Asian Pac. J. Health Sci., 2014; 1(4S): 14-19 e-ISSN: 2349-0659, p-ISSN: 2350-0964

Role of minimally invasive percutaneous plate osteosynthesis in the treatment of distal diametaphyseal tibial fractures

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Received: 10-12-2014 / Revised: 21-12-2014 / Accepted: 31-12-2014

ABSTRACT

The fractures of the distal tibia represent 7-10% of all tibial fractures and they usually encompass a spectrum of skeletal injury ranging from fractures caused by low-energy rotational forces to fractures caused by high-energy axial compression forces arising from motor vehicle accidents or falls from a height. Rotational variants typically have a more favorable prognosis, whereas high-energy fractures frequently are associated with open wounds or severe, closed, soft-tissue trauma. The fracture may have significant metaphyseal or articular comminution or diaphyseal extension. Better prognosis are given in case of low energy traumas. The study evaluates the results of the surgical treatment of distal tibia fractures, using minimally invasive plate osteosynthesis (MIPPO) technique. We treated in our unit 18 patients with distal tibia fractures with the MIPPO technique. The fractures, intra-articular or extra-articular, were classified according to the AO classification. The cases studied did not involve compound fractures or local dermatological lesions and we excluded the C3 fractures, for which traditional osteosynthesis is preferable. On the whole the outcomes were positive, thanks to a correct clinical indication. In conclusion we think that two are the elements that direct the choice regarding the type of approach and the type of device for the synthesis. The first is the condition of the skin, as far as its integrity is concerned, and the second is the articular condition, as far as the comminution and the number of fragments are concerned. Therefore we need to choose a synthesis that can guarantee a good outcome and can avoid dreadful complications and MIPPO is a valid technique when used correctly and by experts.

Keywords: Minimally invasive osteosynthesis; Fixed angle plate; Distal tibial fractures

Introduction

The unique anatomical characteristics of subcutaneous location with precarious blood supply, limited soft tissue and proximity to the ankle joint makes the treatment of distal tibial fractures challenging [1, 2].

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Different methods of treatment are implemented including non-operative treatment, external fixation, intramedullary nailing, and internal fixation with traditional implants(standard screws and plates)[3]. However, certain challenges are associated with each of these treatment modalities [4].

Stable fractures with minimal shortening can be treated conservatively, but requires prolonged immobilisation. It has also been associated with malunion, shortening of affected limb, restriction of range of motion and early osteoarthritis as well5,6. Some of the complications associated with conventional osteosynthesis with plates are wound infection, skin breakdown and delayed union or non union requiring secondary procedures like bone

grafting [7-10]. Similarly,external fixators can cause pin tract infection, pin loosening, malunion and nonunion leading to osteomyelitis and hence not preferred as definitive fixation method[11-13]. In the last decade, minimally invasive percutaneous plate osteosynthesis (MIPPO), performed by indirect reduction, has emerged as a successful treatment modality in complex diametaphyseal tibial fractures [14-16]. The aim of MIPPO is to preserve the osteogenic hematoma of the fracture and the nutritional arteries of the bone while preventing iatrogenic soft tissue damage[17].Vascular injection studies have compared cases treated by MIPPO with classic open techniques and MIPPO was found to result in higher preservation of periosteal circulation[17-19].

Locked compression plates are commonly used for fracture fixation. Locking compression plating (LCP) provides an angular stability for fixation[16,20]. Locked screws prevent the plate from pressing the bone, preserving periosteal blood supply[14]. This system stimulates callus formation due to flexible elastic fixation. The anatomic shape of the plate prevents malalignment of the fracture and provides a better axial and angular weight distribution[17,21].

Materials and methods

Eighteen cases of distal tibial fracture with intra articular extension treated in Sree Gokulam medical college between april 2012 to July 2013 were studied and prospectively followed. Ethical committee clearance was obtained prior to the study. Fractures were classified according to AO classification system and Reudi Allgower fracture classification. Patients with pathological fractures, open fractures and ipsilateral multiple fractures were excluded. Demographic variables, mode of injury, injury-hospital and injury-surgery interval, time required for union, complications and need of secondary procedures were recorded.

Surgery was done on the same day or next day for patients who presented to casualty within six hours of injury without gross swelling of leg. Immediate closed manipulative reduction and immobilization in a BK plaster slab was done. Our plan was to delay surgery in case of limbs with gross swelling untill swelling subsided and wrinkles appeared over the ankle joint.

All surgeries were done under regional or general anesthesia. Tourniquet was routinely applied. Initial fibula fixation was routinely done with one third tubular plate. It restores limb length and helps in the reduction of the tibial plafond in the correct position[22] .A 2 cm longitudinal incision was made at the level of medial malleolus . Care was given not to injure great saphenous vein and saphenous nerve. Under C arm guidance fracture was reduced .Sub cutaneous plane was made with Locking Compression Plate(LCP) itself (figure -1) without striping periosteum and disturbing the fracture hematoma. Calcaneal skeletal traction was not used. When needed a Kirschner wire was used as a joystick to aid in fracture reduction and a reduction clamp was used to hold reduction. Acceptable criteria for reduction included varus -valgus angulation < 5° , anterior-posterior angulation < 10° and shortening of < 15 mm . An appropriate length plate was selected so that at least 6–8 cortices hold could be obtained on either side. If necessary, interfragmentary compression was achieved by a screw through the plate or outside the plate. After applying locking screws at distal part another small incision was made at the proximal part of plate and fixed with locking screws .

Soft tissues were carefully handled and retractors were judiciously used. No primary bone grafting was done irrespective of comminution .Wound was closed with absorbable sutures and staples and limb was splinted with below knee slab.

All patients received cefuroxime 1.5 g at induction followed by 750 mg 8th hourly for 3 days postoperatively .Wound inspection was routinely done on fifth post operative day. Patient was discharged on fifth day of surgery if skin condition was satisfactory and wound was dry.

Figure-1

Follow up

Staples were removed on post operative day 12. Below knee plaster slab was given for 4 weeks. Xray was taken after 6 weeks to assess fracture healing. Following that non weight bearing mobilization of ankle joint was done for another 6 weeks .After 12 weeks, weight bearing was started once callus was visible in X ray and gradually increased according to clinical and radiological signs of fracture healing. Radiological union was defined as the appearance of a mature callus on 3 or 4 planes and clinical union as no pain inducement after full weight-bearing. If fracture union was not progressing satisfactorily, secondary procedures like bone marrow injection or cortico-cancellous bone grafting were considered. Malunion was defined as varus -valgus angulation ≥ 5° and anterior-posterior angulation ≥10° and shortening of ≥ 15 mm. During subsequent follow up after fracture union, if patents wished to remove the hardware or had hardware related complaints like malleolar pain, difficulty of wearing shoes or prominent implants, plate removal was indicated.

Results

Among the eighteen cases operated, 10 were females and 8 were males. Age of the patients ranged from 45–71 years, mean being 55 years. 6 cases were due to fall and 12 cases were due to road traffic accident .According to AO classification, ten fractures were 43C1 and eight were 43C2.Two cases had associated injury resulting from the same trauma. The injuries noted were fracture of radius and fracture of metacarpals. None of the cases were associated with head injury. The average injury surgery interval was 17.75 hrs (range 8-73 hrs) and average injury hospital interval was 4.6 hours(range 3-7 hours). The average operative time was 60 minutes. No single case of injury to great saphenous vein and saphenous nerve was detected . Healing of the fractures occurred with formation of callus. All fractures went to union. Average period of union was 16.1 weeks (range 13-22 weeks). None of the patients developed wound infection ,superficial or deep .There was no case of delayed union, non-union, implant failure or any significant deformity. No case required bone grafting. None of the patients had hardware related complaints like malleolar pain, difficulty of wearing shoes or prominent implants.

CASE 1

CASE 2

Discussion

Distal end fractures of the tibia are usually seen along with serious soft tissue problems caused by both the high energy generated at injury and the corrupted circulation. Borrelli et al[18]. demonstrated that the distal metaphyseal region of the tibia has a relatively rich blood flow through the anterior and posterior tibial arteries. They also showed that open plate techniques performed in this region interfere seriously with blood flow when compared to the MIPPO technique.

Helfet et al[23] in a study comprising 20 pilon fractures treated with MIPPO technique, suggested routine external fixation application. The permanent treatment was performed after the edema in the soft tissues had subsided. In our series, external fixation was applied on one pilon fractures with soft tissue injury, and no postoperative problems were encountered

Infection rates vary between 0 and 50% following the surgical treatment of tibia distal end fractures[20,24]. The rate of infection with MIPPO technique is lower than the ORIF, and similar to external fixation[20,23,24]. Results from our study are in line with these reports. None of the cases in our study developed infection

Stable internal fixation and early mobilization is one of the current concepts in fracture treatment[25]. However, it is difficult to obtain a stable internal fixation in an osteopenic bone. The screw is weakly held to the bone and pull-out is probable which may cause implant failure[26].We encountered no implant failure in patient with osteoporosis. All our patients were above 45 years and non weight bearing mobilization was started after6 weeks and partial weight bearing was started only after 12 weeks.

Anatomical reduction of the fracture before applying the plate is very important surgical step. Malreduction and suboptimal pre contouring of the plate can result delayed union, non union, prominent hardware, malleolar skin irritation and pain[27]. Various reduction maneuvers such as calcaneal pin traction, external fixators or mechanical distractors have been described to achieve reduction1.Many authors recommend fibula fixations before tibia fixation to achieve better tibial alignment and reduction and to prevent valgus malalignment but clear indications for fibula fixation are still lacking and controversial[1,27]. We routinely fixed fibula first before definitive tibial pilon fixation and on follow up did not encounter any malunion ,non union or delayed union

MIPO technique can restore alignment in high velocity distal diametaphyseal tibia fracture and patients can expect predictable return of function. However, Collinge et al. reported increased secondary procedure rate like bone grafting for delayed union[28]. In the current study no patients required secondary procedures like iliac crest bone grafting or per cutaneous bone marrow injection for delayed union or non union .

Because of sub cutaneous location, distal diametaphyseal tibia are prone to have gross swelling,

skin injury and fracture blisters if the leg is left unsplinted for long time and injury-hospital arrival interval is prolonged. Our protocol was to perform a closed reduction and splinting as soon as the patient arrives and fix the fracture as early as possible unless associated with gross swelling or hindered by fracture blisters. The average time for fracture union in the present study is comparable to other studies. Study of Shrestha et al showed that union time was not affected whether patients were operated before or after three days of injury[29].

Conclusion

In conclusion, MIPPO aims to reduce surgical trauma and protect the vascular integrity and osteogenic hematoma of the fracture, and is an effective alternative treatment for tibial diaphysis and distal tibia fractures with low complication and high union rates.

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Source of Support: NIL
Conflict of Interest: None