Original Research Article

Locking compression plate used as external fixator in open (Grade || to |||b) tibia fracture

Kumar Kaushik[1], Sukhsagar Vaishya[1*] , Sheetanshu Shekhar[1], Arjun Singh[2], Ajoy Kumar Manav[3]

[1] Junior Resident, Department of Orthopaedic, Patna Medical College and Hospital, Patna, Bihar, India
[2]Professor and HOD, Department of Orthopaedic, Patna Medical College and Hospital, Patna, Bihar, India
[3]Assistant Professor Department of Orthopaedic, Patna Medical College and Hospital, Patna, Bihar, India

Received: 26-06-2020 / Revised: 29-07-2020 / Accepted: 05-08-2020

Abstract

Purpose : Open fractures are one of the most difficult condition to treat in orthopaedics. Locking plates can be used as an external fixator in case of open fracture particularly of tibia as soft tissue around it (especially distal) are easily compromised by trauma and subsequent treatment by open reduction and internal fixation. The purpose of our study is to evaluate the functional outcome of locking compression plate used as an external fixator in Gustilo and Anderson's grade II to III B open fracture shaft of tibia. **Method :** This was a prospective study in which we treated a total of 8 patients of Open fracture shaft of tibia with "supracutaneous plating" using a metaphyseal locking plate or simple locking plates. There were 5 Male and 3 female patients, with average age of 40 years (Range, 28 to 60 years). 3 patient was having grade II injury,2patients were of grade IIIAwherea as 3 patients were having Grade IIIB injury. After 4 weeks, patients were allowed toe- touch weight bearing for next 6 weeks, followed by partial weight bearing for next 4 weeks. Full weight bearing was allowed once fracture healed clinically as well as radiologically. Plate removal was done once fracture consolidated radiologically. **Result:** The plate was kept in place for average 32 weeks (Range,28 to 40 weeks) .No significant screw tract infection was found in any patients in our series. In 1 patients flap coverage of wound was done, in others, wound healed with debridement, dressing and partial thickness skin grafting when required. (2). Two patients showed delayed union at 24 weeks for which bone grafting was done and fracture union was achieved. Average period of follow-up was 16 months (Range, 12 to 20 months). In 7 patients, plate was placed in situ until full consolidation both clinically and radiologically was seen but in one patient plate has to be removed in 2 weeks because of loosening due highly osteoporotic bone and persistence of infection. She was planned for ring fixator but patient refused and we lost the follow up. At latest follow up all the7 patients were full weight bearing with fully healed tibia.**Conclusion :** Locked Supracutaneous plating of open fracture of long bones have many advantages over conventional tubular uniaxial fixator. Non bulky implant, stable configuration, less risk of pin tract infection, suitability of application even with small fragments and less chances of joint stiffness makes this method a viable option for treatment of open long bone fractures especially tibia.

Keywords: Open fracture, Supracutaneous plating, External fixator, Locking plate.

Introduction

Open tibial fractures pose treatment dilemmas for orthopedic surgeons. These injuries are associated with significant morbidity due to the increased risks of infection, nonunion, malunion, joint stiffness and possible impending amputation[1,2].

The soft tissues around the ankle and distal tibia are easily compromised by trauma and subsequent fracture fixation posing a definite challenge in healing of wounds post operatively[3,4]. Debridement followed by fracture fixation is the usually followed two stage treatment protocol in the management of grade II to

**Correspondence*
Dr. Sukhsagar Vaishya
Junior Resident, Department of Orthopaedic, Patna Medical College and Hospital, Patna, Bihar, India.

IIIB compound fractures of distal tibia[5-8].The instability of the fracture if not stabilized after debridement will compromise eradication of infection and wound healing[9-12]. Hence, temporary bony stabilization by external fixation is advocated[13].Most often, these external fixators need to stay in place for prolonged periods of time. Standard external fixators are relatively inexpensive, easy to apply, and parts of them can be reused. However, most of the external fixator frames used in lower tibial fixation are bulky and cumbersome to the patient, causing inconvenience to them in day to day activities and may also cause disturbance in gait while trying to clear from the opposite limb. Locking compression plate as an external fixation device has been described in the management of open fractures. Plate external fixation is not a new concept. While it has been described in the management of open fractures[14-16]. it is still deemed unconventional and does not enjoy the same place in classical textbooks as other methods of fracture fixation.Understandably, the design of implants of old, such as the Zespol implant[16], or dynamic compression plates coupled with multiple nuts and washers[14,15] may have dissuaded surgeons who may have been otherwise more receptive to this technique. With the advent of anatomically-contoured locking-head plates with fewer moving parts, there has been a resurgence of interest in this technique, as evidenced by the publications that have surfaced over the last decade. It may thus be timely to consider the merits of this novel technique and examine the situations where it may be indicated.

Methods and materials

Between September 2013 to August 2014, a prospective observational study was done in Patna Medical College and Hospital in which 8 patients underwent external plating of tibia.). Male -5, female – 3. Average age was 40 years (Range, 28-60 years). Patients included were with open injury (Gustilo and Anderson's grade II to IIIB) fresh or infected. The indications for using external plating was open injury, infection, too small distal fragment and/or communition at the fracture site. After receiving the patient, proper wound lavage was done if fresh or debridment if infected. Then plate is applied after proper alignment so that it can be used as permanent implant. Wound management is done by regular dressing and once it has healed SSG , musculocutaneous or fasciocutaneous flap was done as per requirement. All the patients in this study (except one) were followed up at regular interval and radiographs were obtained at regular interval at 6 weeks,14 weeks, 5 months and at final follow up. In one case we lost the follow up after we removed the plate due to loosening and persistence of infection.

Site of tibia involved: proximal – 1, shaft – 2, distal – 5.

According to Gustillo and Anderson's classification number of patients in Grade II – 3, III A – 2, IIIB – 3.

2 patients presented late after primary injury(Average 10 days, (range 7-15days). 1of the patients had gross infection at the time of presentation. Average wound healing time was 7 days (5-10 days). After proper wound care when it became healthy SSG was done in 1 patients and Flap in 1 patients.

Surgical technique

With the patient under spinal anaesthesia, the involved limb was prepared and draped in the usual standard sterile fashion. Pre-operative antibiotic treatment was given. No tourniquet was used; this was to allow intravenous antibiotics to reach the compound area. A thorough debridement and wound lavage was given. Fracture alignment was achieved prior to wound closure. Wound was either closed in one layer before the placement of the LCP if closer was possible otherwise left open till flap was done . The plate was at the sufficient height so that it should not limit easy access to wound. Next, a LCP plate for the distal/proximal/shaft of tibia of appropriate length was chosen. The plate was initially fixed to the proximal and distal fragments with a k-wire after acheiving fracture reduction under fluoroscopy guidance. LCP was placed as close to the bone as possible, yet still allowing enough space for regular wound care, grafting and flap to increase the mechanical stability of fixation. It was separated from the skin surface by a spacer of uniform thickness.We prefer bi-cortical locked screw fixation when we use LCP as an external fixator. For the distal tibia, at least four screws (4.5 mm) proximally and three to four screws (3.5 mm) distally was recommended. Successive holes are drilled over locking drill-guides through stab incisions made over the intact soft tissue envelope and screws are placed first distally and later in proximal fragment after ensuing good reduction. Screw tract and wound dressing was done. Regular screw tract and wound dressings were done.

Results

The plate was kept in place for average 32 weeks (Range- 28 to 40 weeks) .No significant screw tract infection was found in any patients in our series. In 1 patients flap coverage of wound was done, in others, wound healed with debridement, dressing and partial

thickness skin grafting when required (1 patients). 1 patients showed delayed union at 24 weeks for which bone grafting was done and fracture union was achieved. Average period of follow-up was 16 months (Range, 12 to 20 months). In all 7 patients, plate was placed in situ until full consolidation both clinically and radiologically was seen. At latest follow up all the 7patients were full weight bearing with fully healed tibia.

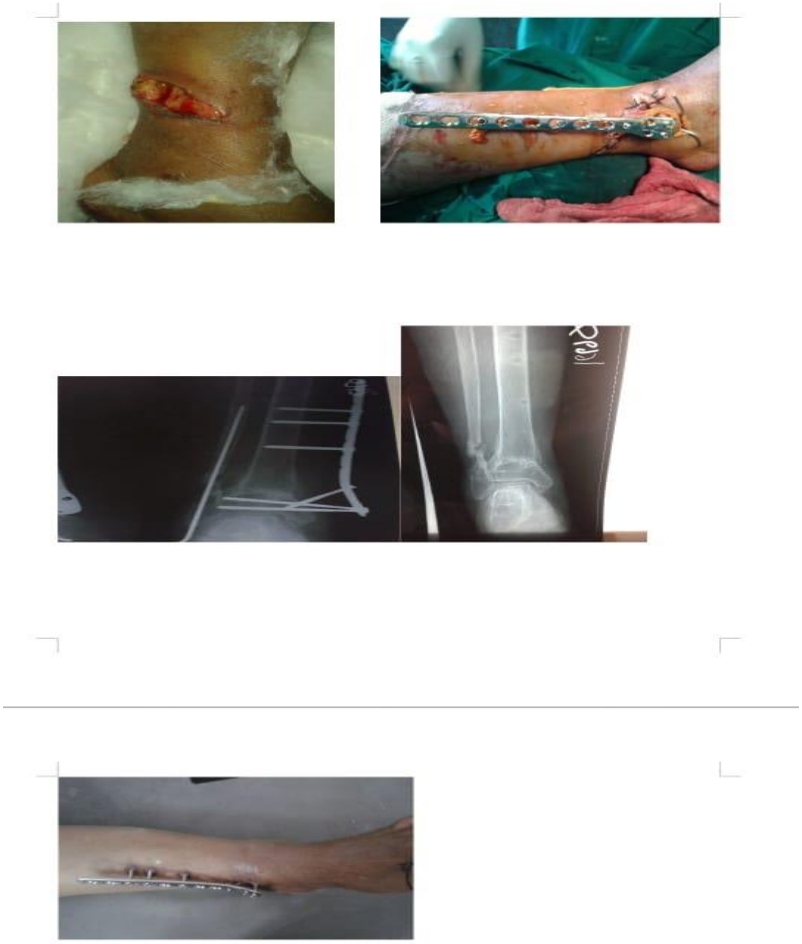

Fig 1 :Pictorial representation of case

Discussion

Conventional external fixator constructs (bar and half-pin, ring, hybrid or newer modular designs) are used either for temporary damage control or as definitive fixation in high-grade open fractures to provide stability while avoiding superinfection of an internal fixation device[17]. However, these frames are often bulky and movement with a lower limb fixator frame in-situ is awkward. Some patients are self-conscious of these fixators and find them less aesthetically acceptable.The conventional surgical treatment for tibial fractures includes nailing and plating but when patient comes with open fracture then people hesitate to do internal fixation for these fracture.

In such situation external fixation is viable option and among these that can be kept for long period and as permanent treatment. For such situation LCP as external fixator can be used which is more patient friendly ,light, do not hinder normal walking (unlike others). The biomechanics of the locking plate are different from those of conventional compression plates; the stable connection of the locking screws to plate does not rely on friction between the plate and the bone. This is similar to what is seen in the external fixator, and locked plates are advocated as internal–external fixators. Therefore, the locked plating technique relies on a secondary fracture-healing model and callus formation should be observed. In fact, locked plates do show superior mechanical stability for fracture fixation.Conceptually, the angle-stable locking compressionplate (LCP) is an internally placed fixator. Although designed for epiperiosteal application, increasing the plate-to-bone distance for locations with a pronounced muscle sleeve results in submuscular placement, desirable where comminution is present to bridge fragments while preserving vascularity. For a subcutaneous bones such as tibia, increasing the plate-to-bone distance lifts the LCP into an extra-corporeal location, while preserving its inherent characteristics of flexibility (long-span) and stability (locked-screw)[18]Ramotowski and Granowski, are the persons who gave the concept of supracutaneous plating system but they used nuts and washers for locking[19]

Ching Hou Ma et al did biomechanical testing to demonstrate that the distance between the bone and the implant significantly reduced construct stability. At a distance of 5 mm, Ahmad et al. observed an inferior performance in the mechanical properties of the locking compression plate (LCP) construct, with a decrease in axial stiffness and torsional rigidity, and recommended that if an LCP is to be used, the distance between the plate and the bone should be 2 mm21.

New technique called far cortical locking(FCL) by Bottlang et al showed that FCL fixation may be advisable for stiffness reduction of periarticular plating constructs to promote fracture healing by callus formation[22]. Furthermore, they report that FCL constructs function as true internal fixators by replicating the biomechanical behavior and biologic healing response of external fixator[20]. FCL constructs reduce the axial stiffness of locked plating constructs by 80–88% and the bending stiffness by 29% [20-24]. According to ChingHau Ma et al., axial stiffness was reduced by 84% for the EFP-6 model and by 94% for the EFP-10 model as compared to the IFP model. The EFP-6 and EFP-10 models decreased the lateral bending stiffness by 12% and 21%, respectively [25]. These studies further strengthen our concept of using LCP as external fixator and proves superior results in our studies.

Use of locking plates for external fixation is well suited to treating patients with high-impact trauma to the legs or patients who require longer periods of external fixation due to soft-tissue problems or other related injuries. We can achieve restoration of anatomy, soft-tissue reconstruction, stable fixation and high union rates using locked plates as stage-1 external fixators.

Despite its low profile, external fixation with the locked plate seems strong enough to withstand the forces acting on the tibia. During our practice, we found a high rate of union when using the locked plate as the definitive external fixator.Nonunion rate of 5-17% has been noted by other authors . I did not get any non union but 1 delayed union for which bone grafting was done .With external plate fixation, can provide better protection of the blood supply, decrease the postoperative pain and risk of infection as does not require any incision. After fracture healing, the external plate was removed easily. In our study, all of the patients underwent uneventful plate removal in the clinic with average of about 5 minutes. The average VAS score was 3.5 (range, 1 to 5). In contrast, the operation for removal of nails and internal locking plate could be troublesome in some cases. In the report by Raja et al on plate removal, the rate of complications was as high as 47%.[25]

References

1. Mills WJ, Nork SE. Open reduction and internal fixation of high-energy tibial plateau fractures. OrthopClin North Am 2002;33(ix):177–98.
2. Perry CR, Evans LG, Rice S, Fogarty J, Burdge RE. A new surgical approach to fractures of the lateral tibial plateau. J Bone Joint Surg Am 1984;66:1236–40.
3. P. A. McCann, M. Jackson, S. T. Mitchell and R. M. At- kins, “Complications of Definitive Open Reduction and Internal Fixation of Pilon Fractures of the Distal Tibia,” International Orthopaedics, 2011;35(3):413-418.
4. T. W. Lau, F. Leung, C. F. Chan and S. P. Chow, “Wound Complication of Minimally Invasive Plate Osteosynthesis in Distal Tibia Fractures,” International Orthopaedics, 2008;32(5):697-703.
5. J.J. Hutson, “Salvage of Pilon Fracture Nonunion and Infection with Circular Tensioned Wire Fixation,” Foot and Ankle Clinics, 2008; 13(1):29-68.

6. L. Eralp and M. Kocaoglu, "Distal Tibial Reconstruction with Use of a Circular External Fixator and an Intrame- dullary Nail: Surgical Technique," The Journal of Bone & Joint Surgery, 2008;90(2):181-194.
7. P. C. Cavadas and L. Landín, "Treatment of Recalcitrant Distal Tibial Nonunion Using the Descending GenicularCorticoperiosteal Free Flap," Journal of Trauma, 2008;64(1):144-150.
8. M. E. Pannunzio, A. B. Chhabra, S. R. Golish, M. R. Brown and W. C. Pederson, "Free Fibula Transfer in the Treatment of Difficult Distal Tibia Fractures," Journal of Reconstructive Microsurgery, 2007;23(1):1.
9. D. Ring, J. B. Jupiter, B. S. Gan, R. Israeli and M. J. Yaremchuk, "Infected Nonunion of the Tibia," Clinical Orthopaedics and Related Research, 1999;369: 302-311.
10. D. B. Thordarson, M. J. Patzakis, P. Holtom and R. Sher- man, "Salvage of the Septic Ankle with Concomitant Tibial Osteomyelitis," Foot & Ankle International, 1997;18(3):151-156.
11. C. L. Toh and J. B. Jupiter, "The Infected Nonunion of the Tibia," Clinical Orthopaedics and Related Research, 1995;315:176-191.
12. S. A. F. Tulner, G. R. Schaap, S. D. Strackee, P. P. Bes- selaar, J. S. Luitse and R. K. Marti, "Long-Term Results of Multiple-Stage Treatment for Posttraumatic Osteomyelitis of the Tibia," Journal of Trauma, 2004;56(3): 633-642.
13. C. Collinge, J. Kennedy and A. Schmidt, "Temporary Ex- ternal Fixation of Lower Extremity," Orthopedics-Healio, 2010;33(1):4.
14. Marti RK, Werken Van der C: The AO-plate for external fixation in 12 cases. Acta OrthopScand 1991;62:60-62.
15. Kerkhoffs GMMJ, Kuipers MM, Marti RK, Werken Van der C: External fixation with standard AO-plates: technique, indicatios, and results in 31 cases.J Orthop Trauma 2003;17:61-64.
16. Ramotowski W, Granowski R Zespol: An original method of stable osteosynthesis. ClinOrthopRelat Res 1991;272: 67-75.
17. Marti RK, Werken Van der C: The AO-plate for external fixation in 12 cases. ActaOrthopScand 1991;62:60-62.
18. Kerkhoffs GMMJ, Kuipers MM, Marti RK, Werken Van der C: External fixation with standard AO-plates: technique, indications, and results in 31 cases. J Orthop Trauma 2003; 17:61-64.
19. Ramotowski W, Granowski R Zespol: An original method of stable osteosynthesis. ClinOrthopRelat Res 1991;272: 67-75.
20. Bottlang M, Feist F. Biomechanics of far cortical locking. J Orthop Trauma 2011;25 (Suppl. 1):S21–8.
21. Bottlang M, Lesser M, Koerber J, Doornink J, von Rechenberg B, Augat P, et al. Far cortical locking can improve healing of fractures stabilised with locking plates. J Bone Joint Surg Am 2010;92:1652–60.
22. Bottlang M, Doornink J, Lujan TJ, Fitzpatrick DC, Marsh JL, Augat P, et al. Effects of construct stiffness on healing of fractures stabilised with locking plates. J Bone Joint Surg Am 2010;92(Suppl. 2):12–22.
23. Bottlang M, Doornink J, Fitzpatrick DC, Madey SM. Far cortical locking can reduce stiffness of locked plating constructs while retaining construct strength. J Bone Joint Surg Am 2009; 91:1985–94.
24. Doornink J, Fitzpatrick DC, Madey SM, Bottlang M. Far cortical locking enables flexible fixation with periarticular locking plates. J Orthop Trauma 2011;25(Suppl. 1):S29–34.
25. Ching-HouMaa, Chin-HsienWua, Yuan-Kun Tu , Ting-Sheng Lin -Metaphyseal locking plate as a definitive external fixator for treating open tibial fractures—Clinical outcome and a finite element study: Injury, Int. J. Care Injured 2013;44: 1097–1101.

Source of Support:Nil
Conflict of Interest: Nil