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Comparison of the effect of locking *vs* standard screws on the mechanical properties of bone-plate constructs in a comminuted diaphyseal fracture model

Keywords: comminuted fracture, locking compression plate

1 Introduction

The purpose of this study was to compare the mechanical properties of bone-plate constructs with locking compression plates (LCP) used either with standard screws or with locking screws on an experimental model of comminuted fracture.

2 Methods

A model of comminuted fracture (mid-diaphyseal 5-mm gap) was created on ovine tibia and treated with a 8-hole, 4.5-mm, broad stainless LCP plate with 3 bicortical self-tapping screws in each fragment. In group 1 (n=6), 4.5 mm cortical screws were placed in slightly inner eccentric position and in group 2 (n=6), 5.0 mm locking screws were used. Quasi-static non-destructive tests were performed in 4-point bending, torsion and axial compression. A laser scan micrometer continuously measured the width of osteotomy gap.

Extrinsic stiffness of bone-plate constructs (K) was calculated, as well as stiffness loss (Kr) compared with contralateral tibia. Slope of the load-gap displacement curve (S) was calculated.

Results were statistically compared between the 2 groups by a 2-way ANOVA and Tukey's Post Hoc tests with significance set at $P<.05$.

3 Results and Discussion

In 4-point bending, there were no significant differences between group 2 (G2) and group 1 (G1) for K (G2: 321.9 ± 65.2 kN/m, G1: 286.0 ± 36.6 kN/m), for Kr (G2: 55.4 ± 10.4%, G1: 64.5 ± 3.9%) and for S (G2: 292.0 ± 84.3 N/mm, G1: 271.4 ± 36.2 N/mm). In torsion, there were no significant differences between the 2 groups for K (G2: 122.1 ± 17.1 Nm/rad, G1: 107.3 ± 16.5 Nm/rad) and for Kr (G2: 44.0 ± 10.3%, G1: 55.0 ± 10.6%).

That is consistent with most other *in vitro* and *ex vivo* studies comparing LCP with non locking (LC-DCP) plates [1] [2].

In compression, group 2 showed significantly lower K (611.1 ± 104.0 kN/m) and higher Kr (66.5 ± 10.3%) than group 1 (1019.2 ± 249.5 kN/m; 47.7 ± 10.8%), whereas other studies showed significantly higher stiffness for locking screws [2] [3]. It might be related to 2 phenomena: i) the friction forces induced by the screws which compress the plate onto bone in standard osteosynthesis and ii) the limitation of bone displacement by the eccentric position of standard screws that are blocked on the inner part of the plate hole, under axial compression. Anyway, there was no significant difference between the 2 groups for S (G2: 254.6 ± 72.6 N/mm, G1: 438.2 ± 228.4 N/mm).

4 Conclusions

Locking screws had no statistically significant effect on the mechanical properties of LCP-plated bones in 4-point bending and torsion, compared to standard screws. In axial compression, locking screws induced a significant decrease in global mechanical properties without significant decrease in local mechanical properties close to the osteotomy gap.

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