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Role of Far Cortex Locking Principle in Distal Femur Extra Articular Fractures.

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Abstract : *Stiffness of the locking plates commonly cause healing problems. far cortex locking principle is one easy way to reduce the locking construct stiffness by still maintaining enough strength of fixation. In this study we review our experience of using FCL principle in distal femur extra articular fractures. Four key features of FCL constructs that contribute to fracture healing and durable fixation are flexible fixation, load distribution, progressive stiffening, and parallel interfragmentary motion. FCl is a simple technique requiring not much learning curve with huge benefits with relation to fracture healing.*

Manuscript

I. Introduction

Distal femur locking plates have been fastly replacing supracondylar nails and distal femur buttress plates for virtue of its improved fixation strength [1]. However, the inherently high stiffness of locked constructs is commonly recognized as a potential cause of deficient healing observed in fractures stabilized with periarticular locking plates [2,3]. Locking plates allow for biological fixation principle that emphasize preservation of blood supply and functional reduction over anatomic reduction. In cases where anatomic reduction and interfragmentary compression is not possible, locked plating constructs rely on secondary bone healing[4,5]. Secondary bone healing is induced by micromotion at the fracture site[4]. Locking plates provide stiff construct not allowing such micro motion that would impair fracture healing.

Several approaches to decrease the stiffness of locked plating constructs were proposed to avoid stiffness related nonunion or delayed union problems(6-8). One of these approaches, termed Far Cortical Locking (FCL), has demonstrated improved fracture healing by providing flexible fixation and parallel interfragmentary motion with sufficient strength of fixation (2, 9). FCL employs locking screws that have a shaft section with a reduced diameter. These FCL screws lock into the plate and into the far cortex of the diaphysis. The reduced screw shaft diameter allows for elastic flexion of the screw within a controlled motion envelope at the near cortex (9). This flexion induces parallel interfragmentary motion for mediation of fracture healing by callus formation. Another method of creating the FCL principle using standard implants was to over drill the near cortex to have sufficient controlled motion at near cortex similar to the FCL crew. We review this method of far cortical locking principle in our case series of supracondylar fractures of femur treated with pre contoured locking plates.

Figure 1: Over drilling near cortex would allow routine locking screw to achieve only far cortex locking.

II. Methodology

We performed a retrospective review of distal femoral extra articular fractures treated surgically with pre contoured distal femur locking plates fixed with the principle of far cortex locking, during 2011 and 2014. All fractures were classified according to the AOClassification of Fractures. All the patients were followed regularly for evaluation of bone healing at monthly interval until 6 months and 3 monthly interval until 1 year. 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.

Far cortex locking operative technique :

The screws across the fracture are fixed using the FCL principle. The near cortex is over drilled slightly with next sized drill bit after drilling the pilot hole for the screw. Now engaging the screw would hold only in far cortex allowing sufficient controlled motion at the near cortex which is intentional. [fig 1& 2]

III. Results

A total of 17 cases were included who underwent locking plate fixation with FCL mode for extraarticular fractures of distal femur. 8 cases were compound and one had bone loss that was shortened intentionally to provide docking of fracture after debibdement and contouring the remaining fragments. All the cases were followed up periodically as per protocol. 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 additional intervention. None of the patients had delayed or non union [FIG 3]. One patient developed knee stiffness but had good union. three patients had prominent hardware on medial side of knee and required implant removal after consolidation of fracture. None required bone grafting as secondary procedure for bone healing.

Figure 2 : Illustration of a FCL Construct

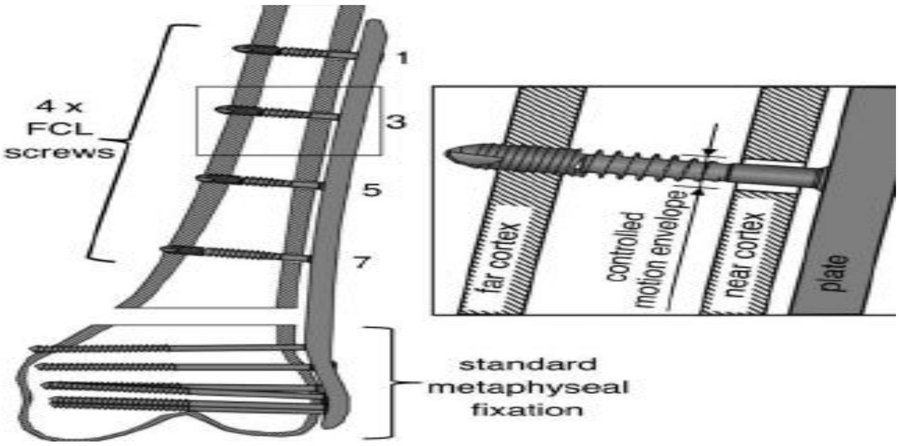
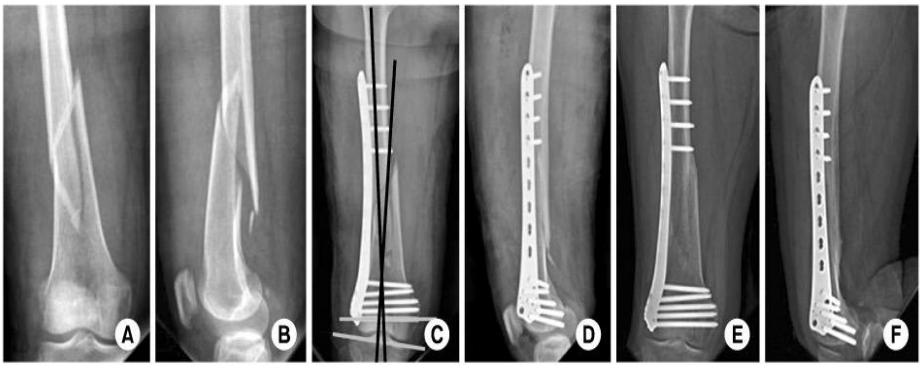


Fig 3 : Extra articular distal femur fracture treated by FCL principle in biologic way showing callus formation at



6 months time.

Discussion :

The stiffness of a fixation construct is a principal determinant of fracture-site motion and thereby affects the mechanism and progression by which a fracture heals [10]. Far cortex locking principle by passes the stiffness of the locking plate construct maintaining the stability enough for the fracture to unite. Our study demonstrates the ability of FCL to have early union without any chances of failure of bone healing and also minimal complications.

In 2011, Henderson et al[11]reported the healing related complications of locked plating of distal femur fractures. They reported a 20% nonunion rate in distal femur fractures treated with traditional locked plates. In 2005, Schutz et al[12] showed that 19% of patients treated with traditional locked plates needed a bone grafting procedure or hardware revision. Predictors of non union in cases of locked construct is proportionate to the amount of soft tissue stripping at the time of injury, comminution, and the age and health of the patient. These are patient controlled factors and have no role with mechanical principles of stabilisation using a locked construct. For callus to form, interfragmentary micromotion must be present. The result of such insufficient motion is an atrophic nonunion. Henderson et al[11] noted decreased callus size in patients who developed nonunions, suggesting that mechanical factors play a significant role [Fig 4]. 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.

We admit that our study has many limitations in terms of smaller study size and patient controlled factors viz fracture pattern, working lengths of screws were not standardised and also that there was no control group.

Figure 4 : 4A shows immediate fracture fixation with a locking construct of rigid fixation. 4B shows no attempt at callus even after 3 months. 4c shows : 5th month x ray with failing hardware due to delayed union and no attempt for callus formation.

IV. Conclusion

Four key features of FCL constructs that contribute to fracture healing and durable fixation are flexible fixation, load distribution, progressive stiffening, and parallel interfragmentary motion. FCl is a simple technique requiring not much learning curve with huge benefits with relation to fracture healing.

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