ORIGINAL ARTICLE

Per Cutaneous Plating Through Multiple Stab Incisions in Comminuted Fractures of The Tibia-A New Technique

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ABSTRACT

Introduction: A study to assess the role of minimally invasive plate osteosynthesis (MIPO) in the treatment of 24 adult patients of comminuted fractures of the tibia is presented.

Materials & Method: It was a prospective and interventional study of clinical cases being operated with minimally invasive plate osteosynthesis. However a new technique with multiple stab incisions was used.

Results: There were 4 cases of proximal tibial fractures, 17 cases of diaphyseometaphyseal fractures and 3 cases of distal tibial fractures. All were treated with "Biological Plating" techniques using indirect reduction methods, with limited operative exposure, without opening the fracture site. A new multiple stab technique was used to fix these fractures. All cases went on to union. 62.5% cases showed radiological union between 14 and 18 weeks and remaining 37.5% in 19 and 23 weeks. 82.3% cases went to full weight bearing in 23 weeks. 8 cases required bone grafting. Incidence of complications was very low, with only 6 cases of superficial infection, delayed union, non union, implant failures. Range of motion at knee and ankle joint was excellent.

Conclusion: The functional outcome for long term result were rated using points, revealed excellent to good outcome in 83% cases with fair result in 17% patients.

INTRODUCTION

The treatment of comminuted fractures of long bones has continued to be a problem in orthopedic surgery over the past ten years, the concept of bridging plate osteosynthesis has been progressing for multifragmentary shaft fractures. The technique minimises the soft tissue trauma to the injured zone which theoretically preserves a better blood supply around the fracture area[1]. Since the damage to the soft tissues and the blood supply is less extensive, more rapid fracture healing can be achieved. High energy trauma causes endosteal blood flow damages[2]. During fixation of fractures by plating or open methods periosteal blood flow further decreases. Plate osteosynthesis is recognized as the treatment of choice for most articular, many metaphyseal and a few diaphyseal fractures. Among various techniques for fixation interlocking intra-medullary nailing is frequently called the golden treatment in comminuted long bone fractures. It is not without limitations, namely its inapplicability in diaphyseal fractures extending into metaphysis and neighbouring joint, requirement for expensive dedicated instruments, large radiation hazards during prolonged C-arm usage during nailing. Nailing takes a longer time for operation and there are more chances of fat embolism during reaming. The proponents of nailing find them biological and useful in open fractures. All forms of biological fixation techniques respect soft tissue envelop, keep multi-planer alignment of the bone, maintain length while allowing some micro-motion at fracture site[5]. Average duration of surgery for closed intra medullary nailing is two hours and average reported blood loss with biological fixation is 740 ml[6]. The objective of biologic fixation is to assist physiological process of bone healing wisely and optimally with minimal amount of operative intervention[7-12]. Stress is laid on maintaining a balance between devascularisation and mechanical perfection. Biological plating techniques are those in which blood supply to the fractured fragments is maximally preserved.

The first attempts of biological plating dates back to initial efforts of Boitzy and Weber later it gaining popularity in the 1980's[13]. 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[14]. Conventional plating techniques if applied to multifragmentary fractures lead to a variety of

complications like delayed union or non-union, infection and implant failure[14-6]. Biological fixation principles can be summarized re-positioning and realigning of the fracture without directly opening the fracture site and its fixation with mechanical construct, while preserving their blood supply. The exposure is limited and the implants used should have a low elasticity modulus, are biocompatible (e.g plate) and surgical exposure.

Minimally invasive plate osteosynthesis (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[16]. The stress is upon minimal opening of the skin maintaining sanctity of fracture hematoma. Advantages cited for MIPO a simpler technique, no additional instduments required (can be done with plating sets), improved union rates, decreased chances of infection, utility in multiply injured, early mobilisation and low incidence of refracture after plate removal. Both nailing or classical plating are in vogue at present. However need for MIPO technique does arise frequently.

Objectives:

To assess prospectively the results of minimally invasive plate osteosynthesis with a multiple stab incisions used for treatment of fracture tibia. All complications witnessed during this period were noted and evaluated.

MATERIAL AND METHODS

Twenty four (24) cases of comminuted fractures of the tibia admitted in Lahore General Hospitals, Lahore between April 2008 and April 2009 were studied. Duration of follow-up was one year. Only closed or grade I open fractures were included. All cases received first aid in casualty with thorough examination to find out associated injuries. Standard anteroposterior and lateral radiographs of the injured part were taken. Above knee back slab was given in all cases temporarily. The patients having other bony or soft tissue injuries were treated appropriately. Since usually long plates are required to span the comminuted area a prior estimation was made. Surgery was performed under general/regional anaesthesia and with a tourniquet in the supine position. A small incision was made on subcutaneous surface of tibia over the distal fragment, the fractured comminuted area without disturbing the soft tissue envelope of the fractured fragments. The incision was deepened up to the bone. A subcutaneous tract was made along the surface where the plate was going to be applied and tunnelled across the fracture to the proximal side. The tract was made with a special double angled periosteal elevator available in different sizes. Sometimes the tract was made with the plate itself. The choice of the plate to be used depended on the anatomy and location of the fracture. An L or T buttress plate was used for proximal metaphyseal and diaphyseo-metaphyseal junctional fractures. A narrow tibia DCP was used for fractures of the diaphysis and either a T buttress or a clover leaf plate was used for the distal tibia fractures. Once the tract was made an appropriate length plate is selected so that at least 6 to 8 cortices hold was obtained on either side of fracture. 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 (under an Image intensifier in some cases). Smallest possible incision was made to slide the plate into the subcutaneous tunnel. The plate was fixed at one end with a screw (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 are passed through small stab incisions directly over the palpable holes in the plate . Use of bone holding forceps was avoided. Careful handling of the soft tissues was practiced. No primary bone grafting was done irrespective of the comminution. Contouring of the plate is necessary especially for fractures of the lower end of the tibia where the plate has to be correctly contoured with approximately 25 degrees of medial angulation and 20 degrees of external rotation[17] .The plate can be slid on either the medial or the lateral aspects of the tibia in the proximal end depending on the fracture geometry but for the lower end it is applied on the anteromedial surface. Associated fibular fracture was fixed additionally only in two cases of the fracture of the distal tibia to maintain length. Post operatively limb was elevated. Above knee back slab was given for 4 to 6 weeks in some case. Isometric exercises of the knee were started as the pain sub sided. Ankle and knee range of motion started after removing the back slab. Toe touch weight bearing was allowed initially, followed by full weight bearing as the radiological evidence of progressive fracture healing was achieved. Long term results were evaluated by modifying the Neer's rating system[18].

Table 1: Period of radiological union

Period of radiological union		
Period in weeks	**No. of cases**	**%**
14-18	12	50
19-23	8	33
24-28	4	17

RESULTS

A total number of 24 patients were operated upon. Eleven(45%) cases were due to road traffic accident, 8 (33%) cases were due to domestic fall and 5 (22%) cases were due to low velocity gun shot injury. There were 18 (75%) closed fractures while remaining 6 (25%) were grade I open (Gustilo Anderson classification). Maximum number of fractures 17 (70%) occurred in the diaphyseal segment, while 4 (18%) in the distal tibia and 3 (12%) in the proximal tibia as classified by the AO group. There was no case with intra-articular extension. Ten cases had other associated injuries resulting from the same trauma. The average injury to surgery interval was 7.75 days with 62% cases operated in the period of 1-10 days after injury. The average operative time was 40 minutes. Healing of the fracture occurred with formation of callus. All fractures went to on union. Fifty percent cases showed union between 14 and 18 weeks, while 33.3% showed union between 19 and 23 weeks. Average period of union was 17.63 weeks. Average time taken for full weight bearing was 19.6 weeks. It was relatively more for cases with bilateral limb injuries. 83.3% cases achieved full weight bearing by 23 weeks Fig 1,2. Average period for hospital stay was 8 days. There were four complications in the form of superficial infection secondary to skin necrosis treated with local debridement and antibiotics. There were 4 cases of delayed union, non-union, implant failure or significant deformity of the implants. Infection in two patients was treated with appropriate antibiotics. Two cases with implant failure needed revision with inter locking nail and bone grafting later. Two cases with delayed and non union required bone grafting done after 3 months of initial surgery. All cases went to union.

Long-term final results were rated using point system for pain, function, work ability, joint movement, and radiological and gross appearance. Twenty one (83%) cases had excellent to good outcome.

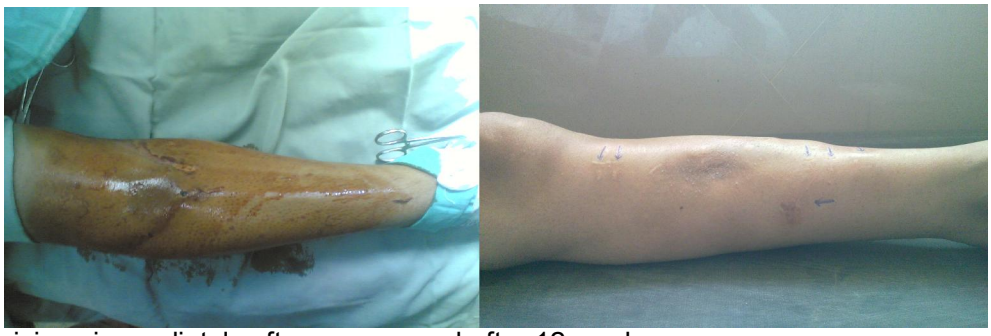

Fig 1: Skin incisions immediately after surgery and after 12 weeks.

Fig 2: Serial X-rays of the same case.

DISCUSSION

The management of complex multifragmentary fractures of long bones has continually been a problem for the orthopaedic surgeons. They have been treated by conservative methods earlier in the form of casts or traction but poor results with regard to joint motion and prolonged recumbence were the problems. Closed methods have also been condemned for the treatment of bilateral extremity fractures and in the multiply injured person[19-20]. Interlocking nailing is also an established method in the treatment of comminuted diaphyseal fractures. Conventional plate osteosynthesis is known to lead to non union, delayed union, increased chances of implant failure, etc in some cases. Despite the belief that soft tissues should be preserved during open reduction of fractures, surgeons traditionally have sought to achieve maximum stability regardless of the impact it might have on the soft tissues[12] Concept of biological plating techniques evolved for treating comminuted fractures of shaft of tibia fractures where interlocking nailing could not be done. Our study results show that the technique results in good results Table 1,2. Baumgaertel et al[21] demonstrated that indirect reduction and bridge plating was superior to direct fragment reduction and anatomical fixation in according to radiological, biomechanics and micro-angiographic evidences. Faster gap filling and callus formation was shown beginning in the second or third week in indirect reduction, and in the sixth week in direct reduction. In 1994, Baumgaertel and Gotzen[22] showed that in classic fixation 80% of the arteries were damaged, but in biological fixation these vessels remain intact. In the study of Tahmasebi et al [23], in which 15 patients with closed comminuted fractures of the femur or tibia were treated through bio-logical fixation. There was no mal-union, non-union or complication, and they found this method to be useful. Finally, Sarafan et al [24] showed that biological fixation is an appropriate method for closed comminuted fractures of long bones, yet is not suggested in open fractures due to the high rate of infection. Minimally invasive plate osteo-syntheses is on the contrary the treatment of choice in peri-articular multi-fragmentary fractures. No special instrumentation is required. It can be used in the transition zone fractures where interlocking nailing is very demanding because of the notoriously poor rotational control of interlocking screws in the metaphyseal flare of the long bone.

Table 2: Functional Outcome.

Functional outcome		
Rating	**No. of cases**	**%**
Excellent	8	33
Good	12	50
Fair	5	17
Poor	0	0

In present study 83% of cases showed excellent to good outcome with the time to full weight bearing union averaging 17.63 weeks. The disparity between the period for full weight bearing and the period of union being mainly because of the presence of other associated injuries which delayed mobilization. Helfet D et al [25] in their study of distal tibial fractures treated with MIPO had no loss of fixation or evidence of hardware failure. There were 7 cases of delayed union, deformity and superficial cellulites. All 32 cases showed union. Radziejowski et al [26] in their study of 22 cases of proximal tibial fractures have also shown good results with union occurring in 12 to 24 weeks. Johner and Wruhs[27] reported a significant increase in complications as progressively higher energy fractures are treated with open reduction and conventional internal fixation. Complications increased from 9.5% for torsion to 48.3% for comminuted fractures. Likewise the infection rate increased from 2.3% for torsion fractures to 10.3% for comminuted fractures. Nonunion was twice as common and infection five times more likely when open fractures were treated with plating. Minimally invasive plate osteosynthesis, on the contrary, is the treatment of choice in periarticular multifragmentary fractures. Equally good results can be expected as far as union and early mobilization are possible. No large series has been done to evaluate the MIPO technique for comminuted fractures. Hence, at present one cannot comment regarding its status as compared to interlock nailing. It needs further evaluation but the beginning is definitely encouraging. With longer follow-up and a larger number of patients, it seems that the minimally invasive technique of plate

osteosynthesis for the treatment of multifragmentary fractures of the lower extremity will prove to be a feasible and worthwhile method of stabilization.

CONCLUSION

From the present small prospective study with a relatively short follow up it can safely be concluded that multiple stab incision technique of passing a subcutaneous plate for minimally invasive plate osteo-synthesis can be safely used to treat most unstable comminuted closed or grade I open fractures of Tibia. Further large scale studies would be desirable.

Disclaimer:

The authors declare lack of any conflict of interest in this research project.

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