CORRELATION BETWEEN BONE MINERAL DENSITY AND FIXATION STRENGTH OF ORTHOPEDIC BONE PLATES

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INTRODUCTION

Fracture fixation stability for orthopedic bone plates is dependent upon bone mechanical integrity. Locked plates have shown theoretical advantages in poor quality bone when compared to traditional non-locked plates, since the locked interface functions to mechanically unite all of the screws to the plate and form a single beam. Dual Energy X-Ray Absorptiometry (DEXA) scanning yields defined bone quality parameters, but how bone mineral density (BMD) correlates to fixation strength during the period of fracture healing may be construct dependent. In this study, we sought to evaluate the effect of BMD on the strength of locked and non-locked plate constructs using a cadaveric distal femoral fracture model.

METHODS

Thirty-two human cadaveric femora (16 matched pairs) were harvested for this study. DEXA screening was performed on all bones to obtain BMD. An extra-articular metaphyseal 3cm gap was then created to simulate a comminuted distal femur supracondylar fracture. All bones were instrumented using distal femur locking plates (Smith & Nephew, Memphis, TN). The left and right femurs of matched pairs were randomly assigned to either locked or non-locked diaphyseal fixation. Metaphyseal fixation in all specimens was accomplished with five bicortical cannulated locking screws. Diaphyseal fixation was with four bicortical screws, either locked or non-locked. All specimens were potted and subjected to an axial cyclic compressive bending load of 50/500 N with a physiological varus moment at 2 Hz for 500,000 cycles. After 500,000 cycles, a constant load was applied until failure. Failure was defined as plate breakage or deformation, screw loosening, or bone fracture.

RESULTS AND DISCUSSION

DEXA results indicated a BMD range of 0.27–1.19 g/cm^2 for the bones utilized. Locked constructs showed no correlation between strength and BMD (R^2=0.01), whereas there was a clear demonstration that BMD moderately correlated to non-locked construct strength (R^2=0.50). The intersection of trendlines occured just above 0.65-0.70 g/cm^2 (Fig 1), a range below which has been described as indicative of osteopenia onset [1]. These results indicate a patient with osteopenia may benefit from a locked plate, whereas a patient with healthy bone may benefit from a non-locked orthopedic plate.

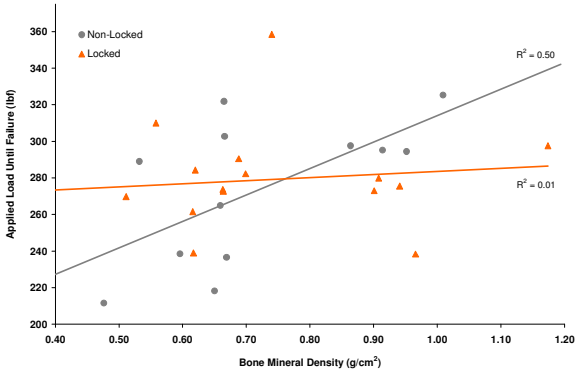

Figure 1: BMD and strength of locked or non-locked constructs after fatigue loading.

CONCLUSIONS

For low BMD bone, locked plates have shown to be stronger after fatigue when compared to non-locked plates. In higher BMD bone, non-locked plates may provide superior compressive capabilities, which improves fixation strength during fatigue. Thus, maintenance of fixation stability during rehabilitation is not only dependent upon BMD, but construct type should also be considered. These results provide a scientific basis to guide surgeons when deciding when locked screws are indicated for fracture fixation.

REFERENCES

1. Orwoll ES and Bliziotes M. *Osteoporosis Pathophysiology and Clinical Management*. Humana Press, Totowa, NJ.