Osseodensification for enhancement of spinal surgical hardware fixation.

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Abstract

Integration between implant and bone is an essential concept for osseous healing requiring hardware placement. A novel approach to hardware implantation, termed osseodensification, is described here as an effective alternative. 12 sheep averaging 65kg had fixation devices installed in their C2, C3, and C4 vertebral bodies; each device measured 4mm diameter×10mm length. The left-sided vertebral body devices were implanted using regular surgical drilling (R) while the right-sided devices were implanted using osseodensification drilling (OD). The C2 and C4 vertebra provided the t=0 in vivo time point, while the C3 vertebra provided the t=3 and t=6 week time points, in vivo. Structural competence of hardware was measured using biomechanical testing of pullout strength, while the quality and degree of new bone formation and remodeling was assessed via histomorphometry. Pullout strength demonstrated osseodensification drilling to provide superior anchoring when compared to the control group collapsed over time with statistical significance ($p<0.01$). On Wilcoxon rank signed test, C2 and C4 specimens demonstrated significance when comparing device pullout ($p=0.031$) for both, and C3 pullout tests at 3 and 6 weeks collapsed over time had significance as well ($p=0.027$). Percent bone-to-implant contact (%BIC) analysis as a function of drilling technique demonstrated an OD group with significantly higher values relative to the R group ($p<0.01$). Similarly, percent bone-area-fraction-occupancy (BAFO) analysis presented with significantly higher values for the OD group compared to the R group ($p=0.024$). As a function of time, between 0 and 3 weeks, a decrease in BAFO was observed, a trend that reversed between 3 and 6 weeks, resulting in a BAFO value roughly equivalent to the t=0 percentage, which was attributed to an initial loss of bone fraction due to remodeling, followed by regaining of bone fraction via production of woven bone. Histomorphological data demonstrated autologous bone chips in the OD group with greater frequency relative to the control, which acted as nucleating surfaces promoting new bone formation around the implants, providing superior stability and greater bone density. This alternative approach to a critical component of hardware implantation encourages assessment of current surgical approaches to hardware implantation.