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Functional and Radiological Outcome of Distal Third Tibia Fractures Managed by Minimally Invasive Plate Osteosynthesis

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Abstract: ***Fractures of the distal tibia can be challenging to treat because of limited soft tissue, the subcutaneous location and precarious vascularity and proximity of ankle joint. From Aug 2014 to Jul 2016, a prospective study was done among 25 patients admitted in Dept. Of Orthopaedics of tertiary care centers who were treated with Minimally Invasive Percutaneous Osteosynthesis for tibia with or without fibula fixation. From our study it is further proved that the effectiveness of Minimally invasive plate osteosynthesis (MIPO)as it has given Excellent/Good functional out come in most of our cases. Radiological score showed anatomical reduction if Minimally invasive plate osteosynthesis was done along with fibula plating. Hence it can be taken as treatment of choice especially in case with displaced intra articular distal tibial fractures.***

Keywords: Distal third tibia fractures, MIPO, Functional Outcome, Radiological Outcome

1. Introduction

Fractures of the distal tibia can be challenging to treat because of limited soft tissue, the subcutaneous location and precarious vascularity and proximity of ankle joint[1][2]. Fractures of distal tibia remain a controversial subject despite advances in both non-operative and operative care. The aim in distal tibia fracture is to realign the fracture, realign limb length and early functional recovery.

Distal tibia fracture remains one of the most challenging for treatment because of high complications[3][4].They are increased in frequency because of higher incidences of Road Traffic Accidents, accounts to 1% of all lower extremity fractures, 10% of tibial fractures and bilateral in 0-8% and compartment syndrome in 0-5%.The mechanism of injury is axial loading due to talus hitting hard the lower end of the tibia[5]. The axial loading on the distal tibia determines the articular surface injury, metaphyseal communition, joint impaction and associated soft tissue injuries[6][7]. Although the mechanism of injury may be complex, the predominant force is vertical compression. The location of the articular portion of the fracture is determined by the position of the foot at the moment of impact.

Fractures involving the distal third of tibia involve the metaphyseal flare which poses the difficulty of decreased implant contact leading to less stability and increased malalignment. This kind of malalignment causes gross mechanical alteration of the ankle thereby leading to increased pain and functional disability. Surgical fixation of distal tibia fractures, require careful preoperative planning because of Fracture pattern, soft tissue injury, and bone quality and articular involvement critically influence the selection of fixation technique. Several techniques have emerged – conservative, hybrid external fixation, intramedullary nailing.

Non-surgical treatment is possible for stable undisplaced closed fractures. But malunion, shortening of affected leg, limitation of range of movement and early OA of ankle have all been reported following treatment of these fractures particularly pilon fractures[8][2][9]. External fixation can be useful in open fractures with soft tissue injury which preclude nail or plate fixation, but may result in inaccurate reduction, a relatively high rate of malunion, or nonunion and pin tract infection, pin loosening[10][11]. With regards to Intramedullary interlocking nailing, a stable fixation with nail in distal tibia may be difficult to achieve two distal locking screws and also the hourglass shape of the intramedullary canal prevents a tight endosteal fit and compromises torsional and angular stability.

Secondary displacement of the fracture on insertion of nail, breakage of nail and locking screws and malunion of the tibia are potential risks. Classic open reduction and internal plate fixation require extensive soft tissue dissection and periosteal stripping with high rates of infections, malunion, delayed union, non union and also requires secondary procedures like bone grafting.

Several minimally invasive plate osteosynthesis techniques have been developed, with union rates ranging between 80% and 100%. These techniques aim to reduce surgical trauma and to maintain a more biological favourable environment for fracture healing. Nevertheless, complications such as angular deformities greater than 7°, hardware failure and non-unions have been reported.

A new advance in this field is represented by the “locked internal external fixators”. It consists of plate and screw systems where the screws are locked in the plate at a fixed angle. Screw locking minimizes the plate and bone contact because the plate does not need to be tightly pressed against the bone to stabilize the fracture. [12][13]

The system works as flexible elastic fixation that stimulates callus formation. The anatomical shape prevents primary displacement of the fracture, and allows a better distribution of the angular and axial loading around the plate. Because of

minimally invasive the periosteal blood supply of the bone and fracture haematoma not disturbed.

Despite with advances in identification, understanding and treatment of soft tissue injury and with the liberal use of Computed Tomography scanning, advances in implant design which includes locking plate technology, still the management of these challenging fractures remains elusive[14]. This prospective study analyses the functional and radiological outcome of Minimally Invasive Percutaneous Osteosynthesis for treatment of distal 1/3rd tibial fractures.

2. Methods

From Aug 2014 to Jul 2016, a prospective study was done among 25 patients admitted in Dept. Of Orthopaedics of tertiary care centers who were treated with Minimally Invasive Percutaneous Osteosynthesis for tibia with or without fibula fixation. The inclusion criteria were: Adults> 18 years of age; Closed fractures and Grade 1 compound fractures; Fracture less than 2 weeks and Reudi and Algower type I, II, III fractures.

Preoperatively, all patients were examined- affected limb to rule out compartment syndrome and neurovascular status, surrounding soft tissue status and other skeletal injuries and systemic examination was also done. Patients were applied AK slab and admitted in the ward, routine investigations were done for all patients. Cardiology opinion obtained for all patients above 50 yrs of age. After anesthetic fitness, patients were taken up for surgery. All the study patients were taken up for the surgical procedure between the 3rd and 12thday after the trauma. The average delay to surgery is 7days. The duration of surgery was minimum 60 min and maximum 120 minutes. The average duration of surgery was 90 min. Those patients to whom fibula fixation was done took more surgical duration.

Surgical Technique
Positioning:Supine position on a radiolucent table with bump in ipsilateral gluteal region
Anaesthesia:Regional

Surgical Exposure:
Fibula:
Fibular reduction and fixation was performed with limb in slight internal rotation using the lateral approach to the fibula, with 1/3 rd tubular plate and 3.5 mm cortical screws.2 cases fixed with Recon plate with 3.5 cortical screws. (Fig 1-5)


Figure 1: Position


Figure 2: Incision


Figure 3: Exposure


Figure 4: Fixation


Figure 5: Closure

Tibia:
In our study we used the technique of MIPO. The patient was positioned in supine on the operating table, after closed percutaneous reduction of distal tibia, 2cm vertical incision was made over the medial malleolus. Plate was inserted after creating a tunnel in a retrograde manner and a small counter incision made proximally to optimally align the plate on tibia and fixed with percutaneously placed screws by stab incisions under image intensifier guidance. Distal segment screws inserted with same incision. (Fig 6-9)

Position of the limb showing Incision with plate insertion technique


Figure 6

Figure 7

Figure 8

Figure 9

Intra Operative C-Arm Images

Figure 10

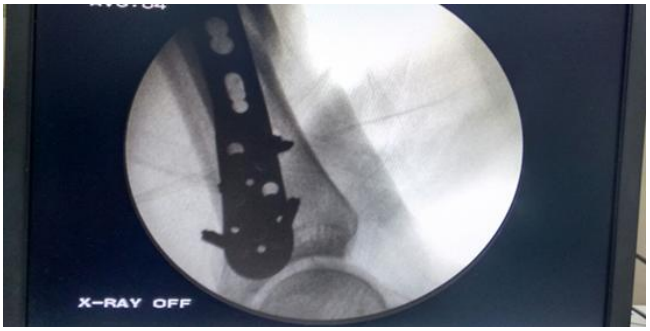

Figure 11

Post-operative protocol:

1) wound inspection done on 2nd day
2) Ankle and knee mobilisation started on 2nd day
3) Suture removal on 12th postoperative day.
4) Patient advised non weight bearing until radiological evidence of union
5) Radiological examination once in every 6 weeks
6) Once radiological union started partial to full weight bearing was allowed.

All cases were assessed using the IOWA ankle score and TEENY WISS radiological scoring.

3. Results

Patient's age ranged from 21 to 65 years. Average of 41.92 yrs. There were 17 males and 8 Females. The mode of injury was RTA (Males:13, Females:4), Self fall (Males:1, Females:4) and others (Males:2, Females:1). Figure 1 shows the incidence based on classification. Fifteen of them were left sided and 10 of them right sided. Twenty of them had fibula fracture above the level of the syndesmosis, two of them at the level of the syndesmosis and three of them had it intact. Eighteen of them presented within 24 hours, five of them between 24-72 hours, and two of them between 72 hours to 1 week.

Out of 25 cases 21 cases both bone fractures, distal third in this 10 cases fibula fixation was done.11 cases fibula fixation not done.4cases was found isolated distal tibia fractures. In our study out of 25 cases 2(8%) cases posterior malleolus fixation was done with screws.3(12%) cases had associated injuries. One case had L3 vertebra burst fracture along with contralateral left calcaneum fracture. Second case had closed contralateral left distal femur fracture and third case had contralateral right calcaneum fracture. Majority were of A3 type (48%) followed by A1 and A2 type (12% each) followed by C1, C2, C3 and B1. The time of partial weight bearing was decided on the type of fracture, adequacy of fixation and the radiological picture at the time of follow up. Most patients started partial weight bearing around 7-8 weeks post-surgical fixation. The time of full weight bearing was usually between 14-16 weeks.

All the fractures united. The time to union was between 16 to 28 weeks. Mean duration of union 18.28 weeks. A malunion was defined as angulation in coronal plane (Varus–valgus) of more than 5 degrees, in the saggital plane (Anterior–posterior) angulation of >10 degrees, or more than 10mm of shortening. In our study 2 patients had varusangulation. None of the patients had more than

10degree of angulation in saggital plane and none had a shortening of more than 10mm.

Detailed analysis of function of the patients with distal tibia fractures was done on the basis of Ankle evaluation scoring system –IOWA [Ottawa Ankle scoring system) In our study 64% patients had excellent results, 32% patient had good results, 4% patient had Fair result.

Functional Score and Teeny Wiss Radiological Scoring

A variety of rating systems were proposed for subjective and objective components. We have used modified Teeny and Wiss Score for radiological evaluation of ankle and IOWA scoring for functional analysis. The mean functional ankle scores were 89.84 with a maximum of 96 and minimum of 76. In our study we were able to achieve good anatomic reduction in 84 % (18cases) of the patients, 12% (3 cases) had good rating, 4% (1 case) showed fair rating. (Tables1 and 2)

Table 1: Teeny Wiss Radiological Score

Reduction	*A1*	*A2*	*A3*	*B1*	*C1*	*C2*	*C3*
Anatomic	3	3	12	1		1	1
Good	-	-	-	-	2	1	-
Fair	-	-	-	-	-	-	1
Poor	-	-	-	-	-	-	-

Table 2: Functional Score

Scoring	Excellent	Good	Fair
A1	2	1	-
A2	2	1	-
A3	8	3	1
B1	1	-	-
B2	-	-	-
B3	-	-	-
C1	1	1	-
C2	1	1	-
C3	1	1	-

4. Discussion

Minimally invasive plate osteosynthesis (MIPO) is the logical next step in the surgical treatment of fractures. It relies primarily on the indirect reduction of the fracture using various techniques, excellently described in the classic works of Mast and Ganz[15]. In this way, the fracture environment is better preserved, as well as the blood supply to the bony fragments [16][17]. Theoretical advantages include less infection and wound problems and better fracture healing[18].

Especially in the region of the distal tibia and ankle joint the soft tissues are frequently involved in the sustained trauma and play a central role in the choice of the surgical fracture treatment. Very often, it is the initial condition of the surrounding soft tissues that limits the possibilities for osteosynthesis and directly relates to the outcome of distal tibial fractures [19][20][21]. The importance of a good, mechanically stable osteo synthesis in the treatment of fractures of the tibial plafond has been well emphasized. When fixing the often comminuted metaphyseal fragment to the diaphysis in an attempt to restore proper axial alignment, very often considerable hardware and thus surgical dissection is required.

Percutaneous plating of the distal tibia offers a similar stability as classic ORIF, however without the need for extensive dissection. Therefore fewer soft tissue complications can be expected, thus allowing the use of this technique even in the presence of moderate to severe soft tissue contusion or grade I or II open fractures. As such, it promises to be a valid alternative to external (hybrid) fixation, although two-stage procedures may be performed[22][23].

In our study we used a single-stage fixation of all distal tibial fractures. We used medial distal tibial locking compression plate for all cases. This plate is a low profile plate of 3.5 mm system. The Medial distal tibial plate is a precontoured plate to that of the distal tibia and thus 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.

In our study 21 patients had associated fibula fracture out of which 15 patients the level of fibula fracture was within 7 cm from the tip of lateral malleolus.In this 10 cases fibula fixation was done.
Mast et al[15]recommended primary definitive internal fixation if the patient was presented early within 8 to 12 hours following injury. They advocated a delay in the definitive procedure for about 7 to 10 days for soft tissue to heal, if the patient presented late. In our study the average duration of delay in the definitive treatment was about 3 to 12 days.

Barei et al[1] demonstrated that distal tibia fractures with intact fibula, on the whole was considered as less severe injury than those with fractured fibula. An intact fibula was identified as less severely injured than C type fractures. The first principle of management by Ruedi and Allgower was restoration of fibular length which remains vital to obtaining good results. The goal of fibula fixation was restoration of limb length, to prevent varus tilt and rotation and gross mechanical alignment. In our study out of 25 cases, 21 cases had fibula fracture. Out of which 15 cases the level of fibula fracture was within 7 cm from tip of lateral malleolus. Fibula fracture fixation was done in 10 cases which showed restoration of limb length without malalignment. Out of 10 cases in 8 cases we used 1/3 tubular plate for fibula fixation whereas in other 2 cases we used 3.5 mm recon plate. In fibula fixation cases 1 case was developed superficial infection in immediate postoperative period which settled with appropriated antibiotics and daily dressing, whereas 1 case went on to a deep infection with wound gaping for which implant exit followed by hybrid external fixator application was done. This case was developed delayed union and hence subsequently bone grafting was done. Later fracture united well without complication. In remaining 11 cases fibula fracture was either an undisplaced fracture or was at a different level thus not affecting stability.

Helfet et al[12][13][23] in their study had a superficial infection rate of 3% and deep infection of 6 % in their series of 32 fractures treated with locking compression plate. In our study we had 64% of excellent functional outcome, 32% had good results and 4% had fair result in a average follow up of

9.9 months.We observed 1 case superficial infection(4%), 1 case deep infection(4%) which was acceptable when compared to the above studies.

Mario Ronga et al[9] in their study of minimally invasive locked plating of distal tibial fractures, they had the following outcomes – of the 21 cases they achieved union in 20 cases and one case went in for non-union. They had 3 cases of angular deformities all less than 7° and no patient had a leg-length discrepancy. Compared to their study, in our study all cases went in for union in mean duration of 18.28 weeks. Two cases had delayed union and two cases had varus angulation deformity- one had acceptable varus angulation of 5 degrees and another had 10 degrees varus angulation was unacceptable. Even though there was varus angulation this patient had excellent functional outcome. In case of unacceptable varus angulation retrospective analysis we observed that this could have been prevented by fixing fibula fracture.

5. Conclusion

From our study it is further proved that the effectiveness of Minimally invasive plate osteosynthesis as it has given Excellent/Good functional outcome in most of our cases. Radiological score showed anatomical reduction if Minimally invasive plate osteosynthesis was done along with fibula plating. Hence it can be taken as treatment of choice especially in case with displaced intraarticular distal tibial fractures.

References

[1] Howard JJ, Barie et al. A prospective study of evaluating incision placement and wound healing for tibial plafond fratures. J Orthoptrauma. 2008;5:250-255.
[2] Rakesh K, Gupta, Rajesh Kumar Rohbilla et al. Locking plate fixation in distal metaphyseal tibial fractures: series of 79 patients. IntOrthop 2010 December;34(8):1285-1290.
[3] Reudi T, Matter P, Allgower M et al. Intra-articular fractures of the distal tibial end. HelvChirActa. 1968; 35:556-582.
[4] Reudi TP, Allgower M et al. The operative treatment of intra-articularfractures of the lower end of the tibia.ClinOrthopRelatRas1979(138):105-110.
[5] Borrelli J, Catalano L. Open reduction and internal fixation of pilonfractures. J Orthop Trauma 1999;13:573-582.
[6] Bourne RB, Rorabec CH, Macnab J. Intra-articular fractures of the distaltibia: the pilon fracture. J Trauma 1983;23:591-595.
[7] Boren P, Richmond J et al Minimally invasive treatment of pilonfractures with a low profile plate preliminary report 2006;8:230-235.Campbell's Operative orthopaedics – eleventh edition.
[8] John Scolaro, MD and JaimoAhn MD. In Brief: Pilon fractures. ClinOrthopRelat Res 2011 February; 469(2): 621-623.
[9] Mario Ronga MD, Umile Giuseppe Longo MD et al. Minimallyinvasive locked plating of distal tibia fractures is safe and effective. ClinOrthopRelat Res. 2010 April;468(4):975-982.
[10] Ovadia DN, Beals RK. Fractures of the tibial plafond. J Bone Joint Surg(Am) 1986;68:543-551.
[11] Patterson MJ, Cole JE. Two staged delayed open reduction and internalfixation of severe pilon fractures. J Orthop Trauma 1999;13:85-91.
[12] Helfet DL, Suk M et al. Minimally invasive percutaneous plateosteosynthesis of distal tibial fractures, Instr Course Lect 2004;3:471-475.
[13] Helfet DL, Koval K et al. Intraarticular pilon fractures of the tibia.ClinOrthopRelat Res 1994(298):221-228.
[14] Resch H, Philander S, et al. Long term results of conservative andsurgical treatment for distal end of tibia 1986; 16:117-123.
[15] Mast J, Jakob R, Ganz R. Planning and Reduction Technique in Fracture Surgery. Springer-Verlag, New York, 1989.
[16] Farouk O, Krettek C, Miclau T, SchandelmaierP, Guy P, Tscherne H. Minimally invasive plate osetosynthesis: does percutaneous plating disrupt femoral blood supply less than the traditional technique ? J Orthop Trauma 1999; 13: 401-406.
[17] Whiteside LA, Lesker PA. The effects of extra-periosteal and subperiosteal dissection on fracture healing. J Bone Joint Surg Am 1978; 60: 26-30.
[18] Kinast C, Bolhofner BR, Mast JW, Ganz R. Subtrochanteric fractures of the femur: results of treatment with the 95 degree condylar blade-plate. Clin Orthop1989; 238: 122-130.
[19] Kilian O, Bundner MS, Horas U, Heiss C, Schnettler R. Long-term results in the surgical management of pilontibial fractures. A retrospective study. Chirurg 2002; 73 65-72.
[20] Rommens PM, Claes P, Broos PL. Therapeutic strategy in pilon fractures type C2 and C3: soft tissue damage changes treatment protocol. Acta ChirBelg1996; 96: 85-92.
[21] Teeny SM, Wiss DA. Open reduction and internal fixation of tibial plafond fractures. variables contributing to poor results and complications. Clin Orthop 1993; 292: 108-117.
[22] Blauth M, Bastian L, Krettek C, Knop C, Evans S. Surgical options for the treatment of severe tibial pilon fractures: a study of three techniques. J Orthop Trauma 2001; 15: 153-160.
[23] Helfet DL, Shonnard PY, Levine D, Borelli J. Minimally invasive plate osteosynthesis of distal fractures of the tibia. Injury 1997; 28 (suppl): A42-A48.