patient (5%) (FIG. 2 & 3). There were 5 patients who had complications. Two patients (10%) had wound dehiscence and superficial infection which healed by secondary intention after debridement, regular dressing and antibiotics. One patient had superficial peroneal nerve neurapraxia which improved gradually over time without any intervention. One patient had nonunion which required bone grafting later on for fracture healing.

Table 1

Sex	M	14
	F	6
Side	R	14
	L	6
Mode of injury	RTA	8
	Fall from height	4
	Fall	8
Age distribution	21 – 35 years	2
	36- 50 years	11
	51- 65 years	5
	>65 years	2
Ao classification	Type A	12
	Type B	2
	Type C	6
Total no. Of patients	20	

Preop X-rays Immediate Postop rays 12 Weeks Follow Up22 Weeks Follow Up

Fig 2: X-rays showing the treatment of AO Type 43 A3 with anterolateral plating and its follow up.

Clinical Outcome at 22 Weeks

Range of Movements at 22 Weeks

Fig 3: showing clinical outcome of the same patient mentiond above at serial followup

Table 2: Showing functional and radiological outcome in our study

Kaikkonen ankle score (functional outcome)	outcome	No. of cases
>85	Excellent	4
70-80	Good	12
55-65	Fair	3
<55	Poor	1
Teeny Wiss radiological score	outcome	No. of cases
>9	Anatomic	4
10-12	Good	12
13-16	Fair	4
>16	Poor	0

4. Discussion

Distal tibia fractures are challenging for the modern orthopaedics due to the increasing incidence of fracture in young population and the associated soft tissue injury. It will affect the productivity of the community. Due to the increased use of high velocity motor vehicles, the number of fractures may increase in future. Distal tibia fractures result from low energy torsional or high energy axial loading mechanisms. High energy fractures are commonly associated with severe soft tissue injury, comminution of metaphyseal and articular fracture fragments of tibial plafond and comminuted distal fibula fractures. Plain radiographs are the primary modality of investigation for diagnosing these fractures. [14] But they are not always enough for the idea about fracture pattern and computed tomography (CT) scan may be needed accurate assessment [14].

The main factor in treating these injuries is to estimate the degree of associated soft tissue injury. Since only closed fractures were included in our study, we used Tscherne soft tissue injury classification to assess and grade the severity of soft tissue injury. Definitive fixation is advisable and proceeded only when the soft tissue injury heals. This is indicated by the skin ‘wrinkle sign’, once limb edema subsides [13]. In our study, internal fixation was carried out at an average of 3 to 4 weeks delay once wrinkle sign developed. Minimally invasive percutaneous plating techniques (MIPPO) preserve the osteogenic fracture hematoma reduce the iatrogenic soft tissue injury and damage to vascularity of bone. But even MIPO techniques should be performed after soft tissues heal. And with a delay of three weeks, MIPPO is not possible in some cases. This is why in our study too, MIPPO could not be carried out even in some AO type A fractures.

The key principles in the management of these fractures are –

1. Restoration of the length and limb axis by open reduction and internal fixation of fibula fracture;
2. The anatomical reconstruction of the articular surface of tibial plafond;
3. The filling of the defect resulting from impaction and the support of the lateral side of tibia, by lateral plating to prevent the valgus deformity [12].

Fibular incision should be more posterolateral to maintain adequate skin bridge between two incisions. The soft tissue must be carefully protected to prevent the breakdown of fibular wound. It is better to place the fibular incision more posterolaterally to maintain adequate skin bridge rather than to place anterolateral incision more anteriorly [15].

In our study we used a single-stage direct internal fixation technique of all distal tibia fractures. Average delay to fixation was 21 days. We used 3.5mm anterolateral distal tibia locking compression plate for all cases. This plate is a low profile plate of 3.5 mm system. The 3.5mm anterolateral distal tibia LCP is a pre-contoured plate to suit the lateral surface of tibial shaft and anterior surface of the tibial plafond abutting the subchondral bone. This design allows placement of the plate without disruption of fractures fragments. The thread holes in the plate locks to that of the screw head and minimize plate-bone interface and maintain the vascularity at the fracture site.

Duckworth has demonstrated that if open reduction and internal fixation done in appropriate patients satisfactory outcome can be achieved despite the severity of injury [16]. Distal tibia can be approached through anterolateral, anteromedial, and posteromedial approaches. Anterolateral approach if used when soft tissue heals gives excellent exposure to fracture anatomy and good fracture reduction can be obtained [17]. The medial plate had variable fixation in anterolateral and posterolateral areas. The anteromedial plates cannot provide buttressing in the anterolateral zone of comminution. Anterolateral plates are efficient in buttressing the area of comminution, however, cannot fix the medial most fragment seen in Type C injuries but were superior in addressing the coronal primary fracture lines across the apex of plafond fracture [18].

Borelli *et al* [19] conducted a cadaveric study over tibial extraosseous blood supply and then various plating techniques and their efficacy. They found an anastomosis network between anterior and posterior tibial arteries which is an extraosseous source for the distal medial aspect of tibia. Open plating over this area tend to disrupt these network thus making fractures in this zone vulnerable for nonunion.

Lau *et al* [20] in their study of percutaneous plating of distal tibia fractures through medial approach reported 15% of late infection and implant removal was done in 25 among 48 patients (52%), most common reason for implant removal was skin impingement.

Yenna *et al* [21] in their study they found that Distal tibia extra-articular fractures stabilized with anterolateral or medial locking plate constructs demonstrated no statistically significant difference in biomechanical stiffness in compression and torsion testing. Therefore, anterolateral plating may be suitable for a broad category of injuries, providing a leading edge for anterolateral approach to lessen the risk of soft tissue complications.

The specific problems of medial plating like implant prominence and wound dehiscence can be avoided in anterolateral plating as there is adequate soft tissue coverage. In our study we were able to achieve excellent and good functional outcomes in about 80% of our patients. Our study shows that anterolateral plating can be a safe and effective modality of treatment for distal tibial fractures with lesser incidence of complications.

Table 3: Comparison of duration of union in various studies

Study	Year of study	Mean # union duration
Devendra Lakhotia *et al* [23]	2016	18 Weeks
Rohit varma *et al*[24]	2017	18 weeks
Padmanaban kosalaraman *et al* [23]	2017	21.4 weeks
Daniel *et al* [25]	2016	15 weeks
Present study	2017-18	16.9 weeks

Table 4: Comparison of complications in various studies

Complications	Padmanaban kosalaraman *et al* [22]	Devendra Lakhotia *et al* [23]	Present study
Wound dehiscence/Superficial infection	16%	12%	2 (10%)
Non-union	8%	0	2 (10%)
Superficial peroneal nerve neurapraxia	0	1(2%)	1 (5%)
Deep infection	0	0	0
Implant failure	4%	0	0

5. Conclusion

Distal tibia fractures with high grade of soft tissue injury are to be internally fixed after a delay for the edema to settle down and the wrinkle sign appears. Respect the soft tissues: do not operate too early or through compromised skin, instead wait till the soft tissues is amenable for surgery. On the other hand, low energy fractures with insignificant soft tissue injury can be addressed by early definitive internal fixation. Restoration of the articular surface and reestablishing its relationship to the tibial shaft is the primary goal of treatment. From our study, 3.5mm Anterolateral Distal tibia Locking Compression Plating for tibial pilon fractures were found to be safe and effective. The skin bridge between incisions of the tibial and fibula exposure must be at least 7 cm. With more number of cases in this study the results and observations would have been more accurate and statistically significant. Long term follow up is also required to see the full functional outcome and long term complications like osteoarthritis. This was not possible in our study as the duration was only for twelve months.

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