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MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS: A REVIEW

Orthopaedics

Dr. Rajnish Kumar Senior Resident, Department of Orthopaedics, ANMMCH, Gaya.

Dr. Shailender Kumar* Associate Professor, Department of Orthopaedics, ANMMCH, Gaya. *Corresponding Author

Dr. S P Singh Professor, , Department of Orthopaedics, ANMMCH, Gaya.

ABSTRACT

Present-day concepts of osteosynthesis emphasize upon biological healing of fractures. This has led to advent of minimally invasive plate osteosynthesis. This technique if used when indicated leads to numerous advantages such as higher rates of unionwith decreased surgical time, blood loss, post-operative pain, infection rates and certain otherpostoperativecomplications. Thistechnique is being applied commonly in fractures such as shaft of humerus, proximal and distal femur, proximal and distal tibiawith several benefits over its conventional counterparts. In this review, the authors highlight upon historical aspect ofdevelopment of this technique, its implementation in different fractures, various factors determining its stable application and itspearls and pitfalls.

KEYWORDS

Distal tibial fractures; locking plates; MIPO

INTRODUCTION:

Management of distal tibial fractures remains challenging[1]. They are usually the result of high energy axial compression and rotational forces. Soft tissue compromise is often severe[2]. Several methods of treatment are implemented including non-operative treatment, external fixation, intramedullary nailing, and internal fixation with traditional implants (standard screws and plates). History of plating dates back to 1886 when the first reported use of a plate for internal fixation of fracture was accomplished by Hansman[1]. The science of plating flourished for several years till the early twenties following an era of disfavor. Plating returned to vogue following the introduction of revolutionary concepts by Muller. He and his colleagues, under the banner of Arbeitsgemeinschaft für Osteosythese (AO) foundation laid down the concepts of operative fixation of fractures. Complete restoration of the bony anatomy under direct vision during fracture fixation was the rule. This resulted in direct fracture healing with absolute stability[2]. But, this came at a price. The price was the risk of bone or soft tissue necrosis and delayed healing as there was widespread soft tissue dissection and interruption of periosteal blood flow[3]. The evolution of MIPO began with the use of bridge plating[8]. In initial days a conventional plate was applied for comminuted femoral fractures using long incisions but with preservation of the vastus lateralis muscle resulting in healing with abundant callus[9]. Subsequently, the size of incisions got decreased, rather two small incisions were given at proximal and distal ends and plates were bridged sub muscularly over the fracture fragments[10-12]. This technique causes minimal distress to soft tissues and bone, provides access to the bone through soft tissue windows, with minimal or no contact with the fracture by indirect reduction tools and leaving behind minimal foot prints. The study focuses over various aspects of application of MIPO technique used in commonly indicated fractures, along with factors influencing its mechanical stability, recent advances and its downside. What are the indications of MIPO? Although minimally invasive approach for plating bears numerous advantages, due to its limitations it is not universally applicable. A careful preoperative planning is required prior to its implementation with bearing in mind the anatomical aspect of the fracture, condition of soft tissue, etiology of the fracture, type of construct required and date since injury. Indications for MIPO have been summarized by Babst and Khong[12]:

epi-/metaphyseal fractures;

- poor soft tissue condition obviating an open procedure;
- conditions where intramedullary nailing is not feasible: unsuitable fracture pattern (intra-articular extension), narrow, deformed or obstructed intramedullary canal;
- cases in which intramedullary reaming is contraindicated or can be detrimental (polytrauma patients with respiratory compromise);
- fractured bones with other implants or prosthesis in situ;
- Settings where of an image intensifier is not available.However, each of these treatment options is associated with certain challenges[3]. Non-operative treatment requires prolonged immobilisation and may be complicated by loss of reduction and subsequent malunion[4]. External fixation may lead to pin-track infections, septic arthritis, malalignment, and delayed union[5]. Intramedullary nailing problems include the technical difficulties with distal nail fixation, the risk of nail propagation into the ankle joint, and the discrepancy between the diaphyseal and metaphyseal diameter of the intramedullary canal. Open reduction and internal plate fixation results in extensive soft tissue dissection which may result in wound complications and infections[3].MIPO technique for distal tibial fractures offers several theoretical advantages such as mechanically stable fracture fixation and less disturbance of the fracture site haematoma and the surrounding soft tissues[6].The aims of this study were to assess the outcome of patients treated with MIPO technique for open or closed distal tibial fractures with specific reference to fracture union, implant failure or other surgical complications.

PATIENTS AND METHODS:

We conducted a multicentred; retrospective study of 54 consecutive patients from two institutions treated with MIPO using the distal tibial locking plate for open or closed distal tibial fractures and followed them up a period of 12 months (SD±4.7). Case notes were analysed for patients' demographic parameters, follow-up reviews and complications. Radiographs were assessed for classification of fractures and evidence of union. Fractures were classified according to the AO classification system. Open fractures were graded using the Gustilo and Anderson classification[7]. The operations were performed by four different surgeons. However, all patients received cefuroxime 1.5g at induction followed by 750mg at 8 hours and 16 hours postoperatively. Deep vein thrombosis prophylaxis was administered as per the units' protocols. Physical therapy was commenced first day postoperatively. Fracture union was defined as radiological evidence of bridging mature callus combined with clinical union as evidenced by pain free full weight bearing. Delayed union was defined as healing of the fracture between 5-9 months and non-union was considered when no evidence of healing was detected after 9 months from the operation[8]. Patients with a clinical rotation difference of >15° and a clear rotation difference between both legs as assessed on the radiographs by a senior orthopaedic trauma surgeon were considered to have rotational malalignment.

RESULTS :

There were 54 patients in the study including 36 males and 18 females of mean age 45 years. According to AO classification; there were 44 patients with 43A type fractures, one 43B, two 43C and two 42A type fractures. The commonest cause of injury was high-energy trauma. Twenty four patients had closed fractures and 54 patients had closed reduction. All patients were fully weight bearing at a period of 8 weeks (SD ±5.0) after surgery. The mean time to union was 4 months (SD ±1.9). There was one non-union in a 38-year-old heavy smoker who

sustained a 43A type closed fracture and was treated with the standard MIPO technique after closed reduction of the fracture. The patient was managed with a non weight-bearing plaster for 4 weeks then partial weight-bearing for 6 weeks followed by full weight bearing. At 5 months postoperatively, there was no evidence of clinical or radiological union and the patient underwent autologous bone grafting from the iliac crest. At 9 months postoperatively, there was still no evidence of radiological union and the patient had pain on weight-bearing. He had normal inflammatory markers and tissue biopsy from the fracture site was negative for infection. There was a delayed union at 7 months in another heavy smoker who was 46- year-old and sustained an open Gustilo I 43A type fracture. He was treated using MIPO after closed reduction and was allowed full weight-bearing at 11 weeks follow-up. Another patient aged 46 years and a heavy smoker showed delayed union at 8 months postoperatively. He had an open Gustilo I 43A type fracture treated by wound debridement and application of locking plate by MIPO technique. The third patient in the open fractures group was a 28 years old patient who presented with persistent pain around the distal end of the scar after sustaining a Gustilo I 43C type fracture which was treated with MIPO technique after closed reduction. He had an area of osteolysis around the distal screw which was subsequently removed with no further problems. There were two superficial wound infections which were treated with oral flucloxacillin and progressed to union. There were no failures of fixation or implants and no rotational malalignment on clinical and radiographic evaluation of the patients.

DISCUSSION :

MIPO technique has become widely practised in the operative management of articular, metaphyseal and transitional zone fractures over the last few years[9]. It has the advantages of respecting soft tissue via small skin incisions, minimal surgical dissection, indirect fracture reduction and minimal hardware application. As a result, healing time is accelerated, and complication rates are low[10]. MIPO is easy to insert and gives better results with respect to alignment correction. However, there is a learning curve and practising the open technique initially is advisable[10]. Adequate preoperative planning is mandatory, as well as accurate surgical timing in secondary skin compromise[11]. Mechanism of action depends on principles of "biological internal fixation" where the aim is to produce the best biological conditions for healing rather than absolute stability of fixation which usually requires a fairly extensive surgical approach to the bone. This takes advantage of indirect reduction of the fracture and application of a bridging plate with minimal screw insertion through stab incisions to fix the plate. The plate functions purely as a splint rather than causing compression of the fracture. The resulting flexible stabilisation has been shown to give early solid union by callus formation[12]. Our study supports this finding with all patients able to fully weight bear at 8 weeks and achieving union at an average period of 4 months after surgery. This is consistent with results from other studies[6] where union was achieved at 22.4 and 23 weeks follow-up respectively. Complications of nonunion and delayed union in our case series may be associated with heavy smoking; a well recognised factor that inhibits bone and soft tissue healing[13,14]. In this study, we had two cases of superficial wound infection, which were treated with oral antibiotics, and no cases of deep infection or revision fixation. These results are also similar to those previously reported in the literature[15] by Stromsoe et al who reported stable osteo-fixation and no soft tissue complications affecting the final result in any of his patients.

CONCLUSION:

MIPO technique is an effective method of treatment for fractures of the distal tibia. The use of indirect reduction techniques and small incisions is technically demanding but decreases surgical trauma to soft tissues.

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