ORIGINAL ARTICLE

MINIMAL INVASIVE PLATE OSTEOSYNTHESIS OF CLOSE FRACTURES OF DISTAL TIBIA

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Background: The limited soft tissue, subcutaneous location and poor vascularity render the tibial fractures very challenging. Treatment of distal tibial fractures using minimally invasive plate osteosynthesis (MIPO) technique may minimise damage to soft tissues and the vascular integrity of bony fragments, leaving comminuted fragments out of the mechanical construct, preserving soft tissues with limited operative exposure. This descriptive study was conducted to assess the outcome of patients treated with MIPO technique for distal tibial fractures. **Methods:** Seventy three cases of multifragmentary fractures of the distal tibia admitted in Bahawal Victoria Hospitals, Bahawalpur between April 2009 and October 2010 were included in this study. Patient's outcome in terms of period of radiologic union of the fractured segments and period of full weight bearing capacity were accessed. **Results:** There were 66 males and 7 females of mean age 43 years. The mean follow-up period was 13 weeks. (Ranging from 9–16 weeks). All patients were fully weight bearing at 16 weeks (ranging 9–16 weeks) showing radiological union. There were two superficial infections treated successfully using oral antibiotics and no failures of fixation. There were no cases of rotational malalignment. **Conclusion:** MIPO is an effective method of treatment for distal tibial fractures. The use of indirect reduction techniques and small incisions is technically demanding but decreases surgical trauma to soft tissues.

Keywords: Distal tibial fractures, Minimally invasive plate osteosynthesis, MIPO

INTRODUCTION

Tibial fractures are usually the result of high energy axial compression and rotation forces. They are usually associated with severe soft tissue compromise.[1,2] The limited soft tissue, subcutaneous location and poor vascularity renders the tibial fractures very chalanging.[3,4] Several methods of treatment are implemented including non-operative treatment, external fixation, intramedullary nailing, and internal fixation with traditional implants (standard screws and plates).[5] However, each of these treatment options is associated with certain challenges.[6] Non-surgical treatment option is possible for stable fractures with minimal shortening, but requires prolonged immobilisation. It has also been associated with malunion, shortening of effected limb, limitation of range of motion and early osteoarthritis as well.[7,8] Non-surgical approach with calcaneal traction remained the treatment of choice prior to case series reported by Reudi and Allgower in 1969 with 84 fractures treated with standard open protocol with 74% of patients reported good to excellent function.[9,10] External fixation can be a useful option in open fractures with soft tissue injury, but can lead to pin-track infections, septic arthritis, mal-alignment and delayed union.[11,12] Soft-tissue management has been seen to play a vital role in the management alongside the bony reconstruction.[13] Conventional plating techniques if applied to multifragmentary fractures, requires anatomic reduction, wide surgical exposure and the fractured fragments are stripped off the soft tissue attachments resulting in a variety of complications like delayed union or non-union, infections and implant failure.[14,15] Biological fixation principles advocate realigning by manipulation at a distance to fracture site, leaving comminuted fragments out of the mechanical construct, preserving soft tissues with limited operative exposure.[16] MIPO is one such method in which percutaneously inserted plate is fixed at a distance proximal and distal to the fracture site through minimal exposure.[17,18]

The aim of this study is to assess the outcome of patients treated with MIPO technique for closed distal tibial fractures.

MATERIAL AND METHODS

Seventy three cases of multi-fragmentary fractures of the distal tibia admitted in Bahawal Victoria Hospitals, Bahawalpur between April 2009 and October 2010 were studied with informed consent. Duration of follow-up ranged from 9–16 weeks. Only closed fractures were included in the study.

All the patients received first aid in casualty with thorough examination to rule out associated injuries. Patients were subjected to routine pre-anaesthetic investigations and additional investigations when indicated. Standard antero-posterior and lateral radiographs were taken as shown in Figure-1 and 2.

Surgery was performed under regional anaesthesia and with a tourniquet in the supine position. A small incision was made on one end of the fractured comminuted area without disturbing the soft tissue envelope of the fractured fragments. The incision was extended right up to the bone with the periosteal tube. A sub-periosteal tract is made along the surface where the plate was going to be applied and extended across the fracture to the other side. The tract was made with a special doubly angled periosteal elevator available in different sizes. At times the tract was made with the plate to be used itself. The plate used depended on the anatomy and location of the fracture. A narrow tibia DCP was used for fractures of the diaphysis and either a T-buttress or a clover leaf plate is used for the distal tibia fractures. Once the tract was made, an appropriate length plate was selected so that at least 6–8 cortices hold could be obtained on either side. A contoured plate was made to slide along the previously created tract. With the plate in-situ and some traction given manually the alignment was checked using the standard anterior superior iliac spine-centre of patella-second toe guide line. An X-ray was taken to check the alignment radiologically and also to confirm the length of the plate, if it is appropriate. The plate was fixed at one end with appropriate screws (4.5 mm cortical or 6.5 mm cancellous). Initially only one screw was passed and maintaining the plate bone contact and the alignment the remaining screws were passed. With the fracture reduced by indirect means without opening the fractured area by gentle external manipulations, the distal end of the plate was marked. The plate was fixed distally with percutaneously introduced screws. The alignment was checked all the time. Use of bone holding forceps was avoided. Careful handling of the soft tissues and judicious use of the retractors is a must. No primary bone grafting was done irrespective of the comminution. All patients received cefuroxime 1.5 g at induction followed by 750 mg at 8 hours and 16 hours postoperatively and analgesia. Physical therapy was commenced first day postoperatively.

Post operatively limb was elevated with ankle and knee range of motion started once pain subsided. Toe touch weight bearing was allowed initially with full weight bearing only with good clinical and radiological evidence of progressive fracture healing. Radiographs were assessed for evidence of union. Fracture union was defined as radiological evidence of bridging mature callus combined with clinical union as evidenced by pain free full weight bearing.

Data were analysed for patients' demographic parameters, injury surgery interval, operative time, time of radiological union and time of full weight bearing capacity.

Figure-1: Pre-operative radiograph of comminuted lower third fracture tibia

Figure-2: Preoperative X-Rays Film showing distal tibia fractures

RESULTS

A total number of 73 patients were operated upon. Age of the patients ranged from 25–60 years, mean being 37.2 years as shown in Table-1. Fifty-three (72.6%) cases were due to road traffic accident (Table-2). Most (47) cases below 50 years of age were victims of RTA and 2 cases above 50 years of age were victims of assault (Table-3). Most of the cases involved in high velocity accident were in the 31–50 years age group. There were no cases with intra-articular extension. Seven cases had associated injury resulting from the same trauma. The injuries noted were fracture of radius ulna, Hoffa's fracture, fractured ribs, fracture pubic rami, contra-lateral fracture tibia. There were 2 cases with associated head injury.

The average injury surgery interval was 10.75 days with 54.7% cases operated in the period of 9–14 days injury as tabulated in Table-4. The average

operative time was 75 minutes (Table-5). Operative time reduced as experience was gained during the study. Healing of the fracture occurred with formation of callus. All fractures went to union. The 49 (67.1%) cases showed union between 9 and 12 weeks, while 24 (32.9%) showed union between 13 and 16 weeks (Table-6). Average period of union was 13 weeks. Average time taken for full weight bearing was 13.6 weeks (Table-7). It was more for cases with bilateral limb injuries. There was a single complication in the form of superficial infection secondary to skin necrosis treated with local debridement and antibiotics. There was no case of delayed union, non-union, implant failure or any significant deformity.

Sixty-eight (93.1%) cases had excellent outcome while 5 (6.9%) had excellent to good outcome regarding radiological appearance. No case required bone grafting.

Table-1: Age and sex distribution of cases

Age	Male	Female	%
21–30	22	—	16.4
31–40	44	7	46.5
41–50	14	2	21.9
51–60	10	1	15.0

Table-2: Mechanism of injury

Mechanism of injury	No. of cases	%
RTA	53	72.6
Assault	12	16.4
Fall	8	10.9

Table-3: Relation between age of patient and cause of fracture

Age	RTA	Fall	Assault
<50	47	3	10
>50	6	5	2

Table-4: Injury surgery interval

Injury surgery interval	Cases	%
5–8 days	24	32.8
9–14 days	40	54.7
>15 days	9	12.3

Table-5: Operative time

Time	Cases	%
<90 min	64	87.6
>90 min	9	12.3

Table-6: Period of radiological union

Period in weeks	No. of cases	%
9–12	49	67.1
13–16	24	32.9

Table-7: Time at which full weight bearing achieved

Period in weeks	Cases	%
9–12	45	61.6
13–16	28	38.4

DISCUSSION

The biological plating was done for first time by Boitzy and Weber, but it has gained popularity in the 1980's. The development of indirect reduction techniques (Mast *et al* 1989), the development of wave plate (Brunner and Weber 1981) and the bridging plate (Heitemeyer *et al* 1985) brought about a basic change to fracture treatment using plates.[17] Minimally invasive plating technique reduces the iatrogenic soft tissue injury and damage to the vascular bone as well as preserves the osteogenic fracture haematoma which is essential to prevent the potentially severe complications.[18] Majority of our cases sustained the tibial fracture after high speed road traffic accident, which are the major cause of the tibial fractures worldwide.[1] Timing of the operative intervention is controversial with advocates for both immediate and delayed surgery.[19,20] In Shrestha *et al* study, surgery was performed within a mean duration of 4.45 days.[21] Because of the financial and administrative constraints in our setup, 54.7% of our cases had to wait for 9–14 days while in 12.3% cases surgery was performed after 15 days. There is evidence in literature that suggests that delayed interventions makes accurate surgical reduction more difficult.[22]

In our study 67.1% of the cases showed radiologic union in 9–12 weeks while in 32.9% it was in 13–16 weeks. Theses results are quite comparable to other studies. Ksekili *et al* reported a mean duration of radiological union to be 20.7 weeks (range: 16–28 weeks) in open and 17.96 weeks (range: 10–36 weeks) in closed fractures.[23] While Shrestha *et al* reported an average duration of 18.5 weeks (range: 14–28 weeks) for the fracture segment union.[21] In studies of Helfet *et al*[24], Hazarika *et al*[17], and Eid A[25], fracture union result was 100%. In series Helfet *et al*[24] and Hazarika *et al*[17] there was two stage procedure first they applied external fixator to convert open fractures to close fractures and in 2nd stage MIPO for the close fracture fixation. While Eid used was an anatomical prebent plate rather than a manually contoured plate that we used in our study.[17,24,25] In our study full weight bearing was achieved in 9–12 weeks in 61.6% of the cases and in 13–16 weeks in the rest of 38.4% cases. This observation is also comparable to the other studies.[23] The operative time in our study was under 90 min in 87.6% of the cases while in 12.3% of the cases operative time exceeded 90min duration.

CONCLUSION

MIPO is an effective technique for the management of distal tibial fractures. It is minimally invasive, though technically demanding, but preserves the biological environment by preserving the soft tissue with better outcome in terms of radiological union and weight bearing.

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