

PROSPECTIVE STUDY OF BIPLANAR FIXATION FOR TYPE V AND TYPE VI CONDYLAR FRACTURES OF TIBIA BY MIPPO TECHNIQUE

Anbu Srinivasan¹, Karunanithi Subramanian², Palaniappan Mathivanan³

¹Associate Professor, Department of Orthopaedics, KAP Viswanatham Government Medical College/MGM Government Hospital, Trichy.

²Assistant Professor, Department of Orthopaedics, KAP Viswanatham Government Medical College/MGM Government Hospital, Trichy.

³Professor, Department of Orthopaedics, KAP Viswanatham Government Medical College/MGM Government Hospital, Trichy.

ABSTRACT

BACKGROUND

Treating complex Tibial Plateau Fractures has often proved to be a nightmare for the operating surgeon. Treatment has evolved from non-operative treatment previously to relatively rigid internal fixation at present. The primary aim of treatment is to achieve early bony union and to allow early mobilisation of the knee joint, thereby minimising the risks of joint stiffness. Recent interests in the fixation of the fracture have been to provide biological fixation by optimising fracture environment in order to improve fracture healing and to minimise complications. This led to evolution of Indirect Reduction and Minimally Invasive Plate Osteosynthesis (MIPO), illustrating the importance of preservation of bone biology. Locking plate principle has galvanised internal fixation of these fractures with a minimal invasive approach (MIPPO).

MATERIALS AND METHODS

This is a case series study carried out in KAP Viswanatham Government Medical College/MGM Hospital, Trichy between 2011 and 2014; 40 patients with type V and VI bicondylar fractures of the Tibia satisfying the following criteria were included in our study. X-rays and 3D CT were taken to analyse the fracture morphology. We used proximal tibia locking plate using 4.5/6.5 system on lateral side and 3.5 system on medial side by medial and lateral and distal midline MIPPO (3 cm) incisions (Locking plates were inserted subperiostally). Functional outcome was assessed by HSS (Hospital for Special Surgery) score.

RESULTS

36 cases went for good bony union. Three cases went for non-union, of which one subsequently united with bone grafting, one case which was fixed a week after injury ended up with loss of reduction for which re-fixation was performed and still went for non-union and one case in which bone grafting was done still went for non-union had to be fixed with Ilizarov fixator. One case got infected and implant was removed and external fixation applied. No implant failure was seen in our series. Most patients could start partial weight bearing within 8 - 12 weeks of plating. Average hospital stay of the patients in our studies was 5 - 10 days. The average range of motion in affected knee in most patients was 110 degrees to 130 degrees 2 years after surgery.

CONCLUSION

From our study, we conclude that MIPPO technique preserves vascularity of the fractured bones and significantly preserves the fracture haematoma (which is proved in many studies is very important for early union), thus aiding biological repair as suggested by BO rules. MIPPO also allows for early mobilisation of the knee, which in turn allows for restoration of good range of motion. It has to be kept in mind that MIPPO signifies "as minimal surgical trauma to the soft tissues as possible and does not effectively mean operating through small incisions."

KEYWORDS

MIPPO, Bicondylar Fractures of Tibia, Biplanar Fixation, HSS Score.

HOW TO CITE THIS ARTICLE: Srinivasan A. Subramanian K, Mathivanan P, A prospective study of biplanar fixation for type V and type VI condylar fractures of tibia by MIPPO technique. J. Evolution Med. Dent. Sci. 2017;6(37):3024-3029, DOI: 10.14260/Jemds/2017/652

BACKGROUND

Treating complex Tibial Plateau Fractures has often proved to be a nightmare for the operating surgeon. Treatment modalities have changed enormously in the last few years.^(1,2,3,4,5,6,7,8,9,10,11,12) It has evolved from non-operative treatment previously to relatively rigid internal

fixation^(2,3,5,9,10,13) at present. Kruttek et al suggested the need to obtain relative stability rather than absolute stability of the fracture. Their study has suggested minimal interference with the zone of the injury for obtaining good results. This is achieved by sliding plates in the submuscular plane on the lateral side of the femur (Minimally invasive percutaneous plate osteosynthesis MIPPO).^(14,15,16,17,18,19) Mast et al were the first to report the importance of reduced surgical dissection of the fracture site and manoeuvre the surrounding soft tissues for facilitating fracture reduction.⁽¹³⁾ This was coined as indirect reduction of the fracture. This technique preserves the blood supply to the bone ends and thereby reduces non-union rates.^(13,14) The primary aim of treatment is to achieve early bony union and to allow early mobilisation of the knee joint, thereby minimising the risks of joint stiffness. Numerous implants have been designed to achieve these goals, but results obtained have been varied.^(20,21) Earlier

Financial or Other, Competing Interest: None.

Submission 15-03-2017, Peer Review 25-04-2017,

Acceptance 01-05-2017, Published 08-05-2017.

Corresponding Author:

Dr. Karunanithi Subramanian,

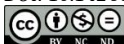
No. 6/1552, Plot No. 54 & 55,

Anand Nagar, No. 1 Tollgate,

Trichy-621216.

E-mail: rajjipmer@yahoo.co.in

DOI: 10.14260/Jemds/2017/652



days of fixation emphasised anatomic reduction and rigid internal fixation. To achieve this, extensive surgical approaches were used which compounded the soft tissue damage, which was already present.^(7,22,23,24) Recent interests in the fixation of the fracture has been to provide biological fixation by optimising fracture environment in order to improve fracture healing and to minimise complications. This led to evolution of Indirect Reduction and Minimally Invasive Plate Osteosynthesis (MIPO), illustrating the importance of preservation of bone biology.^(13,16,18)

This has led to modern fracture fixation techniques, which encourage the use of creating new implants which can be inserted with minimal soft tissue dissection but which provide relatively rigid fixation, thus preserving bone and soft tissue vascularity and aid in fracture union. These implants have been designed to allow early mobilisation and promote healing before implant failure⁽²⁵⁾ sets in by using latest biomechanical properties. The concept of locking plates has changed the way proximal tibial fractures are fixed. Locking plate principle has galvanised internal fixation of these fractures with a Minimal Invasive Approach (MIPPO). Minimally invasive technique has biological advantage not only for fracture healing but also for the whole body as demonstrated by damage control surgery in polytraumatised patients. As proximal tibia is a major weight bearing joint, its fractures are to be considered as serious injuries which mostly result in functional impairment. For preservation of normal knee function and range of motion, it is imperative to maintain joint congruity. This is a formidable task to accomplish, especially in the face of compromised soft tissues, variable bone quality, comminution of the fracture and associated medical conditions of the patients.⁽²⁶⁾ All the factors are to be considered and union has to be promoted by aiding the environment of the fracture region. Quoting the words of Girdlestone in 1932- "Where bone is a plant with its root in the soft tissue and when its vascular connections are damaged it often requires not the technique of the cabinet maker but the patient care and understanding of a gardener." It is understood that the vascular supply of the bone is the basis of all fracture healing. MIPPO has certain disadvantages like additional radiation exposure during application of the plate to the bone and screw fixation and therefore increase in operating time.⁽²⁶⁾ Type V and IV bicondylar fractures of tibia are difficult fractures to treat, the distinguishing feature of the bicondylar fractures is that of metaphysis and diaphysis discontinuity. Hence, the primary aim of surgical intervention should be restoring articular congruity and correcting the metaphyseal-diaphyseal dissociation.

MATERIALS AND METHODS

This is a case series study carried out in KAP Viswanatham Government Medical College/MGM Hospital, Trichy between 2011 and 2014. Ethical committee approval was obtained from our hospital for the study. 40 patients with type V and VI bicondylar fractures of the Tibia satisfying the following criteria were included in our study.

Inclusion Criteria

- Age group of 18 - 70 years.
- All cases of proximal tibial fractures, both intra-articular and extra-articular fractures.

Exclusion Criteria

- Open contaminated fractures.
- Pathological fracture.
- Cases with co-morbid factors/systemic diseases leading to inability to undergo surgery.

X-rays were taken in AP, Lateral and Oblique views and all fractures were classified using the Schatzker classification. 3D Reconstruction CT studies were used to analyse the fracture morphology. All the patients were evaluated for vascular compromise and those who were compromised were excluded from our study. Skin status was carefully evaluated.

We used proximal tibia locking plate using 4.5/6.5 system on lateral side and 3.5 system on medial side by medial and lateral and distal midline MIPPO (3 cm) incisions (Locking plates were inserted subperiosteally). Patients were followed up at 1, 2, 6 weeks, 3 months, 6 months and 2 years thereafter depending on the clinical and radiological progress. Union was defined as full weight bearing without pain and radiological callus in two planes at right angles to each other. The mean follow-up was for 11 months. Fractures were considered healed when mature bridging callus was identified on radiographs and patients reported no pain on weight bearing. Soft tissue outcome was assessed on the basis of presence of infection if any and wound dehiscence. Functional outcome was assessed by HSS (Hospital for Special Surgery) score.

Surgical Technique

The primary aim was to restore the joint congruity. Hence, firstly the articular portion of the Tibial Plateau was reduced, temporarily stabilised with K wires and cannulated screws inserted to hold the reduction in position. Locking plates were used to fix tibial condylar fractures; 4.5/6.5 mm system was used on lateral side and 3.5 mm system on medial side by medial and lateral and distal midline MIPPO (3 cm) incisions. Submuscular plane was developed and then plates were inserted and checked with using biplanar Image Intensification. All the patients routinely received IV antibiotics (Ceftriaxone) at induction and 5 days postoperatively.

Post-Operative Protocol

Two suction drains inserted through the distal incisions, one on each side (medial and lateral) was kept for 72 - 96 hours. Average collection of around 350 mL noticed in the drains, which prevent the occurrence of compartment syndrome by easing the tension due to fluid collection. Continuous Passive Motion was commenced immediately. Non-weight bearing walking with walker support started on the 3rd day post-op and continued non-weight bearing for 2 weeks, toe-touch bearing allowed from 4th week and full weight bearing started from 6th to 8th weeks depending on the progress of the fracture healing as evident by radiology. Physiotherapy was started depending on the pain tolerance by the patient in the form of static quadriceps exercise and knee bending exercises as early as possible. Pain relief was given by prescribing analgesics to motivate patient to do active exercises. To prevent stiffness, patients were advised early mobilisation.



Figure 1. Case 1. Pre-Op



Figure 4. Case 3. 3 Months PO



Figure 2. Case 1. 3 Months PO



Figure 5. Case 4. Immediate PO



Figure 3. Case 2. Immediate PO

RESULTS

Majority of the patients in our series belonged to age group of 20 - 60 years with average age of 40 years. Majority of the patients in our study belonged to young and middle aged men in their prime of health and belonging to the working class. Road traffic accident was the most common cause of proximal tibial fractures in our study. They are usually high velocity injuries. In our study, right side injuries were more common than left. Majority of the patients in our series were males, forming 80% of our cases. Since this is mostly high velocity injury, males who most likely stay outdoors for considerable amount of time are more vulnerable, except in very old age fall at home does not usually produce proximal tibial fractures type V and VI. Fall from height is the second most common mode of injury following RTA in our study. Among vehicular accidents, motorcycle accident is likely to produce type V and VI Schatzker tibial condyle fracture. In 90% of the cases, there was associated fibular fracture.

Of late, most patients get admitted on the day of injury. In our study, 80% cases got admitted within 24 hours of injury and all patients within 72 hours of injury. All cases were on the same protocol of evaluation, comprising x-rays and 3D CT. Articular congruity maintenance was the primary aim in our fixations. The articular congruity was studied and in cases without depression or articular fragment loss, it was fixed with cannulated screws to prevent future loss of reduction and congruity. In 10 cases, we had considerable loss of articular surface in which we used iliac bone graft for articular surface elevation to obtain perfect reduction. 36 cases went for good bony union. 32 cases united within 12 weeks, two cases went for delayed union and two cases which we treated by internal fixation following fasciotomy got superficial infection, which healed with antibiotics. Three cases went for non-union of which one subsequently united with bone grafting, one case which was fixed a week after injury ended up with loss of reduction for which re-fixation was performed and still went for non-union and one case in which bone grafting was done still went for non-union had to be fixed with Ilizarov fixator. One case got infected and implant was removed and external fixation applied. No implant failure was seen in our series. Three cases healed with secondary varus deformity and one case with medial articular surface incongruity. Proximal Tibial Injuries are high velocity injuries that mostly produce enormous swelling and severe soft tissue injury. Compartment Syndrome occurrence is quite common in such high velocity injuries. In such cases, it is only normal to expect complications in closure of surgical wounds and future wound healing. Since we used MIPPO technique, we did not encounter major problems with skin closure. Two cases went for superficial infection after fasciotomy for compartment syndrome, but healed with antibiotics. In most of the patients, surgical incisions healed by primary intention, which suggest that adequate soft tissue healing has occurred and overall good quality surgical techniques have been used. Better preoperative assessment and even better postoperative care with appropriate antibiotic coverage has played a vital role in post-op healing of the wound. Most patients could start partial weight bearing within 8 - 12 weeks of plating; 32 patients had started full weight bearing mobilisation exercise within 12 - 16 weeks of plating and four other patients started full weight bearing by 18 weeks. Average hospital stay of the patients in our studies was 5 - 10 days. Only two patients had to stay for extended time for superficial infection clearance. The average range of motion in affected knee in most patients was 110 degrees to 130 degrees 2 years after surgery. In 36 patients, the average HSS score in our patients was 90 suggesting excellent result. In two patients, the HSS score was 78 suggesting good result. In two cases, HSS score was 70 suggesting fair result.

DISCUSSION

High energy proximal tibial fractures cause severe soft tissue damage. Displaced fractures of the proximal tibial condyles of type V and VI are difficult to treat. The goal of the treatment of intra-articular fracture of proximal tibia is to restore joint congruity as much as possible for restoration of the near normal painless joint function. Conventional open reduction and internal fixation further compounded these damages resulting in complications like wound breakdown and

superficial and deep infection of the surgical site.^(27,28) The aim of MIPO in the treatment of the complex proximal tibial fractures are rapid and optimal healing, minimisation of any soft tissue complication and loss of function and the prevention of non-union or malunion.^(29,30)

Intramedullary nailing in proximal tibial fracture is ruled out because of the misalignments in coronal and sagittal planes. Stability in nailing is also insufficient due to the geographic characteristics of proximal tibial shaft fractures.⁽³¹⁾ The problems of non-union and pin track infection make small wire external fixator a difficult proposition in these cases.^(32,33) These factors make locked plating as an attractive option for treating these complex fractures of the proximal tibia and with MIPO developing in technique and utility, the popularity of locking plates for the treatment of these complex fractures has significantly increased. Choosing appropriate length of the plate to entirely span the diaphyseal segment is the key for mechanical sound fixation, which is the corner stone for allowing healing through callus.⁽³⁴⁾

AO group has formalised biological osteosynthesis (BO) rules under which minimally invasive plate osteosynthesis (MIPO) is categorised. MIPPO fixation techniques can achieve faster and better rehabilitation. The use of MIPO prevents- 1) Large incision (and hence infection prevention), 2) Extensive soft tissue stripping, 3) Disruption of periosteal blood supply and 4) Nerve palsies. Moreover, MIPO shortened the union time after surgery and the period of rehabilitation. Thus, MIPO helps young people back to work as soon as possible.

MIPO techniques avoid direct exposure of the fracture site, aids indirect reduction and the implants act as an internal extramedullary splint. Advantages of MIPO are: 1. Anatomic reconstruction of the articular area, axis, rotation and length reestablishment for the metaphyseal-diaphyseal area. 2. Screws are fixed distally and proximally from the fracture site causing bridging of the comminution and thereby aiding early rehabilitation. 3. Good results are obtained due to avoidance of vascular injury, which provides fast healing and also due to an increased resilience to mechanical stress. 5. Fixation with long plates only distally and proximally from the fracture site produces relative instability that is useful for an accurate and fast healing. The disadvantage of MIPO being it is a demanding technique, requiring a cautious intraoperative clinical and fluoroscopic control in order to confirm anatomic joint restoration and to re-establish limb axis, rotation and length. Additional radiation exposure is needed to fix the screws and therefore the surgical time is increased considerably.⁽²⁶⁾

The limitations of the study were that MIPO needed considerable experience and also it is highly demanding and technically challenging due to the complexity of the fracture.

CONCLUSION

Biplanar fixation by MIPPO technique is a newer concept in treating complex tibial condylar fractures using relative stability as the cornerstone for fixation. From our study, we conclude that MIPPO technique preserves vascularity of the fractured bones and significantly preserves the fracture haematoma (which is proved in many studies is very important for early union), thus aiding biological repair as suggested by BO rules. Early union and faster recovery is noted due to the preservation of vascular supply to the

fractured proximal tibia. MIPPO gives good soft tissue healing because of minimal stripping of the fracture site. MIPPO provides good relative stability, which is the standard prescription for fracture fixation nowadays. MIPPO also allows for early mobilisation of the knee, which in turn allows for restoration of good range of motion. Case selection for MIPPO technique is paramount, as bad selections may prove to be disastrous for the patient.

In our study, we encountered fewer incidences of delayed union and non-union. Bone grafting requirement is minimised due to the preservation of fracture haematoma. Infection incidence is drastically reduced due to limited exposure. Type V and VI fractures are heterogeneous injuries and high complication rate is an inherent risk with it. MIPPO technique avoids many of the complications associated with complex primary tibial fractures.

It must be kept in mind that MIPPO signifies "as minimal surgical trauma to the soft tissues as possible and does not effectively mean operating through small incisions."

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