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Original Research Article

A Study of Management of Long Bones Fractures with Locking Plates

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Abstract

Background: The annual incidence of open long bone fractures is 11.5 per 100,000 people. They are more common in men, and their age distribution is bimodal. The most common type of open fracture is the tibial diaphysis, while open femoral diaphyseal, distal femoral, and proximal tibial fractures are more common among the most badly damaged individuals. Open fractures of the lower limbs are more serious than those of the upper limbs. We in the current study tried to evaluate the management of long bone fractures with locking plates.

Methods: This cross-sectional interventional study was conducted in the Department of Orthopedics, Prathima Institute of Medical Sciences, Naganoor, Karimnagar, Institutional Ethical approval was obtained for the study. The common principle used for the treatment of the fracture was compression in 48% of cases followed by combination in 20% of cases and 16% each were treated with neutralization and bridging respectively

Results: In the current study 52% were closed fractures and 48% were open fractures. Grade I compound fractures were in 16% of cases followed by Grade II compound in 8% and Grade IIIA in 20% of cases and Grade IIIB in 4% of cases. The mean time of healing in closed cases n=13 was 16.5 ± 4.5 weeks. The mean healing time of Grade I compound fracture n=4 cases was 18.5 ± 2.5 weeks. Similarly, the mean healing time of grade II compound fracture n=2 cases was19.5 ± 2.5 weeks. The mean healing time for Grade IIIA compound fracture in n=5 cases was 22.5 ± 2.5 weeks. In the Grade IIIB case, the duration of the healing period was 24.0 weeks

Conclusion: Locked plating is a significant advancement in fracture treatment. In osteopenic bone and for comminuted and periarticular fractures, the locking plate improves fixing stability. Because the locking plates with screw heads thread into the plate and operate as fixed-angle devices, they provide more stability per screw than traditional nonlocking fixation.

Keywords: Locking Plates, Long Bone fractures, Compound fractures, Osteopenic bone.

Introduction

The introduction of the much more rigid fixation obtainable with AO implants led to a new set of clinically significant problems: bone loss under the plate, fracture at the ends of the plates, or refracture through the fracture site or screw holes after plate removal. Anderson et al., [1] and Hidaka and Gustilo [2] had a 22% incidence of refracture after plate removal using the standard, narrow 4.5 mm AO plate on fractures of the radius and ulna. Chapman et al., [3] were able to eliminate refractures in plate fixation of the radius and ulna by using the AO/ASIF 3.5 mm system. Laboratory investigation of this problem has shown two possible causes: stress protection, and devascularization followed by revascularization. Studies by Woo et al., [4] Sommer C et al., [5], Uhthoff et al., [6], and others demonstrate that stiff plates, when applied to healing fractures, result in weaker fracture callus and, when left in place for prolonged periods, weakening of the bone under the plate due to bone resorption. Following Wolff's law, introducing a rigid member across a fracture site alters the signals influencing the homeostatic mechanisms controlling bone apposition and resorption, so that the fracture heals with weaker callus and bone resorption occurs under the plate and in the surrounding cortex. Gautier et al., [7] and others have demonstrated devascularization of the cortex secondary to soft-tissue stripping and disturbance of the intrinsic blood supply to the bone by the application of the plate and insertion of screws. Revascularization of the bone results in bone resorption. The hypervascularity associated with that is most evident under the plate. Both of these factors are important, and newer plate designs have addressed both issues by producing more flexible plates from materials with a lower modulus of elasticity, such as titanium, titanium alloys, carbon fiber, or polymer, and by newer configurations. Only titanium is currently in use clinically, however. Thus, the need for a better fracture fixation plate system is required for the osteopenic, intraarticular metaphyseal fractures and comminuted diaphyseal fractures made the way for the evolution of the locking plate system in treating these cases. With this background, we in the current study tried to study the advantages of the locking plate over the normal conventional plating in osteopenic, comminuted, and metaphyseal fractures.

Material and Methods:

This cross-sectional interventional study was conducted in the Department of Orthopedics, Prathima Institute of Medical Sciences, Naganoor, Karimnagar, Institutional Ethical approval was obtained for the study. Written consent was obtained from all the participants of the study. The patients were assessed based on their medical history and the type of harm they had sustained. Upon admission, the necessary radiological investigations and hematological profiles were completed. The type of surgery and the specifics were recorded. All of the patients were hemodynamically stabilized upon arrival, and then radiographic assessment with x-rays was performed. Hb percent, total leucocyte count, differential count, blood grouping, crossmatching, fasting blood sugar, blood urea, serum creatinine, serum electrolytes, Urine albumin, sugar, and microscopic inspection were all performed routinely on all patients before surgery. The fractures were categorized and treatment was planned based on the radiographs taken.

Surgical Techniques: Plating Exposure: The following principles apply to fixation of most diaphyseal fractures with plates: When exposing the fracture, limit soft-tissue stripping to just the surface on which you expect to place the plate. Avoid the use of retractors and bone-holding forceps, which require circumferential stripping of bone. Fine-pointed tenaculum-type bone-holding forceps are best. There seems to be no advantage to leaving the periosteum intact beneath the plate. For most plates in common use today, application of the plate on the periosteum results in complete loss of blood supply to the periosteum. To ensure that bone union occurs in the presence of such comminution, however, apply a cancellous bone graft across the comminuted zone. Transverse fractures that are inherently stable can be reduced before plate application, and this simplifies fixation. Unstable fractures pose a challenge, particularly if excessive soft-tissue stripping is to be avoided. Patients with humeral fractures had surgery whereas those with lower extremity fractures underwent surgery under spinal anesthesia. Fracture ends were prepared intraoperatively, and bone holding forceps were utilized with considerable caution to avoid crushing the bones. In rare cases, a synthetic bone graft was employed. In the event of gap humeral non-union, a fibula strut graft was employed in addition to the locked plate fixation to maintain length. A combination of locking and ordinary cortical screws was used for alignment and fixation with or without compression. We usually place traditional cortical screws close to the fracture site to achieve some fracture compression, whereas locked screws must be positioned at the extreme holes to ensure a secure stable construct. Locked plates have been adapted for the metaphyseal ends of long bones. Patients with humeral fixation were placed in a broad arm sling following surgery, whereas those with lower extremity fixation were mobile on crutches. The patients were followed up using serial radiographs for 6 to 12 months, and the outcome was measured by time to healing and implant stability.

Results:

Out of the n=25 cases of long bone fractures included in study n=20(80%) were males and n=5(20%) were females. The male to female ratio was 4:1. The mean age of male cases was 42.25 ± 6.5 years and the age range was from 17 years to 66 years. In females, the mean age was 45.80 ± 8.5 years and the age range was from 22 years to 68 years. Out of all the cases 40% were in the age group of 31 – 45 years followed by age of 15 – 30 years with 32% of cases. The details of the demographic profile of the patients included in the study have been depicted in table 1.

Table 1: **Demographic profile of the cases included in the study**

Age group In Years	Male (n)	%	Female (n)	%	Total	%
15-30	7	28	1	4	08	32
31-45	8	32	2	8	10	40
46-50	2	08	2	8	04	16
51 - 60	3	12	0	0	03	12
Total	20	80	5	20	25	100

Out of the n=40 cases in the study road traffic accidents were the common cause of the fractures of long bones in 52% of cases followed by sports-related injuries in 20% of cases which occurred mostly at a young age and 20% of fractures were from trivial falls occurred in old patients with osteopenic bones. The details of the mode of injuries have been included in table 2.

Table 2: Mode of Injury

Mode of Injury	*Frequency*	*Percentage*
RTA	13	52
Sports-related	05	20
Fall from height	02	08
Trivial falls	05	20
Total	25	100

In the current study, 52% were closed fractures and 48% were open fractures. Based on the Gustilo-Anderson classification [8] Grade I compound fractures were in 16% of cases followed by Grade II compounds in 8% and Grade IIIA in 20% of cases and Grade IIIB in 4% of cases and No cases of Grade IIIC were found given in figure 1.

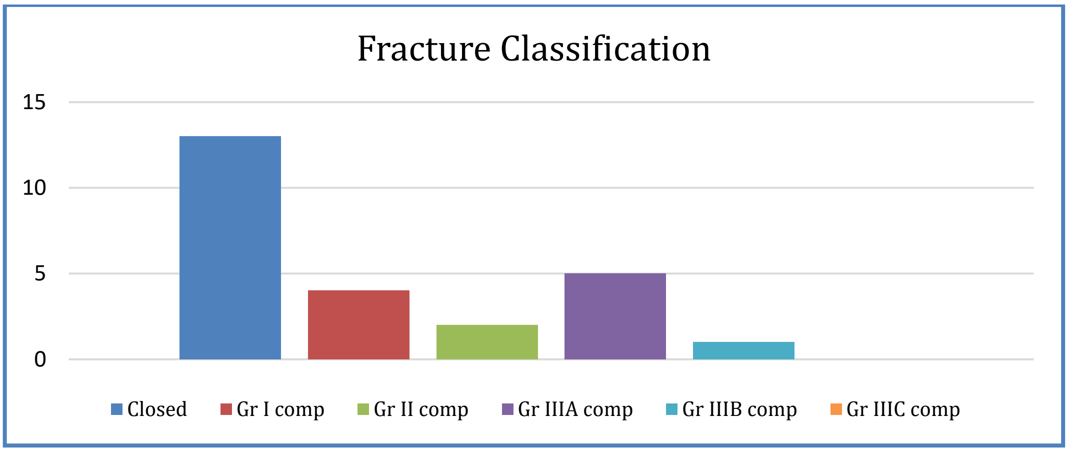

Figure 1: Types of fracture and their incidence in the present study

Out of the total n=25 cases, Normal bone was detected in n=21(84%) cases and osteopenic bone was found in n=4(16%) cases. The common principle used for the treatment of the fracture was compression in 48% of cases followed by combination in 20% of cases and 16% each were treated with neutralization and bridging respectively depicted in figure 2.

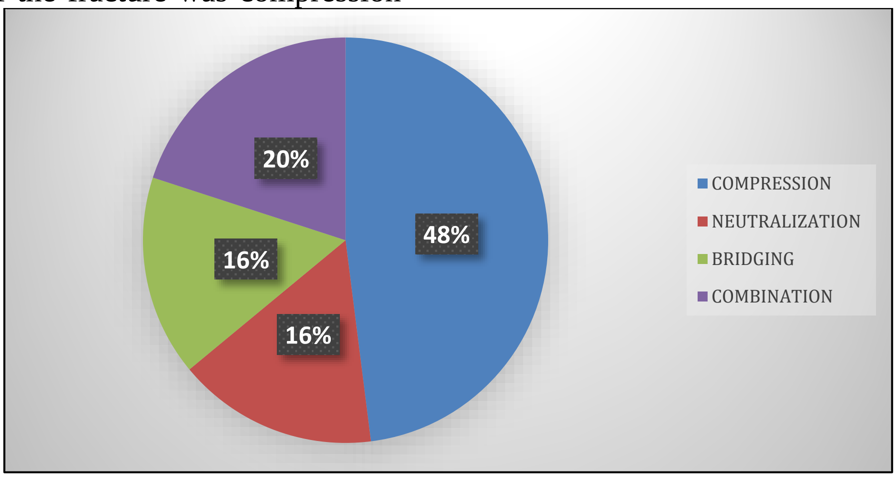

Figure 2: Principles and Biomechanics used for the treatment

The mean time of healing in closed cases n=13 was 16.5 ± 4.5 weeks and the range was from 12 to 20 weeks. The mean healing time of Grade I compound fracture n=4 cases was 18.5 ± 2.5 weeks and the range was from 16.0 to 21.0 weeks. Similarly, the mean healing time of grade II compound fracture n=2 cases was19.5 weeks and ranged from 17.0 to 22.0 weeks. The mean healing time for Grade IIIA compound fracture in n=5 cases was 22.5 ± 2.5 weeks and the range was 20.0 to 25.0 weeks. In the Grade IIIB case, the duration of the healing period was 24.0 weeks.

Table 3: Post Operative Complications recorded in the study

Complications	No of Cases	Percentage
Non-union	1	4%
Infection	2	8%
Implant Bending & Cut Through	0	0
Total	3	12%

The overall rate of complication in the current study was 12% with infection being the common cause in n=2(8%) cases that were managed adequately by antibiotic therapy and one case of non-union was found to occur in Group IIIA compound fracture case. No cases of implant failure or implant bending and cut-through were found in the study. The details have been depicted in table 3.

Discussion:

The optimal treatment of osteopenic fractures, metaphyseal and intraarticular fractures, and highly comminuted fractures, particularly those involving diaphyseal and metaphyseal bone, proximal tibia and distal femur fractures is challenging. There is a greater risk for delayed union or non-union following plate fixation because of poor screw purchase or loosening in these cases. In the present study, we included n=25, all were treated with locking plates of different types following three biomechanical principles compression principle, bridging principle, neutralization principle, and combination principle. And all cases are studied post-operatively till radiological union has occurred. Plate fixation techniques are used in bone fractures to provide stability and bone healing. Compression and stability are a must for proper bone healing. With the original AO/ASIF technique, screws or tension devices were used to achieve good compression. At a later stage especially, designed screw hold for dynamic compression plate allowed axial compression of the fracture zone. [9, 10] The recent development of locking plates can obtain more stable fixation. Moreover, with the application of locking screws, excessive pressure does not develop between the plate and bone. These plates were developed to have a more stable fixation in osteoporotic bone fractures. [11-13] Out of the n=40 cases in the study road traffic accidents were the common cause of the fractures of long bones in 52% of cases followed by sports-related injuries in 20% of cases which occurred mostly at a young age and 20% of fractures were from trivial falls occurred in old patients with osteopenic bones. Aloudah A et al., [14] in their study found the most commonly fractured bone among males was the femur (28.2%) while a humerus fracture was the most common among females (20.8%). Males were significantly higher in the younger age group in RTA cases. Of the n=25 cases studied simple fractures took 12 - 16 weeks for fracture healing and compound fractures between 16 - 20 weeks. One case ended in non-union even after 28 weeks. The case which ended up in this complication is a simple transverse fracture of both bones forearm. In locking plate with adequate compression on either side of the fracture before applying the remaining locking screws aids in fracture union. The locking plate system we used contains combination holes in which either locked or unlocked screws may be placed the use of unlocked screws allows for compression across the fracture site, and, if micromotion is eliminated and absolute rigidity is achieved, primary healing and direct fracture remodeling may occur. However, this requires friction between the plate and the bone. Locking screws, on the other hand, act as internal splints in which stable and controlled micromotion is preferable, which leads to secondary healing through callus formation. So, obtaining an initial compression fit between the plate and the bone with an unlocked compression screw, followed by the use of locked screws in the remaining holes, has been recommended for the treatment of fractures in osteopenic bone and simple transverse fractures.

Conclusion:

Locked plating is a significant advancement in fracture treatment. In osteopenic bone and for comminuted and periarticular fractures, the locking plate improves fixing stability. Because the locking plates with screw heads thread into the plate and operate as fixed-angle devices, they provide more stability per screw than traditional nonlocking fixation. Placing locking plates is a little more complicated than placing regular plates. Fracture reduction is frequently done indirectly. To achieve proper tightness, the locking screw must be precisely oriented along the axis of the receiving hole, and the length of the plate must be carefully determined.

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