Evaluation of Locked Plate in the Osteosynthesis of Fractures in Osteoporotic Bones

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Abstract

Background: The use of conventional dynamic compression plates (DCPs) in osteoporotic bones is associated with higher chances of implant failure. The advent and use of locking combi-plates have ensured a stable construct during osteosynthesis of fractures in osteoporotic bones. Objectives: The study aims to assess the outcome of use of locking combi-plates in the management of fractures in osteoporotic bones in our environment. Materials and Methods: Cases of patients with nonunion and localized osteoporosis from January 2014 to December 2014 that were managed with locked combi-plates were reviewed. Outcome was assessed by time to healing, stability of implant construct after 6 and 12 months. Results: There were 10 patients with mean age of 47.4 ± 12.63 years. There were 9 males and 1 female, and road traffic crashes were the mechanism of injury in 90% (n = 9) and gunshot injuries in 10% (n = 1). Atrophic nonunion was the most common indication for osteosynthesis with 80%, followed by fibrous nonunion with 10.0%. The humerus was the most common long bone involved with 50%. Locked broad DCP was used in 62.5%, and the duration between initial injury and surgery was 6 and 48 months, with an average of 17.5 months. The outcome was such that 90% healed after 12 months on follow-up while one case had the implant backing out and delay union at 6 months. Conclusion: The use of locked plate in the management of nonunion in the presence of osteoporosis ensures stable fixation construct and healing.

Keywords: Fracture, healing, locked plate, osteoporosis

Résumé

Contexte: L'utilisation de plaques de compression dynamiques conventionnelles dans les os ostéoporotiques est associée à des chances plus élevées de défaillance de l'implant. L'avènement et l'utilisation de combi-plaques de verrouillage ont assuré une construction stable lors de l'ostéosynthèse de fractures dans les os ostéoporotiques. Objectifs: L'étude vise à évaluer le résultat de l'utilisation de combi-plaques de verrouillage dans la gestion des fractures dans les os ostéoporotiques dans notre environnement. Méthodologie: Les cas de patients atteints d'ostéoporose non syndiquée et localisée de janvier 2014 à décembre 2014 qui ont été gérés avec des combi-plaques verrouillées ont été examinés. Le résultat a été évalué par le temps de guérison, la stabilité de la construction d'implant après 6 et 12 mois. Résultats: Il y avait 10 patients avec un âge moyen de 47,4 12,63. Il y avait 9 hommes et 1 accident de la route et de la route était le mécanisme de la blessure dans 90% (n = 9) et les blessures par balle dans 10% (n = 1). La non-union atrophique était l'indication la plus courante pour l'ostéosynthèse avec 80%, suivie d'une non-union fibreuse avec 10,0%. L'humerus était l'os le plus fréquent impliqué avec 50%. La plaque de compression dynamique bloquée (DCP) a été utilisée à 62,5% et la durée entre la blessure initiale et la chirurgie était de 6 et 48 mois avec une moyenne de 17,5 mois. Le résultat était tel que 90% ont été guéris après 12 mois de suivi, tandis que 1 cas avait l'implantation de l'implant et retardé l’union à 6 mois. Conclusion: L'utilisation de la plaque verrouillée dans la gestion de la non-union en présence d’ostéoporose assure une construction stable de fixation et une guérison.

Mots-clés: Ostéoporose, plaque verrouillée, fracture, guérison

INTRODUCTION

Plate osteosynthesis of fractures has been a major consideration in operative fracture management. The use of conventional...
dynamic compression plates (DCPs) for immediate osteosynthesis of fractures following traumatic event is fraught less with complications of implant failure. When conventional plates are used in osteoporotic bones, internal fixation is compromised as a result of poor screw purchase, increase risk of implant backing out as adequate torque is not generated to hold the implant.\cite{1} The use of cement-coated screws has been advocated to ensure good purchase of screws, thereby ensuring a stable construct. The advent and use of locking combi-plates have ensured good and stable construct during osteosynthesis of fractures in osteoporotic bones.\cite{1}

Fragility fractures in Western societies are common in the elderly and are regarded as a systemic metabolic disease.\cite{1,2} Surgeons in developing countries are faced with problems of localized osteoporosis from inadequate fixation or prolonged immobilization after nonsurgical management by traditional bone setters.\cite{3-5} Management of cases of fibrous, atrophic, and gap nonunion are done in a background of osteopenia of the bone. The study aims to assess the outcome of use of locking combi-plates in the management of fractures in osteoporotic bones in our environment.

**Materials and Methods**

It was a retrospective study to review ten patients with nonunion and localized osteoporosis who were treated from January 2014 to December 2014 with locked combi-plates. Cases of fragility fractures were excluded from the study. Indications for the use of locked plate in this study were nonunion in long bones of the humerus, femur, and tibia with radiologic confirmation of osteopenia. Diaphyseal femoral fractures that were managed by locked nailing and infected nonunion were also excluded from the study. Preoperative assessment done included screening for infection, grouping and cross-match of blood, and obtaining an informed consent. Patients with humeral pathologies had surgery under general anesthesia while those with lower extremity pathologies were operated under spinal anesthesia. Intraoperatively, fracture ends were prepared and bone holding forceps was used with extreme caution in order not to crush the bones. Synthetic bone graft was used in some instances [Figure 1]. In the case of the gap humeral nonunion, a fibula strut graft was used to maintain length in addition to the locked plate fixation. Alignment and fixation with or without compression were done with a mixture of locking and conventional cortical screws. As a rule, we placed the conventional cortical screws close to the fracture site to achieve some compression of the fracture while locked screws must be placed at the extreme holes to ensure a stable construct [Figure 2]. Locked plates have been adapted for the metaphyseal ends of long bones [Figure 3]. Postoperatively, the patients with humeral fixation were placed on a broad arm sling, while those with lower extremity fixation were mobilized on nonweight bearing with crutches. The patients were followed up for between 6 and 12 months with serial radiograph, and outcome was assessed by time to healing and stability of implant.

**Results**

There were 10 patients with mean age of 47.4 ± 12.63 years. There were 9 males and 1 female, and road traffic crashes were the mechanism of injury in 90% \( (n=9) \) and gunshot injuries in 10% \( (n=1) \) [Table 1]. Atrophic nonunion was the most common indication for osteosynthesis with 80%, followed by fibrous nonunion and gap nonunion with 10% each. The humerus was the most common long bone involved with 50%. Locked broad DCP was used in 62.5% while proximal femoral locked plates were used in the proximal femoral fractures and distal femoral locked plate for the distal femur. The blood loss was between 450 and 1000 ml, and transfusion was done only in the patients with femoral nonunion and humeral gap nonunion. The duration between the initial injury and surgery was 6 and 48 months, with an average of 17.5 months. The main outcome was the radiographic measurement of fracture union and 90% healed after 12 months on follow-up while one case had the implant backing out and delay union at 6 months. The case was redone with synthetic bone graft applied with union achieved after 24 weeks. Complications of shortening were seen in a case of proximal femoral nonunion, and

![Figure 1: Intraoperative picture with synthetic bone graft](image1)

![Figure 2: Postoperative image after locked plate fixation](image2)
Discussion

Prolonged immobilization of fractures and inadequate fixation from nonsurgical management may result in loss of bone mass and consequent localized osteoporosis as seen in cases of delayed presentation and mismanagement by traditional bone setters. Osteoporotic fractures are a feature of an aging population globally and is usually a systemic problem affecting several bones. In developing countries and in Sub-Saharan Africa in particular, where this study was carried out, osteoporosis and fragility fractures are not common because of the abundant sunshine in the tropics. The problem of managing fractures in osteoporotic bones by orthopedic surgeons in this region is therefore man made and self-inflicted. To ensure a stable construct and healing, appropriate implant is therefore needed. Osteoporosis presents a problem in osteofixation of fractures in fracture treatment as it might not be able to generate enough torque with the screws to securely hold the plate.\textsuperscript{[1]}

The mean age of patients in our series is low and it represents a young age group unlike the elderly age group in Western societies with fragility fractures. Localized osteoporosis in this lower age group, therefore, arises from prolonged immobilization and disuse. These patients are also prone to reduced muscle mass. Road traffic accident is the most common cause of fracture, and this has been corroborated by previous studies in our environment.\textsuperscript{[3]} All patients had delay in presentation, hence, the delay in intervention. The reason for the delay is because the victims patronize traditional bone setters and they only present to hospital when treatment fails.\textsuperscript{[4]} The misdemeanor of traditional bone setters’ treatment has been extensively reported by the previous workers, and this includes loss of limbs, traditional bone setters gangrene, tetanus, malunion and nonunion in addition to localized osteoporosis.\textsuperscript{[5,6]} The problem of nonunion and osteoporosis presents a fascinating scenario in achieving healing in these patients. Osteoporotic bone is characterized by poor bone quality, loss of bone mass, and microarchitectural deterioration of bone tissue. Fracture healing is a complex biological process that may be influenced by biological (age, gender, and disease) and mechanical (reduction, osteosynthesis) factors.\textsuperscript{[7,8]}

The surgical techniques and devices, which are able to restore the anatomy with a reduced strain at the bone implant interface, have been suggested in osteoporotic bone fractures management. Researchers have suggested the use of augmentation techniques to improve anchorage in osteoporotic bone, using bone autograft or allograft, bone cement or bone substitute.\textsuperscript{[9,10]} In a review of six patients with nonunion of osteoporotic humeral shafts, Vidyadhara \textit{et al.} used intramedullary fibular strut graft and DCP for anchorage and fixation. They concluded that this surgical approach achieved union without the need for simultaneous or further need for cancellous bone graft. The fibula in this instance acted as an internal splint to the fracture site, aiding stability, and enhancing cortical purchase.\textsuperscript{[11]} Other advantage

### Table 1: Study demographics

| Case | Sex | Age | Mechanism of injury | Indications for surgery | Anatomic site | Implant used               | Complications | Outcome | Duration before intervention (months) |
|------|-----|-----|---------------------|------------------------|---------------|-----------------------------|---------------|---------|--------------------------------------|
| 1    | Male| 40  | RTA                 | Atrophic nonunion      | Humerus       | Locked broad DCP            | None          | Healed  | 20                                   |
| 2    | Female| 43  | RTA                 | Fibrous nonunion       | Proximal femur| Femoral locked plate        | Shortening    | Healed  | 16                                   |
| 3    | Male| 34  | RTA                 | Atrophic nonunion      | Proximal femur| Femoral locked plate        | None          | Healed  | 6                                    |
| 4    | Male| 38  | RTA                 | Atrophic nonunion      | Proximal femur| Femoral locked plate        | None          | Healed  | 13                                   |
| 5    | Male| 56  | RTA                 | Atrophic nonunion      | Distal tibia    | Locked broad DCP            | None          | Healed  | 11                                   |
| 6    | Male| 45  | Gunshot injury      | Gap nonunion           | Humerus       | Locked broad DCP            | None          | Healed  | 14                                   |
| 7    | Male| 38  | RTA                 | Atrophic nonunion      | Humerus       | Locked broad DCP            | None          | Healed  | 12                                   |
| 8    | Male| 60  | RTA                 | Atrophic nonunion      | Distal femur   | Femoral locked plate        | Implant infection | Healed  | 48                                   |
| 9    | Male| 45  | RTA                 | Atrophic nonunion      | Humerus       | Locked broad DCP            | None          | Healed  | 6                                    |
| 10   | Male| 75  | RTA                 | Atrophic nonunion      | Humerus       | Locked broad DCP            | None          | Healed  | 8                                    |

RTA=Road traffic accident, DCP=Dynamic compression plate

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**Figure 3:** Variety of locked plates

Postoperative implant infection was seen in the case of distal femoral nonunion.
is the ability to act as a load-sharing device. The fibula strut graft was used only in the patient with gap nonunion in our series, and this was to reduce the limb length discrepancy following debridement. In our patient, locked DCP was used rather than a DCP to give additional anchorage. We were able to improve anchorage in our series with the use of a combi-locked plate device which is an improvement over the earlier broad dynamic plates. The locking compression plates consist of plate and screw systems where the screws are locked in the plate, minimizing the compressive forces exerted between plate and bone. It can serve as an internal fixator, especially when used in osteosynthesis in fresh fractures. Thus, the plate does not need to compress the bone neither does it require precise anatomical contouring that disturbs the periosteal blood supply. Locking plates are the fixation method of choice for osteoporotic, diaphyseal or metaphyseal, severely comminuted fractures.\[1\] Adaptations have been made for the proximal and distal femurs and the proximal and distal humerus. It was previously thought that locked plates were expensive and not readily available; however, this has changed in recent years. The locking plates when used appropriately help improve the fixation construct, thereby improving healing.\[12-14\] The complication of implant failure noted was managed with a redo surgery still using the locked plate, but in addition, a bone graft substitute was used. Blood loss is major consideration in nonunion treatment. Provision for blood transfusion should always been considered in the preoperative evaluation of patients. We were able to achieve complete union in most of the patients in 1 year because of the stability of the implant construct. Kumar et al. in their study of use of locked plate in humeral nonunion reported the average time to union of 16 weeks and complications of delayed union, persistent nonunion, and transient radial nerve palsy.\[12\]

**Conclusion**

Management of fractures complicated by localized osteoporosis in the presence of nonunion presents a peculiar scenario in resource-poor countries. Orthopedic surgeons in developing countries need to come out with solutions as they are daily confronted with these problems. Locking fixation technique when properly applied and the use of bone graft substitute can help overcome these challenges.

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**Conflicts of interest**

There are no conflicts of interest.

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