6. Summary

In vitro biomechanical comparison of plate-rod combination and interlocking nail constructs in a canine tibial gap fracture model

The purpose of this study was to compare the biomechanical properties of an Interlocking Nail (ILN) and a Plate-Rod-Combination (PRC) in a canine comminuted fracture model. The hypotheses were that construct torsional and compressive compliances will be greater with ILN than with PRC and that construct bending compliance will be similar for both fixation devices.

Twelve canine tibial pairs of similar size were used. Three groups were formed (n=4/group). The group size was determined in a pilot study. In each pair, one tibia was instrumented with a 160 mm x 6 mm ILN, using four 2.7 mm screws. The contralateral tibia was stabilized with a 4 mm Steinmann pin, combined with an 11-hole, 3.5 mm limited contact - dynamic compression plate. To mimic a comminuted fracture, a 10 mm mid-diaphyseal defect was created. Four paired specimens were cyclically loaded in torsion (±5 Nm), compression (167.58 N), or bending (3.5 Nm). Construct compliances were determined at the 10^{th} cycle, then compared within and between constructs using two-factor ANOVA and Tukey's post-hoc tests (torsion, compression). Bending tests were compared using a paired student's t-test. Finally, the samples were tested to failure. The load to failure was compared using a paired student's t-test. The significance level was set at $p<0.05$ for all tests. The mode of failure was reported qualitatively.

Compliance curves for the ILN constructs were consistently bilinear in both torsion and compression. In torsion, the initial compliance between the constructs was significantly greater than the secondary compliance ($p<0.001$). Importantly, the maximum mean torsional angle with ILN was close to 35°. Initial compliances were also greater in the ILN in comparison to the PRC constructs in compression ($p<0.005$). Conversely, in either torsion or compression, there were no significant differences in secondary compliances between ILN and PRC constructs. Finally, bending compliance curves did not show the bilinear appearance found in torsion or compression. Moreover, ILN and PRC construct

compliances were not significantly different in bending. During failure testing, the ILN was more prone to deformation than the PRC.

The results of this study demonstrate that in a comminuted fracture model the combination of a bone plate and an IM pin provides a significantly more rigid fixation method than an ILN in torsion. This finding may result from a mismatch between the screw and nail hole diameter as well as deformation of the screw threads and the nail hole under torsional loads.

Clinically, by improving tibial fracture repair stability, plate-rod-combinations may reduce post-operative morbidity and promote faster return to limb function, compared to an interlocking nail.