Evaluation of Bone Substitutes using a Rabbit Posterolateral Lumbar Intertransverse Process Spinal Fusion (PLF) Model: A Subchronic Pilot Study

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Statement of Purpose: Posterolateral lumbar intertransverse process spine fusion is a well-recognized type of spinal arthrodesis performed in orthopedics. The traditional surgical technique consisted in harvesting autologous iliac crest bone graft (ICBG) in order to induce and enhance a bone bridging phenomenon from one level to the next and became the gold standard for years. However, non-union rates with single-level arthrodesis varied between 5-35% and were higher for multiple spinal levels[1,2]. Additionally, apart from the limited availability of autogenous bone graft, postoperative complications were observed including prolonged surgical time, increased risk of blood loss, infections and morbidity of bone donor site as well as non-union at the recipient site, leading to pseudoarthrosis and residual pain. This study evaluated the bone fusion potential of synthetic bone substitutes in comparison to autograft using a rabbit posterolateral lumbar intertransverse process spinal fusion (PLF) model.

Methods: Three (3) skeletally mature male New Zealand White rabbits underwent single-level, bilateral, posterolateral intertransverse process fusions at L4-L5 using either synthetic resorbable bioactive biphasic CaP bone substitutes (60% HA, 40% β-TCP; 0.5-2mm granules and putty; Eclipse™, Biomatlante) or autologous iliac crest bone graft (ICBG) controls. The study protocol was approved by an Institutional animal care and use committee (IACUC) of a fully AAALAC and CCAC-certified research center.

A dorsal 6-cm midline skin was made centered over the L4-L5 level. A 4-6 cm longitudinal incision was performed through the lumbar fascia exposing the underlying longissimus muscle. After sharp and blunt dissection, a high-speed electric burr was used to decorticate the exposed transverse processes (TPs). Approximately 2.0-2.5 mL of ICBG (controls) were also obtained bilaterally and morselized (<0.5 mm). Either Test or Control Articles (1-2cc) were placed bilaterally in paraspinal muscle beds over the dorsal aspect of TPs.

Animals were then allowed to recover with unrestricted weight-bearing in environment-controlled grouped-housed cages. CT-Scans (Somatom Sensation 16, Siemens) were performed immediately post-op, then after 6 and 8 weeks post-implantation. At necropsy, lumbar spines were harvested *en-bloc*, manually palpated, imaged by high-resolution radiography (Faxitron, MX-20) and 3D reconstructed by Micro-CT (Nikon, XTH 225). The spines were then processed for non-decalcified histology (Exakt 400 CS, Micro Grinding System) in order to produce 20-60-µm sagittal sections.

Results: Bilateral posterolateral lumbar intertransverse process surgical insertions procedures were performed successfully. All animals maintained good health status and gained weight throughout the 8-week implantation period. Following necropsy, manual palpation showed slightly decreased mobility in the case of the biphasic CaP putty group both in lateral bending and flexion-extension. Also, µCT and Faxitron imaging revealed intertransverse foci that may represent initial ossification in presence of unresorbed biphasic CaP particles (Figures 1 and 2).

Figure 1. µCT 3D reconstruction of lumbar level L4-L5 after 8 weeks (Lateral view, Nikon XTH 225; 17-µm res).

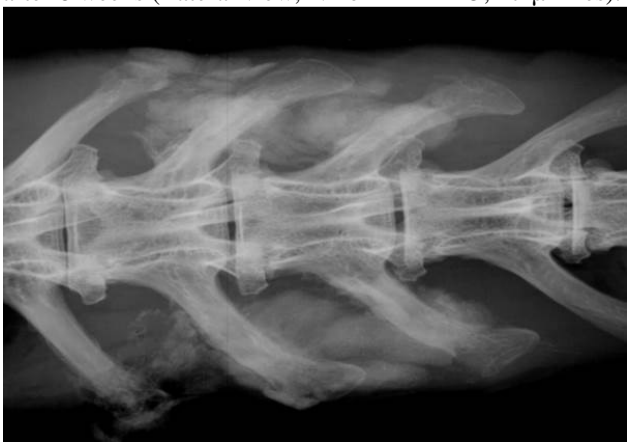

Figure 2. High-resolution radiography of lumbar level L4-L5 after 8 weeks (AP view, Nikon XTH 225).

Conclusion: This posterolateral lumbar intertransverse process spine fusion (PLF) model showed decreased mobility in absence of solid fusion in rabbits after 8 weeks. Longer implantation time-points are needed to show complete bridging with these evaluated biomaterials and may extrapolate to others.

References:

[1]Boden SD. Tissue Eng. 2000; 6(4): 383-399.
[2]Kraiwattanapong C. Spine 2005; 30(9): 1001-1007.