Far Cortical Locking Screws in Distal Femur Fractures

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abstract

Distal femur fractures routinely heal by secondary bone healing, which relies on interfragmentary motion. Periarticular locking plates are commonly used for fixation in distal femur fractures but are associated with a high nonunion rate, likely due to the stiffness of the constructs. Far cortical locking (FCL) screws are designed to allow micromotion at the near cortex while maintaining purchase in only the far cortex. Although clinical data are limited, these screws have been shown in biomechanical studies to provide excellent interfragmentary motion, and animal models have shown increased callus formation compared with traditional locking screws. The purpose of this study was to examine the clinical effects that FCL screws have on healing in distal femur fractures treated with locked constructs. In this retrospective case series, 15 patients with a distal femur fracture treated with MotionLoc screws (Zimmer, Warsaw, Indiana) were analyzed. Serial radiographs were evaluated for callus presence and time to union. All fractures were either 33-A3 or 33-C2 according to the AO classification system, and 5 (33%) were open. Bone loss was recorded in 2 patients. There were no nonunions, and average time to union was 24 weeks. There were no implant failures, and all 5 open fractures, including the 2 with bone loss, healed without intervention. There was 1 reoperation due to painful hardware. Although this is a small case series, these results are promising. Far cortical locking screws may provide the answer to the high nonunion rate associated with distal femur fractures treated with traditional locked constructs. [Orthopedics. 2015; 38(3):e153-e156.]

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The introduction of locked plating has revolutionized how fractures with significant comminution and poor bone quality can be treated. In many cases, locking plates are used in situations where a bridge plating technique is indicated.\(^1\) Supracondylar femur fractures are commonly associated with significant comminution and osteoporotic bone; therefore, bridge plating is commonly used. Periarticular locking plates are now an accepted method for treating these fractures by allowing sufficient construct stability while preserving blood supply and providing proper reduction.\(^2\)

Recently, the stiffness provided by locking technology has become a concern. Because interfragmentary compression is not used when bridge plating, fracture healing occurs through secondary bone healing.\(^2\) Secondary bone healing produces callus induced by interfragmentary motion. The high stiffness associated with locked constructs may not provide the amount of motion needed to obtain adequate callus formation for physiologic healing.\(^3-5\) Delayed union, nonunion, implant failure, and deficient callus have all been linked to locked plating, likely due to the increased stiffness provided by the construct.\(^5-7\)

In 2005, far cortical locking (FCL) screws were introduced. An FCL screw differs from a traditional locked screw by not engaging the cortex closest to the plate. This is accomplished by overdrilling the near cortex, and in the case of the MotionLoc screw (Zimmer, Warsaw, Indiana), the core diameter of the screw is smaller at the near cortex also. Combined, these factors provide increased motion at the near cortex. Biomechanical studies have evaluated the effect of FCL screws on fracture mechanics.\(^4,8\) For instance, FCL screws reduce axial stiffness by 80% in metaphyseal femur fractures and produce parallel interfragmentary motion.\(^4\) These biomechanical observations have also been shown in an ovine model, where FCL constructs demonstrated nearly 50% more callus formation and symmetry at the near and far cortex compared with a traditional locked plate construct.\(^9\)

Bottlang et al\(^10\) recently reported clinical results that demonstrated a 3\% nonunion rate with no implant failures. Far cortical locking screws seem promising in the biomechanics laboratory and in animal models; however, limited clinical data are available.

The purpose of this study was to examine the clinical effects of FCL screws on fracture healing and time to union in patients with distal femur fractures treated with a bridge-plating technique.

**MATERIALS AND METHODS**

After institutional review board approval, a prospective trauma database was retrospectively reviewed to identify all patients who underwent surgical fixation of a supracondylar femur fracture using a lateral periarticular locking plate in bridge-plating mode between January 2007 and April 2013. Radiographs and operative notes were reviewed to identify those in whom FCL screws had been used in the proximal fragment.

Patient demographics, AO fracture classification, open fracture classification, presence of bone loss, and complications were recorded. Specifically, complications were defined as nonunion, hardware failure, repeat operation, or infection. To further evaluate fixation characteristics, working length and number of proximal FCL screws were also recorded. To evaluate healing, serial orthogonal radiographs taken at defined intervals of 4 to 8, 10 to 14, 16 to 20, 22 to 26, and 28 to 32 weeks were reviewed. The radiographic union score was calculated using the previous work by Whelan et al.\(^11\) At each time interval, callus formation at each cortex was evaluated and assigned a numerical value according to the following scale: 0=no visible callus; 1=callus present but not bridging; and 2=bridging callus. Final union was defined as bridging callus present on 3 of 4 cortices, translating to a numerical value of at least 6.

**RESULTS**

Far cortical locking screws were used in a total of 16 patients. One patient had FCL screws intermixed with traditional locking screws and was excluded. Therefore, 15 patients were analyzed. Average age was 58 years, and 11 (73\%) patients were female.

All fractures were characterized as either 33-A3 or 33-C2, with 10 (66\%) being 33-A3. One-third (n=5) of the fractures were open, and all were classified as type 3A according to the Gustilo-Anderson open fracture classification.\(^12\) Bone loss was reported in 2 patients who sustained open fractures. Fracture characteristics are summarized in the **Table**.

In all patients, the MotionLoc screw was used to obtain a far cortical locking construct. Average working length was 12 cm, and the average number of proximal screws was 4.

Average time to clinical and radiographic union was 24 weeks. By using the radiographic union score as described, it was observed that the medial and posterior cortex trended to form callus earlier in the healing process compared with the other cortices. However, at the time of final union, all cortices showed similar callus presence. All open fractures, including those with bone loss, healed without ad-
ditional intervention. The Figure demonstrates a case with bone loss resulting in bony union.

There was 1 (7%) complication, which was reoperation for painful hardware in which the distal screws were irritating the patient medially. The hardware was removed at 9 months after injury. Importantly, there were no nonunions or hardware failures.

**DISCUSSION**

This study demonstrates the early clinical results of FCL screws. With a nonunion rate of 0% and a low complication rate, these results are encouraging.

The introduction of locked plating has had a dramatic effect on how we care for the osteoporotic patient with comminution. However, unacceptable nonunion rates in supracondylar femur fractures have raised concern about the stiffness of the locked construct and the inability to produce the correct amount of interfragmentary motion needed for secondary bone healing. Far cortical locking screws have shown encouraging results in the laboratory in both biomechanical and animal studies; however, clinical results are limited. The current study aimed to evaluate and report the results of FCL screws in the clinical setting.

In 2011, Henderson et al shed light on how locked plating of distal femur fractures is associated with healing com-
lications. They reported a 20% nonunion rate in distal femur fractures treated with traditional locked plates. As expected, a high nonunion rate comes with a high revision rate. In 2005, Schutz et al \(^{14}\) showed that 19% of patients treated with traditional locked plates needed a bone grafting procedure or hardware revision.

Many factors lead to nonunion and the need for revision. The amount of soft tissue stripping at the time of injury, comminution, and the age and health of the patient most likely all play a role in the rate of nonunion. These factors are specific to the nature of the injury and cannot usually be controlled. However, the stabilization method and mechanical factors can be controlled. Because most distal femur fractures are treated in a manner that uses secondary bone healing, stiffness of the construct plays an important role. For callus to form, interfragmentary micro-motion must be present. The result of insufficient motion is an atrophic nonunion. Henderson et al \(^{13}\) noted decreased callus size in patients who developed nonunions, suggesting that mechanical factors play a significant role. They also showed that titanium constructs produced more callus compared with stainless steel constructs, which also suggests that stiffness is contributing to the nonunion rate.

Bottlang et al \(^{10}\) reported their early clinical results. In their prospective, observational study, 31 distal femur fractures were treated with MotionLoc screws. There was 1 nonunion, which required revision at 6 months. Similar to the current authors, they reported no implant failures.

In the current case series, in which FCL screws were used, the nonunion rate was 0%. It may be that by overdrilling the near cortex and having screws with more elastic properties, an adequate amount of interfragmentary motion exists to produce secondary bone healing. Decreasing the axial stiffness of the construct could raise concern for early implant failure. It is important to note that no implant failures were encountered in this case series. The only complication was painful distal hardware where FCL screws were not used.

This study is limited by several factors, including its retrospective nature and the small sample size. There was also no comparative control group. Stiffness of a construct can be influenced by many factors, such as working length, plate type, and number of screws. These factors were not controlled for.

**CONCLUSION**

In this case series examining FCL screws, the dramatic decrease in the nonunion rate and low complication rate are promising. Based on the authors’ results and those reported previously by Bottlang et al \(^{10}\), FCL screws may provide the answer to the high nonunion rate associated with distal femur fractures treated with traditional locked constructs. Further randomized, prospective research comparing the 2 types of constructs is warranted.

**REFERENCES**