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Dynamic locked plating for fixation of distal femur fractures using near- cortical over-drilling: Preliminary results of a prospective observational study

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ABSTRACT

Introduction: Nonunion after locked plating of distal femur fractures is not uncommon. Authors wanted to assess if "Dynamic" locked plating using near-cortex over-Drilling technique would provide a mechanical environment the promotes callus formation, thereby avoiding non-union encountered when applying locked plates with the conventional method.

Methods: This study was conducted at an academic Level 1 Trauma Center.

This is a prospective study conducted from November 2015 to November 2016. Follow-up was 10 months on average (ranging from 8 to 12 months).

The study included 20 patients with 20 fractures (13 males, 7 females). The average patients' age was 41.2 years (18–64 years). According to the Müller AO classification of distal femur fractures (33A-C) there were 15 cases with extra-articular fractures (AO 33A), 5 patients with intra-articular fractures (AO 33C).

Dynamic Locked plating using near-cortical over-drilling technique was done for all patients.

Two blinded observers assessed callus score on 6-week radiographs using a 4-point ordinal scale. A 2-tailed *t*-test. Two-way mixed intra-class correlation testing was performed to determine reliability of the callus measurements by the 2 observers.

Results: All patients achieved union, time to union was 13.4 weeks on average (range form 8–24 weeks). Delayed union was observed in 2 patients. The average callus score for fractures was 1.8 (SD 0.6). All fractures united in alignment except 1 fracture which united in valgus malalignment, the deformity was appreciated in the postoperative radiographs.

No wound related complications, no loss of reduction, no catastrophic implant failure or screw breakage were detected.

Conclusion: Dynamic locked plating using near-cortex over-drilling is a simple technique that uses standard locked plates that promotes callus formation when used for fixing distal femur fractures.

1. Introduction

Fracture Healing is greatly influenced by the fixation method. Classis compression plate fixation requires the creation of a rigid plate/bone construct which involves soft-tissue stripping and devitalization of the underlying bone, this may lead to inhibited callus formation. Hence, the concept of bridge plating with minimal soft tissue stripping using locking plates has been promoted.[1,2]

Locking plates allows for stable bridge plating in cases with short end segments, thus their use is becoming more common for fixing distal femur fractures.[3]

However recent data from multiple centers has demonstrated nonunion rates between 10% and 20% when using locked plates.[4] Insufficient fracture site motion and nonunion has been attributed to the stiffness of these implants.[5]

The concept of "Dynamic" Locked Plates, has been proposed to decrease construct stiffness & improve callus formation, various biomechanical & animal studies,[6–8] using special implant design, have been done & showed that this concept decreases stiffness of locked plates & promote callus formation. Near-cortical over-drilling technique has been proposed by Gardner et al. [9], is based on the same biomechanical concept of dynamic licked plating but

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uses standard Locking plates instead of a specially designed implant (Fig. 1).

Authors wanted to clinically validate if the near-cortical over-drilling technique will promote callus formation thus proving it's a form of dynamic locked plating fixation using conventional locked plates & not the specially designed dynamic locked plates. Authors also wanted to see if the results achieved by Gardner et al. [9] are be reproducible.

2. Method

This is a prospective study conducted from November 2015 to November 2016 in an academic level 1 trauma center. Follow-up was 10 months on average (ranging from 8 to 12 months).

Inclusion criteria included, adult patients (18–65 years old) who suffered from closed fractures of the distal femur. Patients who had diabetes mellitus, associated vascular injury, open fractures or Pathological fractures were excluded.

Twenty patients with 20 fractures (13 males, 7 females) where included in the study who met the inclusion criteria & didn't have of the exclusion criteria. The average patients' age was 41.2 years (18–64 years).

Fractures were classified according to the Müller AO classification[10] of distal femur fractures (33A-C) & authors found the following; 15 cases had extra-articular fractures (AO 33A), among them 5 patients were (AO 33-A1), 3 patients were (AO33-A2) & 7 patients were (AO 33-A3). Five patients had intra-articular fractures, among them 3 patients had simple articular component and complex metaphyseal component (AO 33-C2), 2 patients had complex articular, metaphyseal components (AO 33-C3). (Table 1).

The mechanism of trauma was high energy trauma (e.g. motor car accident, motor bike accident or hit by a motor vehicle) in 18 patients and low energy (e.g. direct blow or fall to the ground) in 2 patients (Table 2).

Seventeen patients had only distal femoral fractures, 3 patients had another ipsilateral fractured bone (1 fracture patella, 1 fracture proximal tibia, 1 fracture distal tibia).

Intervention: Dynamic Locked plating was done for all patients using near-cortical over-drilling method as described by Gardner et al. [9]. In this method, regular locking plates are used & both cortices are drilled first using a 3.2-mm drill through a standard centering sleeve mounted to the locking hole in the plate. Then a 5.0-mm drill is used to drill the near cortex only. A 4.0-mm standard locking screw is then inserted and locked to the plate. This over-drilling will allow some motion between the near cortex & the screw, thus decreasing the stiffness of fixation by the standard locking plate as shown in the study conducted by Gardner et al. [6]. Near-cortical over-drilling was done for the proximal screws only (4–6 screws were used proximally) (Fig. 2).

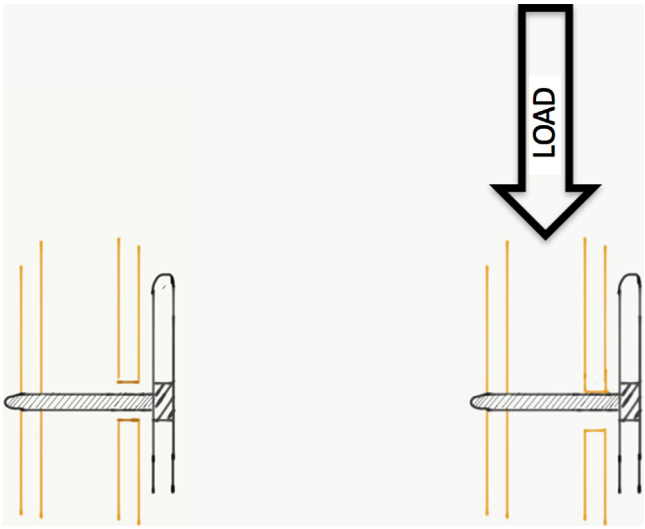

Fig 1. Illustration of the biomechanical concept of dynamic locked plating using near-cortical over-drilling technique.

Table 1
Patients' fracture pattern distribution.

Type of fracture	Number of cases	Percentage
(AO 33-A1)	5	25%
(AO 33-A2)	3	15%
(AO 33-A3)	7	35%
(AO 33-C2)	3	15%
(AO 33-C3)	2	10%

Table 2
Mode of trauma.

Mode of trauma	Number of cases	Percentage
Road traffic accident	7	35%
Motor car accident	3	15%
Motor bike accident	8	40%
Low energy	2	10%

Twelve cases were managed using minimally invasive plate osteosynthesis (MIPO), the other 8 cases were managed by open reduction internal fixation. No bone graft was used in any case. All Surgeries were performed by the first author.

Postoperatively, partial weight bearing as tolerated by the patient was allowed. The 1st post-operative visit was a wound check after 2 weeks, then follow-up by X-ray is done at monthly intervals till complete union, then at final follow up. Weight bearing was allowed as tolerated by patients. Knee range was encouraged after surgery & formal physical therapy was started after wound was healed.

Callus formation was assessed using Plain x-ray (antero-posterior & lateral views of the femur). Authors thought using other imaging techniques like CT scan to evaluate callus formation would subject patients to more irradiation & may be difficult to interpret due to presence hardware.

Authors adopted the method proposes by Gardner et al. [9] for assessment of callus; 2 blinded observers assessed callus score on 6-week radiographs using a 4-point ordinal scale (0 = none, 1 = minimal, 2 = moderate, 3 = robust). A 2-tailed *t*-test. Two-way mixed intra-class correlation testing was performed to determine reliability of the callus measurements by the 2 observers.

Union was defined as painless weight bearing and radiographic bridging of 3 of 4 cortices on 2 radiographic views. A 16-weeks mark was considered for delayed union & a 24-weeks mark was considered for non-union.

3. Results

All patients achieved union, time to union was 13.4 weeks on average (range form 8–24 weeks). Delayed union was observed in 2 patients with slow union, both were smokers, both achieved full radiological union by 20 and 24 weeks respectively (Table 3).

The average callus score for the fractures was 1.8 (SD 0.6). Five cases had a callus score of (1), 13 cases had a callus score of (2) & 2 cases had a callus score of (3) 2 cases healed by 1ry intention & had a callus score of (0), they were the 2 patients who showed delayed union (Fig. 3,Fig. 4). (Table 4). The two-way mixed intra-class correlation analysis showed agreement amongst observers in both consistency (0.712) and absolute score (0.723).

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