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Management of comminuted distal metaphyseal tibial fractures with 3.5 mm anatomical anterolateral locking compression plate: A study of 34 cases

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Abstract
Introduction: Management of distal metaphyseal tibial fractures is a formidable challenge to the orthopaedic surgeon. Some of the confounding factors in management are delicate soft tissue in this area, presence of ankle joint in close proximity, small distal fragment size, ligament injuries, occasional fibular fractures and compaction of cancellous bone among others. The conventional implants are unsuitable for managing such fractures successfully.
Material and method: The 3.5mm anatomical anterolateral locking compression plates are precontoured plates that have been designed and developed especially for fixation of distal tibial metaphyseal fractures to overcome some of these problems. 34 patients underwent management using this implant. The study was done prospectively.
Aim: The aim of the study was to evaluate the management of such fractures with this implant and to assess the functional outcome of the same.
Results: 83% of patients in our study had excellent to good functional outcome.
Conclusions: We concluded that that the anatomical anterolateral plate is an excellent option for managing such fractures and gives consistent and reproducible clinical results.

Keywords: Metaphyses, locking plate, pilon, syndesmosis, ankle joint

1. Introduction

Distal metaphyseal fractures of the tibia are challenging injuries for the orthopaedic surgeon to manage successfully. Conservative treatment of these fractures quite often results in a number of complications including limb shortening, malunion, nonunion and ankle stiffness [1]. The most important variables that affected the final clinical outcome are the type of fracture, associated soft tissue injury, the method of treatment and the quality of the reduction [2]. Their proximity to the ankle makes the surgical treatment more complicated than the treatment of tibial midshaft fractures. The two traditionally accepted methods of fixation of distal tibial metaphyseal fractures have been intramedullary nails and plates. However, these fractures are generally not amenable to intramedullary nailing because the width of the distal tibial metaphyses relative to the nail diameter is large, this causes ‘toggling’ which results in varus collapse of such fractures leading to malunion and late onset arthrosis of the ankle joint [3]. The problem also lies with producing reproducible and consistent results with intramedullary nail fixation since this requires accurate nail placement in the centre of the metaphyses, which is not always achievable due to a number of reasons [4, 5]. Since the locking bolts are placed very close to the fracture site, this results in building up of extreme shear stress which may cause hardware failure. Also, getting enough purchase of distal locking bolts in the distal metaphyses is not always possible owing to the very short fracture fragment size as also the comminution that is often associated with these fractures. There are always some chances of nail penetrating the ankle joint.

Plating is also beset with its own set of problems, owing to the peculiar shape of the distal tibial metaphyses which requires plate contouring and also the problem of getting enough purchase in the subchondral bone of the distal fracture segment due to its small size. The periarticular nature of the fracture further complicates the issue since there are always some chances of screws penetrating the joint. Stress shielding is a problem with the regular dynamic compression plates (DCP). Open reduction and internal fixation with conventional plates (DCP) requires extensive dissection and may result in wound complications [3]. Implant prominence is also a major problem [4, 6-8]. Medial plating using minimally invasive techniques though promising has certain limitations like less accurate reduction, inability to fix posterior malleolus and implant prominence [7-11]. The optimal treatment of unstable comminuted distal metaphyseal tibial fractures hence remains controversial [12].

The 3.5mm anatomical anterolateral locking compression plates (LCP) are precontoured plates that have been designed and developed especially for fixation of distal tibial metaphyseal fractures. The aim of the present study was to evaluate the management and functional outcome of comminuted distal tibial metaphyseal fractures fixed with 3.5mm anatomical anterolateral locking compression plates.

2. Material and Method

34 patients with comminuted distal tibial metaphyseal fractures underwent fixation using the 3.5mm anatomical anterolateral locking compression plates. The study was conducted at a tertiary care centre between Dec. 2012 to Sep. 2016. The average follow up of patients was 16.3 months and patients with a follow up of less than 12 months were excluded from the study. The average age of our patients was 39.4 years and male to female ratio was roughly 3:1. The inclusion criteria of the study were: 1. Comminuted distal tibial metaphyseal fracture 2. Closed fractures and open injuries with Gustilo & Anderson grade I or II 3. Unilateral involvement. The exclusion criteria were 1. Old fractures (>4 weeks) 2. Complex pilon fractures (AO 43C3) 3. Pathological fractures 4. Bilateral involvement 5. Open injuries with Gustilo & Anderson grade more than II. 6. Pre-existing arthrosis of the ankle or previous old healed fractures. The average delay of five days between injury and surgical procedure (range: 3-8 days) was mainly due to the time taken to reduce the gross local swelling. 21 patients had sustained the fracture in road traffic accident and 13 patients had a twisting injury of the ankle resulting from slip and fall. Out of this 8 had sustained the injury during sporting activities especially while playing football.

The 3.5mm anatomical Anterolateral LCP distal tibial plate merges locking screw technology with conventional plating techniques [13]. The combi holes in the LCP shaft combine a dynamic compression unit hole with a locking screw hole. Combi holes provide flexibility of axial compression and locking capability throughout the length of the plate shaft. A 60^0 twist in shaft is contoured for distal tibial anatomy. The rectangular head has 4 holes angled at 7^0 to capture the posterior malleolus. The head accepts 3.5mm locking, 2.7mm and 3.5mm cortical and 4.0mm cancellous screws. The head provides a low profile construct. In addition there are 3 holes for accepting 2.0mm Kirschner wires. The locking screws provide a fixed angle construct while using conventional plating techniques for handling osteopenic bone and multifragmnetary comminuted fractures. These screws don’t rely on plate to bone compression to resist load but function similarly as multiple small angled blade plates.

Anteroposterior and lateral radiographs of the leg including the ankle joint were obtained to establish the fracture pattern, classification and pre-operative planning. The tibia is assigned the numeric code of 43. Injuries of the tibial plafond are then categorized as extra-articular (43 type A), partial articular (43 type B), or total articular (43 type C). Each type is then further divided into one of three groups depending on the amount of fracture comminution. 18 patients had type A2 or A3 fractures. 12 patients had Type B fracture and the remaining 4 had C1 or C2 type fractures, type C3 were excluded from the study. Fig.1 shows example of type 43 A3, fig.2 shows example of type 43 B2 and fig.3 shows example of type 43 C2 injury. 4 patients had a concomitant fibular fracture at or below the level of syndesmosis (Table 1). The patients were taken up for surgery only when the skin condition was absolutely satisfactory and local swelling has subsided. All the surgeries were performed under tourniquet control.

Fig 1: Radiograph showing example of Type 43A3 injury.

Fig 2: Radiograph showing example of Type 43B2 injury.

Fig 3: Radiograph showing example of Type 43C2 injury

Since a 3.5mm anatomical Anterolateral LCP distal tibial plate was used in all the cases, the standard anterolateral approach was used [14]. The anterolateral approach avoids dissection over the tenuous soft tissue envelope of the distal tibia. The anterolateral approach allows excellent access to the vast majority of the tibial plafond, particularly the lateral, posterior, and central aspects. The skin incision is oriented longitudinally and in line with the fourth ray and travels over the anterolateral aspect of the distal tibia. The entire contents of the anterior compartment are then retracted laterally to expose the underlying anterolateral aspect of the distal tibia and the capsule of the ankle joint. This best preserves the vascularity of distal tibia [15]. The fracture fragments were temporarily stabilised with Kirschner wires to attain a stable reduction, this was checked under image intensifier. The anatomical anterolateral plate is than placed over the distal tibia taking due care for implant placement relative to ankle joint line. Plate holding reduction clamps are used along with Kirschner wires through head of the plate to align the plate to the bone. Distal locking screws were passed first followed by more proximal screws. Lag screws were appropriately used either free hand (Fig.4) or through the plate (Fig.5). 4 cases had concomitant distal fibular fractures which were fixed with either a semitubular plate or a thick Kirschner wire (fig.6) depending on the skin condition. Primary bone grafting was performed in 3 cases to fill up the gap at the fracture site caused by compression of cancellous bone i.e. bone loss. Limb elevation, to achieve gravity-assisted venous drainage along with active toe and ankle movements were carried out for the initial two weeks. Sutures were removed at approximately two weeks in the majority of patients.

Fig 4: Radiograph showing management of case in Fig.1 with lag screw directly through bone.

Table 1

Percentages of Various Independent Variables
Male 66% Female 34%
Road Traffic Accidents 62% Twisting Injuries (slip and fall) 48%
Type 43 A 53% Type 43B 35% Type 43C 12%
Concomitant fibular fracture 12%

Fig 5: Radiograph showing management of case in Fig.2 with lag screw through the plate.

Fig 6: Radiograph showing management of case in Fig.2, with a Kirschner wire through fibula.

Non-weight-bearing ambulation was permitted at approximately two weeks, after proper wound healing and appearance of the wrinkle sign. Patients were followed up clinically and radiologically in the fracture clinic at monthly intervals for the first six months and then every two months up to one year to assess progress of union and possible complications. Full weight-bearing was permitted only after clinico-radiological evidence of union. Union was defined as bridging of three of the four cortices and disappearance of the fracture line on the plain radiographs for a patient who was able to bear full weight. Fracture in the process of union but not united at six months was considered as delayed union. Nonunion was defined as a fracture that did not heal within a year. Malunion was defined as the incongruity of the articular surface of more than 2 mm or malalignment greater than 5° in any plane. At the end of one year, final functional outcomes were assessed using the Olerud and Molander scoring system.

3. Results

If the reduction is anatomical the precontoured anatomical plate sits well on the bone. The head of the plate should sit under the anterior compartment tendons. Good repair of the anterior (extensor) retinaculum is important to prevent tenting of the tendons of the anterior compartment; with this step the skin closure also becomes easy. In two cases where the fibula had to be plated closure was difficult. The lateral surgical wound was subjected to delayed closure. Three cases had superficial wound infection and they were treated with debridement and healed with topical care. No other patient had wound dehiscence in the post-operative period. The mean time to full weight-bearing was 14 weeks (range: 13–28 weeks). The mean time to union was 18 weeks (range: 16–30 weeks). Two fractures however had delayed union, with union time of less than nine months. One of the cases with delayed union had an anterolateral gap in the tibia due to cancellous bone impaction and required secondary bone grafting before union could be achieved. One more case had a non-union at fracture site which was attributed to non-anatomical reduction and rigid fixation at fracture site. This case was managed successfully by secondary bone grafting. This case however developed a varus angulation of 7^0 with anterior angulation of 5^0. Anatomical alignment (varus or valgus angulations <5°, internal or external rotation <5°, limb length discrepancy <1 cm) was achieved in all cases except two. Both the cases were type 43 C2 fractures and both had an accompanying distal fibular fracture. Shortening was about 2cm and varus collapse was 10^0. These two cases were managed conservatively. The distribution of functional outcome according to the Olerud and Molander score showed that 18 patients had an excellent functional outcome (score >92) while 5 patients had good outcome (score 87-91). Six patients had a fair outcome [16].

Table 2: Showing functional outcome

Functional Outcome as per Olerud and Molander Score		
>92	18(53%)	(Excellent)
87-91	10(30%)	(Good)
65-86	6(17%)	(Fair)

4. Discussion

Distal tibial fractures remain one of the most substantial therapeutic challenges that confront the orthopaedic traumatologist. The lack of consistent results with the use of external fixation techniques and an improved understanding of the associated soft tissue injury gave way to the reconsidering of open treatment with internal fixation but after a period of soft tissue recovery. Both medial and lateral distal tibial plating have been propagated as being equally effective in the management of distal metaphyseal tibial fractures and give comparative functional outcome [17]. However, the lateral plating group had a lower complication rate and fewer hardware problems in a number of published studies [18]. We therefore performed our study to evaluate the management and functional outcome in such fractures fixed with anatomical anterolateral plates. Our study shows that Anterolateral plating of distal tibial metaphyseal fractures gives fairly consistent and reproducible clinical results. The specific problems of implant prominence as seen with medial tibial plating are avoided using a lateral plating system. Soft tissue healing is the other major complication of medial plating, is also less with using the anterolateral plating. In our series about 83% of patients had excellent to good outcome. The remaining 17% had fair outcome. In the fair outcome group one two had delayed and one had non-union. One explanation for fair functional outcome was a coexisting distal fibular fracture that made the ankle unstable. Such patients also had a longer period (6 weeks) of cast immobilisation that resulted in ankle stiffness. Also, all these patients had other medical comorbities like diabetes mellitus, peripheral vascular disease and congestive cardiac failure among others that hampered bony union and soft tissue healing. They also complained of skin irritation and medial malleolus pain. The main limitation of our study was our inability to do a comparative analysis of the two types of plating systems i.e. medial and lateral. Since surgical management and assessment of clinical and functional outcome was done by the operating surgeons it might have resulted in observer bias. Severe pilon factures (43C3) were excluded from the study.

5. Conclusion

1. 3.5mm anatomical anterolateral locking compression plate is an excellent option for the management of distal tibial metaphyseal fractures. The development of this anatomical plate is a significant advancement over the conventional 4.5mm limited contact dynamic compression plate (LCDCP). The 4 locking options in the head of the plate gives a very stable and sturdy biomechanical construct.
2. Lag screws should be strategically used while managing such complex fractures which are usually spiral-oblique in morphology.
3. The anatomical anterolateral plate is well contoured to the distal tibial anatomy and approximates well with the underlying bone if the fracture is anatomically reduced. Hence we didn’t find it necessary to contour the plate as claimed by some authors [19].
4. The head of the anterolateral plate sits underneath the anterior tendons and when the retinaculum is repaired well the soft tissue tension is considerably reduced. This substantially cuts down rate of wound complications and dehiscence.
5. Additional measures like primary bone grafting and supplementary fibular fixation in comminuted fractures with cancellous compaction are recommended for optimal results. Fibula stabilisation is strongly recommended if the fracture is at the level of or distal to the syndesmosis.
6. We had slightly modified the traditional Anterolateral approach by giving an outwardly curved incision over distal tibia. This equalises tension over medial and lateral tissues and makes the closure easy.

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