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MINIMALLY INVASIVE PERCUTANEOUS PLATE OSTEOSYNTHESIS TECHNIQUE FOR PILON FRACTURES OF DISTAL TIBIA

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Abstract:

Objective: *Minimally Invasive Percutaneous plate Osteosynthesis, has been introduced to utilise all of the recent developments in biological osteosynthesis and internal fixators. It involves inserting a plate percutaneously, bridging the fracture site which is secured proximal and distal to the fracture zone. It also offers biological advantages and involves minimal soft tissue dissection with preservation of the vascular integrity of the fracture as well as preserving osteogenic fracture haematoma. This study aimed to evaluate the biological advantages of MIPPO in treating the pilon fractures of distal tibia. Methods: We conducted a study on indirect reduction and minimally invasive percutaneous plating in the treatment of 26 cases of pilon fractures of distal tibia, some with extension to ankle with minimal displacement, using locking dynamic compression plate. All fractures were classified according to AO classification.18 fractures were peri-articular and 8 were intra-articular. All were closed fractures. Results: At final follow up 10.7 months (mean, 6-20 months), all the fractures were healed without repeating the surgery and the mean union time was 14.9 weeks. One patient had mal-alignment of the limb with 8˚ internal rotation, but there were no angular deformity more than 5˚. One patient had impingement of hardware but was removed after healing of fracture. All patients had excellent or satisfactory ankle function. There were no infections or serious soft tissue complications. Conclusion: MIPPO technique results in higher rates of union and minimizes the complication rates in the pilon fractures of distal tibia.*

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INTRODUCTION:

The quest for effective fracture treatment has a long history. The term ''osteosynthesis'' was first used by Lambotte to describe stable bone fixation[1] and Gurlt, Lister described methods of internal fixation[2]. However Robert Danis was the first to develop plate designed to provide rigid fracture fixation[3] and ''primary'' fracture healing, and is generally regarded as the father of modern osteosynthesis[4].After initial enthusiasm, numerous problems arose as the technique was used more widely. Anatomic reduction of all fracture fragments usually requires wide exposure of the fracture zone, leading to delayed healing, nonunion, and an increased risk of infection[5]. Greater understanding of the complexity of fracture healing has helped in the development of osteosynthetic techniques that favour biology over rigid fixation and stability. The wave plate[6], the bridge plate[7] and the Limited Contact-Dynamic Compression Plate (LC-DCP)[8] were introduced to apply the principles of ''biological plate fixation''[5,9], the aim being to take advantage of biological support from bone and soft tissues that is still present after injury[10] . However, the LC-DCP, even with a reduced contact surface, still relied on compressive forces, undermining the fracture healing process[8]. Newer implant designs, known as ''internal fixators'', addressed this problem; for example the Zespol system[11], the point contact fixator (PC-fix)[12]. The latest AO developments, the less invasive stabilization system (LISS)[13] and the locking compression plate (LCP) [14] were designed to achieve an angular-stable connection between the screw head and the force carrier without frictional forces between the implant and the bone[15]. Following on from these developments, ''Minimally Invasive Percutaneous plate Osteosynthesis'' (MIPPO), has been introduced to utilise all of the recent developments in biological osteosynthesis and ''internal fixators''. MIPPO involves inserting a plate percutaneously, bridging the fracture site which is secured proximal and distal to the fracture zone[16]. Unstable fractures of the distal tibia with or without intra-articular fracture extension can present a management dilemma. Traditionally, there have been a variety of methods of management described and high rates of associated complications reported. Non-operative treatment can be technically demanding and may be associated with joint stiffness in up to 40% of cases as well as shortening and rotational malunion in over 30% of cases[17-18]. Traditional open reduction and internal fixation of such injuries results in extensive soft tissue dissection and periosteal injury and may be associated with high rates of infection, delayed union, and non-union[19,21,22]. Similarly, external fixation of distal tibial fractures may also be associated with a high incidence of complications, with pin infection and loosening in up to 50% of cases and malunion rates of up to 45%[18]. MIPPO may offer biological advantages. It involves minimal soft tissue dissection with preservation of the vascular integrity of the fracture as well as preserving osteogenic fracture haematoma[20]. Experience of the application of these techniques to fractures of the distal tibia is less extensive and opinion regarding optimal technique differs. Some authors advocate temporary external fixation prior to definitive MIPPO and routine fixation of associated fibula fractures[23].

MATERIALS AND METHODS:

All pilon fractures with closed metaphyseal-diaphyseal junction and metaphyseal fractures requiring internal fixation were enrolled in this prospective study between October 2007 and December 2009. We had 26 patients, 19 males and 7 females. The mean age at the time of injury was 46.0 years (range, 17-79). The mechanism of injury included a slip and fall in 12 patients, a fall from significant height in 6, road traffic accident (RTA) in 5 and fall from bike in 3 patients. The fractures were classified according to AO classification, 5(43-A2), 6(43-A3), 1(43-B2), 4(43-B3), 4(43-C1), 3(43-C2) and 3(43-C3). For soft tissue conditions Tscherne classification was used 15(C0), 8(C1) and 3(C2). There were no open fractures in our group. All surgical treatments and clinical follow up visits were conducted at our teaching hospital. All cases were performed or closely supervised by our senior authors. We have used different kinds of internal fixators like LCP and LISS for diaphyseo-metaphyseal fractures of distal tibia. We have used an external fixator associated with LCP plate for pilon fracture which extended till ankle joint.

Rapid skeletal stabilisation can be achieved by skeletal traction, bridging external fixation or simple splintage. Careful patient assessment allows the timing of surgery to be optimised for the soft tissues. This minimises the severe postoperative wound problems often associated with the surgical management of these complex fractures. Good quality plain radiographs (antero-posterior, lateral and long leg alignment views) are obtained with CT scans, if necessary, to determine optimal plate location. Identification of the size and location of the articular fragments is essential before reconstruction. In the distal tibia, the plate is normally applied on the anteromedial aspect. Contoured plates are commercially available, but we have used standard one third tubular cloverleaf and LC-DCP plates, prebending them for each specific fracture.

Surgery performed under regional anaesthesia with the patient supine on radiolucent table. Tourniquet was applied to the proximal part of the affected limb. Routine preparation and draping of the injured limb is performed. Initial attention is paid to the fracture lines, which extends to the tibial pilon and evaluate it with help of fluoroscopy or CT scan. The approach was choosed to be anteromedial side of tibia. A small incision (4-5cm) was taken on one end of the fractured comminuted area without disturbing the soft tissue envelope of the fractured fragments. The incision is extended right up to the bone. Both direct and indirect techniques of fracture reduction are used depending upon the nature and pattern of fracture. If the fracture is communited and affects the articular surface then an extra anterior incision is made for reduction of joint surface. A periostal subcutaneous tunnel is made with periostal elevator or with the plate itself. A small incision is made proximally to the fracture side and the tail of plate is exposed through it. A pre-measured and pre-contoured narrow LC-DCP or LCP is used for distal tibial fractures. Accurate plate contouring and positioning is confirmed by fluoroscopy. The length of plate selected is important and should be as long as is reasonably possible given the particular fracture pattern. With the fracture reduced by indirect means without opening the fractured area by gentle external manipulations. A cortical screw is inserted through a screw hole at distal end and the axial fracture alignment is confirmed by fluoroscopy before inserting any further screws. Fix the proximal part of plate with screw via proximal incision. Subsequent cortical screws are inserted close to either side of fracture via stab incisions (Fig 1. c). If possible, a lag screw is also inserted across the fracture in order to further reduce the fracture gap and add to the rigidity of the fixation. The alignment is checked all the time. Use of bone holding forceps is avoided. Handling of soft tissues and retractors should be taken care. With fractures extending into the ankle joint, careful attention is paid to restoration of articular surface continuity. Associated fibular fractures should be fixed in the cases of the fractures of distal tibia to additionally maintain length. The incision was irrigated and closed, sterile dressings are applied and the limb is immobilized by the posterior support splint and ankle is maintained in neutral position.

Following wound inspection, the postoperative back slab is changed for a short leg lightweight cast for six weeks. The weight bearing status is dependent on the individual picture, but most patients bear partially weight at least for six weeks. Outpatient physiotherapy is instituted to maximise the range of motion at the foot and ankle.

All the patients were asked for the follow up examinations. They were reviewed at 2 weeks for first 3 months and then every 3 months during the first year and yearly thereafter. They were observed at on average 10.7 months (range 6-20) after the trauma. Medical records and radiographs were assessed. A healing time less than 6 months were considered as normal union, whereas a healing time between 6 to 9 months were considered as delayed union. Fractures not healed within 9 months were classified as a non-union. Malalignment was defined as angulation or rotational deformity more than 5˚. Partial weight bearing was allowed when radiological union was evident on X rays, progressing to full weight bearing over one month. Healing was defined as bridging mature callus formation combined with pain free full weight bearing.

RESULTS:

Between October 2007 and December 2009, 26 patients with distal tibial or pilon fractures were treated. 19 male and 7 female, all were available for follow up. Mean age was 46.0 (range, 17-79) .All fractures united without secondary procedures; the mean hospital stay was 13.7days (range, 7-24 days). The mean time of union was 14.9 weeks (range, 8-25 weeks). The time to full weight bearing averaged 13.5 weeks (range, 6-22 weeks). The average operation time was 94.9 min (range, 75-120min).

Radiological assessment revealed satisfactory alignment in all patients except for one patient who got mal alignment of the limb with 8˚. Fracture reduction was anatomical or nearly anatomical without angular displacement or rotational deformity more than 5˚. That there were less complications like superficial infection or deep infection, delayed wound healing, non-union or hardware failure. 8 patients had some leg discomfort over the plate but never caused functional disability. One patient had plate impingement but was removed after healing of fracture. The patients were asked to partial weight bearing for at least 6 weeks postoperatively. The patients were attended in out patient department for regular follow up. The ranges of ankle movement were assessed in all patients. Most of the patients regained full range of ankle motion.

Based on our clinical and radiological definitions of fracture healing, a total of 12 patients were classified as healed at 6 months, 8 patients at 9 months and 6 patients at 15 months post-operatively. At the time of study, implant removal had been carried out in 9 patients. The mean time until removal was 13.6 months (range, 10-18months). The implant removals were also performed by MIPPO technique without any complications.

DISSCUSION:

In the past diaphyseal and distal tibia fractures were usually treated by intramedullary nailing or by the classic open approach with plates (ORIF). Both were related to complications such as nail or locking bolt fractures, malunion, local septic complications and bone healing problems, especially after ORIF[24-25]. Traditional techniques either fail to inadequate reduction and hold the fracture or may further disrupt the already tenuous soft tissue envelope. Peri-articular fractures of distal tibia are difficult to treat. In combination of poor soft tissue cover, these fractures are often comminated with small metaphyseal fragments.

Minimally invasive techniques do not allow direct visualization of the fracture. As a consequence of this, the surgeon is dependent on intraoperative fluoroscopy to confirm that an adequate reduction has been achieved. Fractures of distal 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 non union. Where the soft tissue injury is significant, bridging external fixation is advantageous for skeletal and soft tissue stabilisation[26]. Definitive fixation is advisable when the soft tissue allows it, when the 'wrinkle sign' is evident[27].

Many literatures on distal tibia or pilon fractures are plagued by wound infections[27-29]. The antero-medial aspect of the distal tibia is at most risk of wound infection and dehiscence. Studies using external fixation techniques reported significant reduction in infection rates[30-31]. Infections rates in the MIPPO techniques are better than traditional ORIF and comparable to external fixation technique[32-33]. Studies involving external fixation techniques showed complications such as loosening, malunion, imperfect articular reduction and pin tract infections[26-27, 34]. ORIF has lowest rate of angular malunion compared to external fixation[26] or intramedullary nailing[35] but the main disadvantage is high infection rates.

In our study, we confirm that good results can be obtained by this technique in the treatment of close tibial fracture with peri-articular and intra-articular fracture with extension to the ankle that are not suitable for nailing and traditional plating. Most patients had acceptable postoperative alignment without any rotational deformity. The functional outcomes in the current patients were excellent or satisfactory, even in the cases of displaced extension into the ankle. The advantage of percutaneos plating in these fractures, in allowing immediate movement is important for periarticular fractures. It allows early active range of movement as postoperative plaster immobilisation in not necessary. We haven't found ankle stiffness after the surgery. The partial weight bearing as tolerated was allowed at a mean of 5.4 weeks postoperatively and full weight bearing was allowed at a mean of 13.5 weeks postoperatively.

Fig. 1 A ,B shows intra-articular pilon fracture type 43-C2, C shows stab incisions with minimally invasive technique and **D** shows stab incision sutured**, E** post operative radiograph showing minimally invasive fixation of pilon fractures.

In our series a few distal fibula fractures were fixed in order to stabilize the ankle mortise. Ankle joint injury is also common in pilon fractures, so it should be carefully examined and reconstruct it in order to prevent post traumatic arthrosis of the joint. There are certain advantages on indirect reduction and leaving the fracture site close. There will be minimal soft tissue dissection with the preservation of vascular integrity of the fracture as well as preserving osteogenic fracture haematoma as it will stimulate callus formation.

Fracture healing is defined as mature callus formation seen on plain radiograph with pain free full weight bearing. Mean fracture healing was found at 23.1 weeks postoperatively. When fracture is healed, physically active patients might experience stress related pain or discomfort at the plate ends, which can be treated by plate removal through same incisions using MIPPO technique.

The final outcome of pilon fractures is largely dependent upon the residual articular displacement and chondral damage. It is obvious that these are not directly influenced by this technique of MIPPO. Instead we believe the real advantages lie in the prevention of soft tissue problems and the possibilities for earlier and even single-stage operative procedures, contributing to a favourable outcome. As described above, minimally invasive percutaneous plate osteosynthesis in the treatment of several types of distal tibial fractures are better as compared to that for conventional plating technique. It is applied in simple metaphyseal or peri-articular multifragmentary fractures of distal tibia where intramedullary nail or external fixations are not suitable. Equally good results as far as union and early mobilization are possible. But still no large series has been done to evaluate the MIPPO technique for comminuted pilon fractures

CONCLUSION:

In conclusion, our presented study supports the few other published studies concerning percutaneous plating of the tibia and these should inspire more trauma surgeons treating distal tibia fractures to use minimally invasive techniques, in an effort to decrease morbidity and associated complications, especially of the soft tissues. It needs further evaluation but the beginning is definitely encouraging. With follow up and large number of patients it might be proved to be best choice for stabilization method for comminuted pilon fractures.

REFERENCES:

1. Lambotte A. The classic contribution to conservative surgery of the injured hand. Clin Orthop 1987; 214: 4-6.
2. Browner BD, Jupiter JB, Levine AM, et al. Skeletal trauma. Philadelphia: W.B. Saunders Company 1992; 3-30.
3. Danis R. Theorie et pratique de I'osteosynthese. Paris: Masson 1949.
4. Miclau T, Martin RE. The evolution of modern plate osteosynthesis. Injury 1997; 28(1): 3-6.
5. Gerber C, Mast JW, Ganz R. Biological internal fixation fractures. Arch Orthop Trauma Surg 1990; 109: 295-303.
6. Brunner CF, Weber BG. Besondere Osteosynthesetechniken. Berlin Heidelberg New York: Springer 1981.
7. Heitemeyer U, Hierholzer G. Die iiberbriickende Osteosynthese bei geschlossenen Stiickfrakturen des Femurschaftes. Aktuelle Traumatol 1985; 15: 205-209.
8. Perren SM, Klaue K, Pohler O, et al. The limited contact dynamic compression plate (LC-DCP). Arch Orthop Trauma Surg 1990; 109: 304-310.
9. Ganz R, Mast J, Weber B, et al. Clinical aspects of ''bio-logical'' plating. Injury 1991; 22(1): 4-5.
10. Perren SM. Backgrounds of the technology of internal fixators. Injury 2003; 34(2): 1-3.
11. Ramotowski W, Granowski R. Zespol: an original method of stable osteosynthesis. Clin Orthop 1991; 272: 67-75.
12. Tepic S, Perren SM. The biomechanics of the PC-Fix internal fixator. Injury 1995; 26: 5-10.
13. Haas NP, Schu¨tz M, Hoffmann R, et al. LISS d Less Invasive Stabilization System: ein neuer Fixateur interne fu¨r distale Femurfrakturen. OPJ 1997; 13: 340-344.
14. Wagner M, Frigg R. Locking compression plate (LCP): ein neuer AO Standard. OPJ 2000; 3: 238-243.
15. Schutz M, Sudkamp NP. Revolution in plate osteosynthesis: new internal fixator systems. J Orthop Sci 2003; 8(2): 252-258.
16. Krettek C, Schandelmaier P, TscherneH. Distale Femurfrakturen, Transartikukire Rekonstruktion, perkutane Platten osteosynthese und retrograde Nagelung. Unfallchirurg 1996; 99: 2-10.
17. OO Oni, H Stafford, PJ Gergg. A study of diaphyseal fracture repair using tissue isolation techniques. Injury 1992; 23: 467-470.
18. Russell TA. Fractures of the tibia and fibula. In: Rockwood CA, Green DP, Buckolz RW, Heckman JD, editors. Fractures in adults. 4th ed. Philadelphia: Lippincott 1996. 2139-2157.
19. S. Olerud and G. Karlstrom. Tibial fractures treated by AO compression osteosynthesis. Acta Orthop 1972; 1: 100-104
20. Farouk, C Krettek, T Miclau, et, al. Minimally invasive plate osteosynthesis and vascularity: preliminary results of a cadaver injection study. Injury 1997; 28: 7-12.
21. WD Fisher, DL Hambledon. Problems and pitfalls of compression fixation of long bone fractures: a review of results and complications. Injury 1978; 10: 99-107.
22. MA McFerran, SW Smith, HJ Boulas, et al. Complications encountered in the treatment of pilon fractures. J Orthop Trauma 1992; 6: 273-285.
23. DL Helfet, PY Shonnard, D Levine, et al. Minimally invasive plate osteosynthesis of distal fractures of the tibia. Injury 1997; 28: 42-48.
24. OL Brown, DR Dirschl, WT Obremskey. Incidence of hardware-related pain and its effect on functional outcomes after open reduction and internal fixation of ankle fractures. J Orthop Trauma 2001; 15(4): 271-274.
25. P Hochstein, M Aymar, H Winkler, et al. Surgical treatment of diaphyseal tibial fractures-Choice of procedure and results of treatment of 187 fractures, Unfallchirurgie 1994; 20 (5): 259-275.
26. Rammelt S, Endres T, Grass R, et al. The role of external fixation in acute ankle trauma. Foot Ankle Clin 2004; 9: 455-474.
27. Syah Bahari, Brian Lenehan, Hamad Khan. Minimally invasive percutaneous plate fixation

of distal tibia fractures. Acta Orthopaedica Belg 2007; 73: 635-640.
28. Bonar SK, Marsh JL. Tibial plafond fractures: Changing principles of treatment. J Am Acad Orthop Surg 1994; 2: 297-305.
29. Bone LB. Fractures of the tibial plafond. Orthop Clin North Am 1987; 18: 95-104.
30. Marsh JL, Bonar S, Nepola JV et al. Use of an articulated external fixator for fractures of the tibial plafond. J Bone Joint Surg 1995; 77: 1498-1509.
31. Mockford BJ, Ogonda L, Warnock D, et al. The early management of severe tibial pilon fractures using a temporary ring fixator. Surgeon 2003; 1: 104-107.
32. Blauth M. Bastian L. Krettek C, Knop C, et al. Surgical options for the treatment of severe tibial pilon fractures. A study of three techniques. J Orthop Trauma 2001; 15: 153-160.
33. Helfet D, Shonnard P, Levine D, et al. Minimally invasive plate osteosynthesis of distal fractures of the tibia. Injury 1997; 28(1): 42-48.
34. Piper Kj,Won HY, Ellis AM. Hybrid external fixation in complex tibial plateau and plafond fractures: An Autralian audit of outcomes. Injury 2005; 36: 178-184.
35. Im GI, Tae SK. Distal metaphyseal fractures of tibia: a prospective randomised trial of closed reduction and intramedullary nail versus open reduction and plate and screw fixation. J Trauma 2005; 59: 1219-1223.

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