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Original article

Minimally invasive osteosynthesis of distal tibial fractures using anterolateral locking plate: Evaluation of results and complications

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ABSTRACT

Purpose: Soft tissue healing is of paramount importance in distal tibial fractures for a successful outcome. There is an increasing trend of using anterolateral plate due to an adequate soft tissue cover on anterolateral distal tibia. The aim of this study was to evaluate the results and complications of minimally invasive anterolateral locking plate in distal tibial fractures.

Methods: This is a retrospective study of 42 patients with distal tibial fractures treated with minimally invasive anterolateral tibial plating. This study evaluates the bone and soft tissue healing along with emphasis on complications related to bone and soft tissue healing.

Results: Full weight bearing was allowed in mean time period of 4.95 months (3–12 months). A major local complication of a wound which required revision surgery was seen in one case. Minor complications were identified in 9 cases which comprised 4 cases of marginal necrosis of the surgical wound, 1 case of superficial infection, 1 case of sensory disturbance over the anterolateral foot, 1 case of muscle hernia and 2 cases of delayed union. Mean distance between the posterolateral and anterolateral incision was 5.7 cm (4.5–8 cm).

Conclusion: The minimally invasive distal tibial fixation with anterolateral plating is a safe method of stabilization. Distance between anterolateral and posterolateral incision can be placed less than 7 cm apart depending on fracture pattern with proper surgical timing and technique.

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Introduction

The treatment for distal tibial fractures ranges from conservative to surgical procedures using external fixators, intramedullary nailing and internal fixation.^{1–6} All methods of fixation have merits and demerits and hence there is no consensus for superiority of one method over the other for these types of fractures.⁴ Soft tissue healing is of paramount importance along with bone healing in distal tibial fractures for a successful outcome.^{7–11}

Minimally invasive plating techniques reduce surgical soft tissue injury and maintain a more biologically favorable environment for fracture healing.^{12,13} Most of the studies showed good results with open reduction and internal fixation.^{14–18} Few studies with this type of fixation have shown poor results.^{19–23} However the results

depend on severity of injury, soft tissue trauma, surgical timing, surgical technique and comorbidities of the patient.^{5,6,24} Further, literature support that a 7-cm skin bridge must be present between surgical incisions to minimize soft tissue complications.^{25–27}

We retrospectively reviewed patients with distal tibial fractures treated with anterolateral tibial plating with or without fibular fixation. We evaluated functional and radiological outcomes. In addition we analyzed the surgical incisions used for anterolateral distal tibial plating and fibular plating and their effects on wound healing and soft tissue complications.

Materials and methods

We retrospectively analyzed the patients operated on with anterolateral distal tibial plating from 2010 to 2013. During this time period a total of 42 patients were operated on (32 males, 10 females) with mean age of 42.8 years (range, 25–75 years). Fractures were classified according to AO classification. Open distal tibial fractures were excluded from the study. All the fractures were

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fixed in single stage after the swelling subsided and wrinkling of the skin occurred (Fig. 1a). Initial management for low energy distal tibial fractures with minimal soft tissue injury consisted of below knee splint with foot end elevation on pillow. For high energy fractures with moderate to severe soft tissue injury, we used calcaneal pin traction with foot end elevation on Bohler Braun splint.

Incisions for fibular fractures were given posterolaterally (Fig. 1b). After fibular fixation, reduction of distal tibial fracture was checked under C-arm (Fig. 1c). Anterolateral distal tibia plating (3.5 mm locking compression plate, synthes/periarticular lateral tibial plate) was done through minimally invasive technique using anterolateral incision (3–5 cm, Fig. 1d). For proximal locking mini open incision was given to protect the neurovascular bundle (Fig. 1e). The superficial peroneal nerve was protected (Fig. 1f) and superior extensor retinaculum was incised.

In cases of extrarticular fractures, indirect reduction was achieved through manual reduction and percutaneous pointed reduction clamp. If direct articular reduction was required in AO type C1, C2 and C3, transverse arthrotomy was done. For complex articular fractures, the anterolateral fragment was externally rotated followed by reduction of centrally impacted fragment to the posterolateral fragment. The K-wires were inserted in posterolateral fragment to act as a joystick for reduction. The K-wires were inserted from anterior tibia to the posterolateral fragment. The medial fragment was reduced to the posterolateral fragment using reduction clamp followed by percutaneous K-wire fixation. At last anterolateral fragment was reduced in position and stabilized with K-wires. In cases of intraarticular fractures, small lag screws were placed between the major articular fragments before plate fixation depending on the fracture configuration.

Sutures were removed at the 14th day. Further follow-ups took place at 3, 6 weeks and then at 3, 4, 5, 6, 9 and 12 months with a clinical and radiological examination (lateral and anterior-posterior views). Patients were mobilized with full weight bearing when fracture healed as evidenced by bridging callus in anterior-posterior and lateral radiographs (Fig. 2a–c). The fracture was considered healed when a visible callus bridging of one cortex was

present on both lateral and anterior-posterior X-rays and the patient was full weight bearing without pain.²⁷

Skin incisions, distance between the skin incisions, any complications related to soft tissue, wound breakdown and implant exposure were reviewed from the medical records until final follow-up (Fig. 3a, b). Complications were defined as minor or major depending on the severity of the complication and need for further operative intervention. Major complications were those which resulted in morbidities and required further operative intervention such as deep infections and failures of fixation.¹⁰ All other events that did not require further operative intervention such as superficial wounds were considered as minor complications.

Results

30 patients (71%) had high energy trauma among which 20 patients had road traffic accidents, 4 patients were pedestrians hit by vehicles and the other 6 patients with a history of fall from height. Other 12 patients (29%) had low energy trauma caused by mechanical fall. Fractures were classified according to AO classification. 14 patients had extrarticular fractures (4, 43-A1; 4, 43-A2; 6, 43-A3). 2 patients had partial articular fractures (2, 43-B3). 26 patients had complete articular fractures (14, 43-C1; 8, 43-C2; 4, 43-C3). Patients were operated on after trauma in mean time of 8.53 days (range, 3–17 days). All the patients were operated on in a single stage with initial fibular fixation followed by anterolateral plating. Direct reduction was done in 12 cases; out of them 4 were extrarticular, 1 partial articular and 7 had intraarticular fractures.

34 patients had associated fibular fractures. Among these, fibular fixation was done in 30 patients. 4 patients with minimally displaced and well aligned fibular fracture at higher level were not fixed. Mean distance between the posterolateral and anterolateral incision was 5.7 cm (range, 4.5–8 cm) (Fig. 3b). Distance between the two incisions was less than 7 cm in 24 patients (80%), whereas distance was more than 7 cm in 6 cases (20%).

Radiological and clinical healing of fracture occurred in 29 patients at 4 months, 9 patients at 6 months, 1 patient at 9 months,

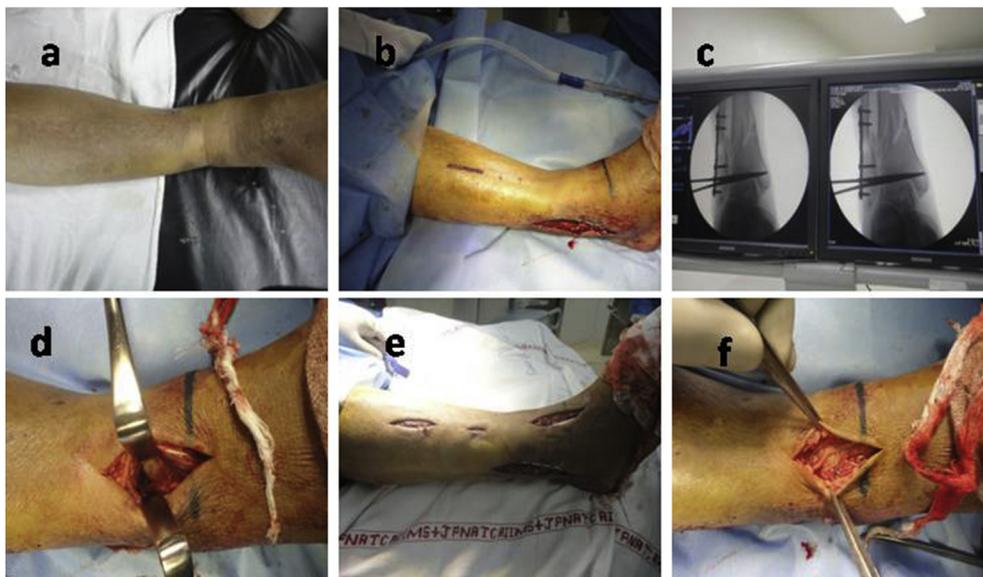


Fig. 1. Wrinkle sign of skin on the planned day of surgery (a). Fibular plating after open reduction through posterolateral incision (b). Reduction of distal tibial fracture after fibular fixation checked under C-arm (c). Anterolateral approach of distal tibia for minimal invasive technique (d). Proximal locking of anterolateral plate using stab and mini open incision (e). Superficial peroneal nerve just below anterolateral skin incision (f).

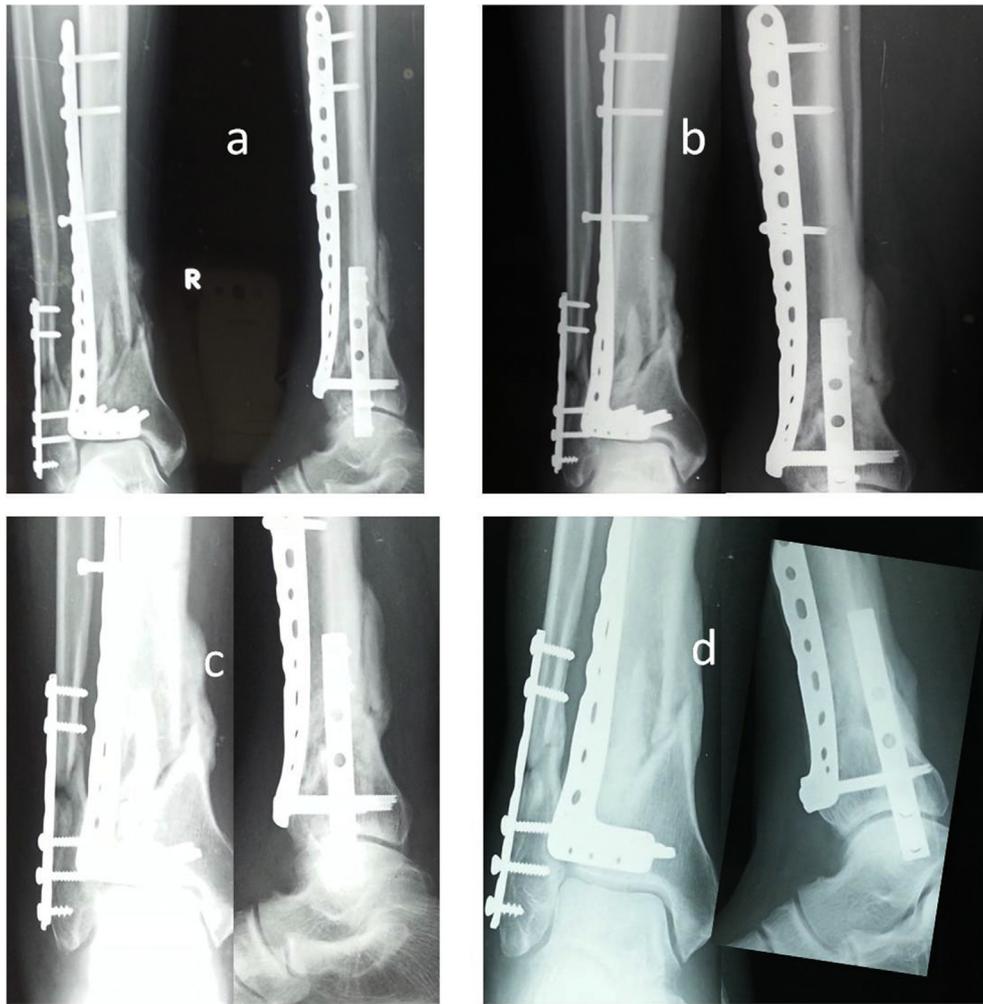


Fig. 2. Follow-up radiographs at 6 weeks when patient was allowed partial weight bearing (a). Fracture healing at 12 weeks when patient was allowed full weight bearing (b). Follow-up radiographs at 6 months (c). Follow-up radiographs at 1 year (d).

and 1 patient at 12 months. These patients were followed up for at least 12 months with mean period of 25 months (range, 12–48 months). Full weight bearing without any support were allowed in mean of 4.95 months (range, 3–12 months). Two patients, both

with simple fractures (AO 43A1), were lost to follow-up after discharge.

Mechanism of injury in 5 complete articular fractures (1, C1; 3, C2; 1, C3) was road traffic accidents with varus forces. All these

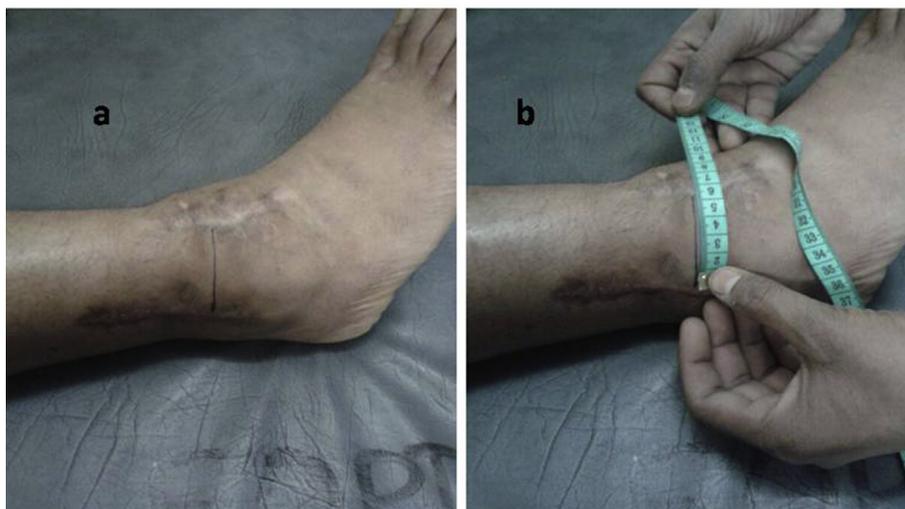


Fig. 3. Healed scar marks of anterolateral and posterolateral skin incision (a). Skin bridge measurement between two incisions (cm) (b).

patients were operated on with anterolateral tibial plating and fibular plating (Fig. 4a–d). Only one patient with varus collapse had marginal necrosis as minor complication which was healed without sequela. All these fractures united in mean time period of 4.2 months (range, 3–5 months).

According to the established criteria, one major local complication of wound was identified. However 5 minor local complications of wound were identified including 3 cases of marginal necrosis of anterolateral wound, 1 case of marginal necrosis of posterolateral fibular wound, 1 case of superficial infection. Three cases had marginal skin necrosis of anterolateral wound as minor complication in the early postoperative period (Fig. 5a). The wounds were healed by secondary intention in all these patients at 6 weeks by regular dressing. One case of skin necrosis occurred in the posterolateral skin incision, and healed at 4 weeks by regular dressings. In one patient superficial infection occurred, and was treated by intravenous antibiotics and regular dressing and healed at 6 weeks without any sequela. One patient with history of hypertension and diabetes required debridement and reclosure (major complication) and healed at 6 weeks.

Delayed union occurred in 2 cases. In the first case, fracture was healed at 9 months and in other at 12 months. Both these patients were chronic smokers. None of the cases required secondary bone grafting. One case of sensory disturbance on the dorsolateral arch of the foot was observed. Partial recovery was observed in this case at final follow-up. One patient presented with swelling at upper incision site used for proximal locking (Fig. 5b). This was diagnosed

as muscle hernia of tibialis anterior by clinical examination and confirmed by ultrasound. As the patient was asymptomatic, reassurance was given only.

38 patients reached full range of motion at ankle by 6 months. The movements of the ankle ranged from 5° to 15° of dorsiflexion and from 5° to 35° of plantar flexion. Two patients with type C3 pilon fractures had ankle stiffness. Anatomical alignment was within the acceptable range without anteroposterior angulation (>10°) and mediolateral angulation (>5°) in all patients when compared to the normal lower limb. Limb shortening (>1.5 cm) was not present in any case. Eight patients had mild to moderate ankle pain. All these patients had articular depression <2 mm with no arthritic changes until final follow-up. None of the cases required implant removal during the time of the study.

Discussion

For quite some time, distal tibial fractures have been treated by open reduction and internal fixation with plates. The risk of disrupting blood supply is increased with the classic approach of open reduction and internal fixation in the metaphyseal region of the tibia.²⁸ Open reduction with plates leads to devastating complications of infection and wound breakdown with implant exposure.²⁹ Historically, an anteromedial approach has been used for the management of tibial pilon fractures. One of the major disadvantages of this approach is the risk of wound breakdown with implant exposure. In addition, this approach limits visualization of the

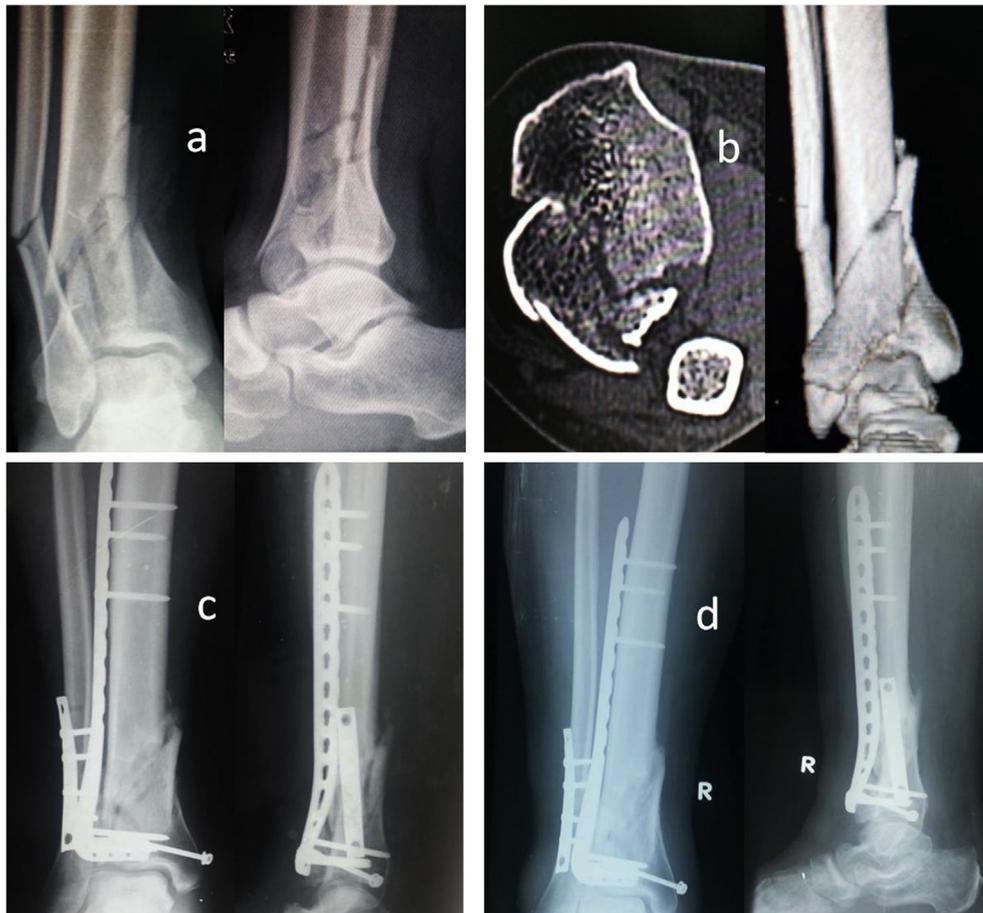


Fig. 4. Tibial pilon fracture with varus forces as mechanism of injury (a). CT scan with 3 D views to assess fracture pattern and comminution (b). Postoperative radiographs at 5 months, anterolateral plate for tibial pilon fracture with percutaneous anteromedial screw for anteromedial fragment (c). Follow-up radiographs at 10 months (d).



Fig. 5. Marginal necrosis of anterolateral skin incision in postoperative period (4 weeks) (a). Muscle herniation of tibialis anterior muscle (b).

lateral Chaput fragment. Implant prominence in anteromedial plating has required implant removal as revision surgery in most of the cases. Anterolateral area of distal tibia has better soft tissue coverage and offers direct exposure to the anterolateral fragment.

Fibular fixation through separate incision along with conventional distal tibial plating is complicated by wound healing problems. But with precontoured locking plate for distal tibial fixation, fracture can be managed through smaller incisions via minimally invasive approach. Locking plates cause less damage to the periosteal blood supply, which may decrease the incidence of delayed union or nonunion and secondary loss of fixation.³⁰ In our study, 38 out of 40 fractures healed within 6 months with a mean time period of 4.15 months (range, 3–6 months). Two patients with simple fractures (AO 43A1) were lost to follow-up after discharge. No case of loss of fixation or implant or screw breakage occurred in our study. Six patients (15%) had soft tissue complications (marginal skin necrosis and infection) in this study. Marginal skin necrosis was seen in five cases, out of which four had anterolateral skin incision and one had a posterolateral skin incision. Three cases with anterolateral skin margin necrosis healed without any operative intervention. In one case, anterolateral incision was placed 6 cm from posterolateral incision while in another the skin bridge between the two incisions was 8 cm. In the third case with distal tibial extraarticular fracture with no fibular involvement, only anterolateral tibial plating was done only. The fourth case with anterolateral skin marginal necrosis (major complication) required operative intervention in the form of re debridement and reclosure, and healed without any sequela. This patient was a chronic smoker with a long history of diabetes.

Many studies have reported high complication rates related to soft tissue with operative management of tibial fractures. McFerran and Smith evaluated complications encountered in the treatment of plafond fractures, and the local complication rate was 54% comprising wound breakdown, deep soft tissue infection/osteomyelitis and superficial wound infections.²⁰ Similarly, Ovardia and Beals reported that 16 patients out of 142 required soft tissue procedures for wound closure.¹⁶ To prevent soft tissue complications, a 2-stage protocol has been recommended which consists of an initial use of external fixation with or without fibular fixation until the soft tissue envelope recovers sufficiently to allow definitive fixation.^{28,30–33} We fixed all the fractures in a single stage with a mean time of 8.53 days (range, 3–17 days). The aim of surgery was stable fixation of fracture with less periosteal damage and minimization of the soft tissue compromise. We delayed the surgery until swelling subsided and wrinkles appeared over the distal tibia.

In the cases of low energy trauma the time delay was 6 days (range 3–9 days) and in high energy trauma it was 9.5 days (range 4–17 days). In addition soft tissue problems due to iatrogenic trauma were decreased using a minimally invasive approach with anterolateral locking plates for fracture fixation.

When performing the exposure of the fibula, we minimized the amount of dissection over the anterior surface of the fibula. This potentially helped to minimize trauma to the source vessels supplying the overlying skin bridge. 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.³⁴ It is better to place the fibular incision more posterolaterally to maintain adequate skin bridge rather than to place anterolateral incision more anteriorly. The anterolateral incision placed more anteriorly for fracture reduction and the proper placement of the plate on the anterolateral surface will cause more soft tissue retraction. Along with this more anterior incision will compromise anterolateral fragment reduction and fixation.

Traditionally tibial pilon fractures with varus injury pattern are advised for medial plating. This might be true with the use of the classical open approach and conventional plates. The lateral approach allows greater soft tissue coverage and decreases subsequent trauma to already tenuous soft tissue envelope compared to a medial approach and placement of a medial plate.¹¹ We operated on five of the tibial pilon fractures with varus injury by anterolateral plating with good functional and radiological outcomes. Full weight bearing without any support in these cases was allowed in mean of 4.2 months (range, 3–5 months). Zachary et al concluded that regardless of whether the fracture exhibits varus or valgus comminution patterns, an approach using anterolateral plating provides similar stiffness from a biomechanical perspective when compared to medial plating in a fracture model. Therefore, anterolateral plating may be suitable for a broad category of injuries, supporting the recent push in the literature toward an anterolateral approach to lessen the risk of soft tissue complications.³⁵

In conclusion, distal tibial fractures can be successfully treated by anterolateral plating in a single stage. Minimally invasive techniques along with the use of locking plates can minimize complications related to soft tissue and bone healing. Despite a measured skin bridge of less than 7 cm in 80% cases, the major soft tissue complication rate was low in our study. With careful attention to surgical timing, respect for soft tissue handling and using a minimally invasive technique, incisions may be placed less than 7 cm apart depending on the needs of the fracture pattern. Revision

surgery for implant removal due to implant prominence can be avoided with anterolateral plating. Furthermore, long-term studies are needed to compare the overall complication rates and to assess patient's functional outcomes of fixation of distal tibial anterolateral plating. Anterolateral fixation of tibial pilon fractures with varus forces needs comparative study with a higher number of cases and for a longer duration of follow-up.

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