Result of distal medial tibial locking plate osteosynthesis in treatment for distal metaphyseal tibial fractures

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Summary

Objective: Minimally invasive percutaneous plate osteosynthesis (MIPPO) technique has now become more popular with the development of the locking plate. This study aimed to assess the outcomes of the using MIPPO technique with the medial distal tibial locking plate in treatment of the distal metaphyseal tibial fractures. *Subject and method:* Between April 2013 and December 2016, 70 patients (male/female: 53/17) of mean age 44 years (range 19 - 74) underwent MIPPO for metaphyseal tibial fractures using medial distal tibial locking plate (Intercus, Germany). Seventy fractures included 59 closed and 11 open (Gustilo classification, grade I: 4 cases, grade II: 7 cases). The main outcome measurements of this prospetive observational study are the wound healing, alignment, full weight bearing time, function and complications. *Result:* Sixty three cases were primary osteosynthesis, 7 cases were temporary fixed with external fixators before changed by locking plate. All the wounds of the MIPPO surgery primary healed, just one fibular plating wound was deeply infected. No case was varus, valgus or rotation > 5°. All of 70 tibial fractures were firm union without secondary displacement. The average time back to walk without crutche was 12.5 weeks. The mean AOFAS score was 85 at a mean of 15 months follow-up. *Conclusion:* Using medial distal tibial locking plate with MIPPO technique in treatment for the distal metaphyseal tibial fracture is safe and effective. This technique decreases the incidence of complications and can help patients to resume their function early.

Keywords: Distal tibial fracture, locking plate, MIPPO.

1. Background

The treatment of unstable fracture in metaphyseal-distal region of the tibia remains controversial. Open anatomical reduction and plate osteosynthesis requires extensive soft tissue dissection with consequent periosteal injury. High rates of infective complication and wound dehiscence have been reported [1], [2]. With the development of locking nails, distal tibia fractures were treated by indirect reduction in a closed fashion. The goal with this procedure was secondary bone healing with callus formation. Problems such as malunion with rotational and axial malalignment are known disadvantages of this method [1], [3].

Minimally invasive percutaneous plate osteosynthesis (MIPPO) is a technique which aims to reduce soft tissue injury and damage to bone vascularity, as well as preserving the osteogenic fracture haematoma. MIPPO technique has now become more popular with the development of the locking plate. Through a small skin incision, the plate is tunnelled extraperiostally along the medial aspect of the tibia and fixed with head locking screws. The better of the precontoured distal medial tibial locking plate than other locking plate in rate of

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the wound complications was reported [4], [5], [6], [7].

This study aimed to assess the outcomes of the using MIPPO technique with the medial distal tibial locking plate in treatment of the distal metaphyseal tibial fractures.

2. Subject and method

This is a prospetive observational study of 70 adult patients included 53 males and 17 females of mean age 44 years (range 19 to 74 years old). Seventy patients get 70 distal metaphyseal tibial fractures were treated in the 108 Military Central Hospital between April 2013 and December 2016, using medial distal tibial locking plate (Intercus, Germany).

Seventy fractures included distal third 42A-C fractures, 43A, 43C1, 43C2 fractures (AO/ASIF classification). Our series involved closed fractures and open fractures grade I, II (Gustilo classification). Proximal and middle third tibial fractures, type 43B, 43C3 of pilon fractures were excluded since a different approach and surgical technique is required.

The Intercus' medial distal tibia locking plate has been developed for fractures in the distal and metaphyseal area that may reach into the shaft. It is made of titanium and anatomically contoured to the distal medial tibia. There is a dense net of threaded screw holes in the distal section (8 holes) to provide a higher anchoring stability. Those threaded holes are angled to allow optimal fixation of the screws in the epiphyseal and metaphyseal area without penetrating the joint.

Antero-posterior (AP) and lateral radiographs of the leg including the ankle joint were obtained to establish the fracture pattern, classification and preoperative planning.

Through a small incision over the medial malleolus, sparing the saphenous vein and nerve, the tibial plate was inserted extraperiosteally. Fracture fragments were reduced using indirect reduction techniques, with pointed forceps. Direct open reduction may be used in difficult cases. Image intensification was used intraoperatively for assessment of fracture reduction and fixation. Fragments position, gap, longitudinal axis were controlled using fluoroscopy. Fixation of the plate was always done through a small incision with a 3.5mm mono- or bi-cortical locking screw. Fibula fractures were usually fixed with open reduction and plate or K-wire osteosynthesis prior to tibial fracture management.

Postoperative plaster cast immobilisation is not used. Elevation of the fractured limb to achieve gravity-assisted venous drainage along with active toe and ankle movements were carried out for the initial two weeks. Up to the first follow-up visit at 6 weeks, patients were only allowed to bear partial weight with crutches. Follow-ups took place at 6 weeks and at 3, 6, 9 and 12 months after surgery with a clinical and radiological examination (lateral and AP X-ray).

The fracture was considered union when a visible callus bridging of one cortex was present on both lateral and AP X-ray and the patient was full weight bearing without pain. Healing within the first 6 months was defined as normal, 6 - 9 months as delayed, and more than 9 months as nonunion. Malunion was defined as the malalignment greater than 5° in any plane. Soft tissue outcome was assessed from history of wound infection, wound dehiscence, plate impingement and plate removal. We use American Orthopaedic Foot and Ankle Score (AOFAS), time back to walking without crutche were used to assess the functional outcome.

3. Result

Fifty seven cases were high-energy fractures due to road traffic accident or fall from a height, and 13 cases had low-energy trauma. Eleven cases were open fractures classified by Gustilo classification. There were 4 cases grade I and 7 cases grade II. Twenty two of 59 closed

fractures get severe soft tissue injury. The fractures were classified by AO/ASIF classification. All fractures were located in distal third of tibial shaft and distal tibia (region 42 and 43 of AO/ASIF classification). Fracture lines usually were in both regions so we grouped them to 4 groups: 5 cases simple fractures (42A, 43A1); 24 cases wedge fractures (42B, 43A2); 33 cases complex fractures (42C, 43A3); 8 cases complete articular fractures, articular simple (43C1, 43C2).

Sixty three cases involved 59 closed fractures and 4 open fractures were definitive fixed by MIPPO technique using medial distal tibial plates. The mean time until surgery was 5.5 days (range 0 - 14 days). Seven cases were not suitable for primary osteosynthesis with locking plates, so they were temporary fixed with bridging external fixators. They were changed by locking plates with MIPPO technique in the mean of 5 weeks (range 4 - 6 weeks). In 39 cases, the distal fibular fracture was involved. These fibular fractures were performed ORIF with plates or K-wires prior to tibial plating.

Closed reduction achieved tibial anatomical alignment in 58 fractures and open reduction was required in the remaining 12 fractures. Open reduction was performed through a small incision direct to displaced fracture line or through the wound of open fracture. No case was added primary bone grafting. Anatomical alignment (varus or valgus angulations < 5°, internal or external rotation < 5°) was achieved in all cases. The mean operative time was 65 min (range 40 - 120). The mean postoperative inpatient treatment time was 4.5 days (range: 3 - 9, of 69 cases), but one case had 35 days inpatient because of the fibular plating wound dehiscence. No other patient had wound dehiscence in the postoperative period.

The average time to try standing with full weight bearing was 8.5 weeks postoperation (range: 5 - 13 weeks). The time back to walk without crutche ranged from 8 to 18 weeks (average 12.5 weeks). The minimal follow up time was 8 months, all of 70 fractures were firm union, none delayed or nonunited. The mean time to union was 15.3 weeks (range: 12 - 19 weeks). We did not get any plate bending or screw, plate breakage. The healing processes had ensured with anatomical alignment without rotation (> 5º), shortening (> 1cm) or varus/valgus (> 5º) deviation when compared to the other leg. Three patients not having a minimum follow-up of one year were excluded from the AOFAS estimate. The mean AOFAS was 85 at a mean of 15 months follow-up (67 patients).

4. Discussion

Fractures in metaphyseal-distal region of the tibia are often associated with significant soft tissue injury. The key point in management of this injury is to recognise the importance of the soft tissue component. Failing to appreciate the soft tissue condition will invariably complicate the injury with infection, wound dehiscence or nonunion [8].

Hasenboehler E et al [9] have excluded from primary osteosynthesis with locking compress plate (LCP) for all cases who were open fractures, deep abrasion with skin or muscle contusion, crush injury with severe damage to underlying muscle, subcutaneous avulsion, heavy contamination with extensive soft tissue damage often associated arterial or neural injuries. Temporary fixation was achieved with an external fixator in those cases. Initial plate osteosynthesis or exchange external fixator by locking plate is only advisable when the soft tissue allows it, when the ‘wrinkle sign’ is evident.

Our protocol in management of distal metaphyseal tibial fracture consists of soft tissue assessment prior to surgery, although MIPPO technique have a biological advantage over open reduction and internal fixation (ORIF), especially when dealing with critical soft tissue conditions. In our study, osteosynthesis operation was

performed when the soft tissue conditions at the distal one third of the leg allows. In cases soft tissue at the medial aspect was severe damage, another approach and different hardwave device and surgical technique were chosen. The mean time 5.5 days (63 patients) and 5 weeks (7 patients were used external fixator) waiting for plate osteosynthesis was due to soft tissue conditions.

In study of Hazrika S et al [10], there were 8 cases open and 12 cases closed fractures. The median number of days between admission and definitive fracture fixation was 10 days. In cases unused temporary external fixation, no patient waited more than 8 days before definitive treatment. Thirteen patients had temporary fracture stabilisation with an external fixator prior to osteosynthesis with a LCP. The report of Hasenboehler E et al [9] with 32 patients (24 closed and 8 open fractures), the mean time until surgery was 3.15 days (range 0 - 13 days).

Reports from various institutions suggest internal fixative modalities and techniques, ranging from open reduction and internal fixation, intramedullary nailing (IM), minimally invasive technique. These treatment modalities are associated with their benefits and complications. As report by the group of Borelli et al [11], the risk of disrupting blood supply is increased with the classic approach ORIF in the metaphyseal region of the tibia. Evidence shows that ORIF can often be complicated by infection and wound dehiscence. Previously published infection rates in the management of this injury range from 0% to 50%. ORIF has been shown to have the highest infection rates compared to other methods of treatment [8], [12], [13]. Intramedullary nailing techniques have been shown to reduce soft tissue complication, but increase rate of malunion and nonunion. Fractures in metaphyseal-distal region of the tibia are sometime unsuitable for intramedullar nailing [3], [7].

In all seventy cases, fracture stabilisation was achieved with a 3.5mm medial distal tibial locking plate. Osteosynthesis with intramedullar locking nail is a disadvantage for these fractures. The locking screws of the nail would perforate into fragmental or fracture line. Dependent on availability of implants, we just had Sugical Implant Generation Network (SIGN) nail. This locking nail is used for a tibial fracture that fracture line is minimal 5cm above ankle joint. All locking screws fix in one coronal face therefore varus or valgus malaligment have been shown with hight rate. The visible fracture line located in or extended into distal tibia was present on AP or lateral X-ray of all 70 patients. MIPPO technique is an advantageous and feasible alternative for these fractures. With a medial distal tibial locking plate it minimises soft tissue compromise and devascularisation of the fracture fragments [13], [14].

Primary osteosynthesis in 63 cases was MIPPO technique. Fifty eight closed fractures were performed with closed indirect reduction, another closed fracture and 4 grade I open fractures were reduced through the wound or small incision direct to displaced fragment. Seven of the 11 open fractures had bridging external fixator applied prior to definitive treatment due to the wound condition. Open direct reduction was performed during external fixating. When changing by locking plates, minimal invasive percutaneous plating was applied the first, then external frame was removed. Post osteosynthesis satisfactory anatomical alignment was observed in all cases (varus or valgus angulations < 5°, internal or external rotation < 5°).

As shown by group of Gupta RK et al [1], precontouring was required for all locking plates so as to approximately match the contour of the distal tibia in all 80 fratures. Even so 20 precontoured distal medial tibial LCP were required extra correction of the contour. We might not bend plate to correct plate contour in our patient group. It was not mandatory for the plates to be contoured as there was no necessity to ensure an exact fit to the bony contour. Mechanically, a locked construct does not require a friction fit of the plate against the bone [5], [13], [14], [15]. Intercus's medial distal tibia locking plate has contour suitable for the contour of the

medial metaphyseal tibia. This plate is light flexible so could not correct alignment by using a reduction screw through and based on the plate.

We knew that compression of the gap fracture is usually difficult to achieve with percutaneous plate osteosynthesis technique [5], [8]. In our study, the locking plate was used as a bridging construct across the fracture. It did not compress to cortical bone so a gap below the plate has advantages in preserving periosteal circulation. Eight of 70 cases had articular fractures. The plafond fracture had been reduced and temporary fixed with K-wires before MIPPO technique was performed.

The appropriate length of plate was chosen to allow at least 3 locked screws to be placed proximal to the fracture. We fixed at least 2 bicortical locked screws and 1 monocortical screw per proximal fracture. Minimal amount on the distal tibia, 2 long and 1 short screws were locked between plate and bone. There is no case with broken screw or fail hardware was noted in our study. Gautier E and Sommer C [5] currently recommend at least 2 screws per main fragment with purchase of at least 3 cortices for simple fractures and at least 2 screws per main fragment with purchase of at least 4 cortices for comminuted fractures. One case with plate bending of more than 18° was observed in the study of Hasenboehler E et al [9], but mobilisation with partial weight bearing of 32 patients started on the mean of 2.75 days (range 1 - 12) postoperatively. Bahari S et al [12] met one case of hard-ware failure of 42 AO distal tibia locking plates. One of the proximal screws broke but the overall alignment and angulation was maintained.

All of 70 fractures were firm, anatomical alignment union without rotation (> 5°), shortening (> 1cm) or varus/valgus (> 5°) deviation. The mean time back to walk without crutche was 12.5 weeks postoperatively (range: 8 - 18). The mean time to fracture healing was 15.3 weeks, without bone grafting. Gupta RK et al [1] performed primary bone grafting in 5 cases to fill up the gap at the fracture site caused by compression of cancellous bone and secondary bone grafting in 3 cases delayed and nonunited (of 80 fractures).

We found that distal tibial locked plating allows early active range of ankle movement and postoperative plaster immobilisation is not necessary, therefore ankle stiffness is not a problem. Sixty seven patients were estimated at the time more than one year postoperative examination. The mean AOFAS score was 85 at a mean of 15 months follow-up. Our result resembles the estimate in 42 patients of Bahari S et al [12], the mean AOFAS was 90 at 19 months follow-up.

5. Conclusion

Using medial distal tibial locking plate with MIPPO technique in treatment for the distal metaphyseal tibial fracture is safe and effective. This technique decreases the incidence of complications of soft tissue. The wound dehiscence after MIPPO surgery has not occured in any case, but one fibular plating wound was deeply infected. The medial distal tibia locking plate applied with MIPPO techniques using fluoroscopy intraoperation allows fracture reduction and alignment easily. Anatomical alignment (varus or valgus < 5°, rotation < 5°) was achieved, all of 70 cases were firm union without secondary displacement. This technique can help patients to resume their function early. The average time back to walk without crutche was 12.5 weeks. The mean AOFAS score was 85 at a mean of 15 months follow-up.

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