ACHIEVING GREATER BONE-PLATE COMPRESSIVE FORCES IN FRACTURE FIXATION

An Investigation Into Screw Thread Form Effects

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INTRODUCTION

Conventional cancellous screws have proven purchase in healthy bone, but may be prone to loosening in osteoporotic bone. We hypothesized that optimizing screw thread form may improve purchase into poor quality bone and enhance bone-plate compressive forces. The purpose of this study was to evaluate the mechanical characteristics of a cancellous bone screw with a high major to minor diameter ratio using two osteopenic models.

METHODS

Twelve 'osteopenia' bone screws (major to minor diameter ratio of 1.85) were inserted through a thin B-type straight plate into a pre-drilled pilot hole to a depth of 20mm per ASTM recommendations [1]. Testing media included two groups: low density (10 pcf) solid rigid polyurethane foam blocks (n = 6) (Pacific Research Laboratories, Vashon, WA) and osteopenic fresh-frozen femoral diaphyseal cadaver (n = 6) (femur bone mineral density < 0.60 g/cm^2).

Rotational loading was applied manually using a hex driver until torque reached a peak value, which was denoted as stripping torque. The amount of compression gained between plate and bone was also measured using Tekscan (Boston, MA, USA) across a range of possible clinical insertion torques. This same procedure was used for twelve traditional cancellous bone screws (major to minor diameter ratio of 1.60), which were inserted through a conventional straight plate into both test medias.

RESULTS AND DISCUSSION

There was a linear relationship between applied torque and compressive force generation for both screws. General trends in data were consistent across both test medias. The 'osteopenia' bone screws showed a 34% increase in torque in foam block testing before stripping occurred ($p << 0.01$), and they were able to gain greater compression against bone across a range of insertion values as compared to conventional bone screws (Figure 1). Thus, these screws may provide better fracture reduction and lagging capabilities in the clinical situation. Greater compression may lead to enhanced mechanical stability over time during cyclical loading of the healing process.

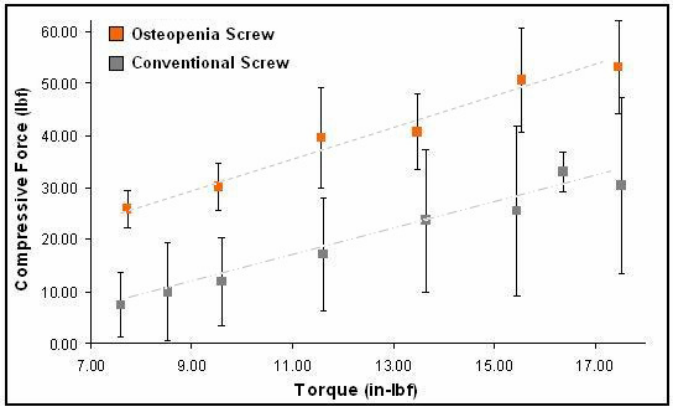

Figure 1: Plate-bone compression forces in an osteopenic cadaveric bone model. Correlation coefficient, R^2 = 0.97 for both screws.

CONCLUSIONS

When tested in surrogate foam and cadaveric bone models, bone screws with a higher major to minor diameter ratio provided superior stripping torque and compressive forces as compared to conventional cancellous bone screws. While tested in a clinically appropriate scenario, it is also recognized that one potential limitation is the comparison of two constructs of different plate design. However, this study was able to demonstrate a consistent difference in bone-plate compressive forces associated with two screw thread form designs. These findings indicate that the use of a specialized non-locked osteopenia screw may be advantageous in poor quality bone.

REFERENCES

1. ASTM F 543 07. Standard Specification and Test Methods for Metallic Medical Bone Screws.