A Novel Resorbable, Osteoconductive Tetracalcium Phosphate Phosphoserine Bone Adhesive for Spinal Fusion: Initial Histologic, Biomechanical, and Radiographic Findings in a Rabbit Posterolateral Fusion Model

H Eisenbrock DO; B Hess BS MBA; G Kay DMD MMSc; M Brown BS; D Kosh; A Marchenko BS; J Slotkin MD; E Woodard MD

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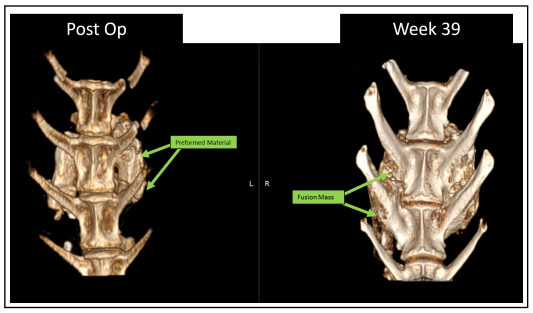
Introduction

We describe initial in vivo investigations of a novel calcium and phosphoserine based bone adhesive. This material shows a unique constellation of properties including rapid selfsetting, immediate tensile and load -bearing strength, and notable capacity to adhere to both bone and metal. This material is gradually biodegraded and replaced by bone through bone growth and remodeling. The aim of this study was to examine the tensile strength, radiographic findings, and histologic characteristics of this material in a rabbit posterolateral fusion model.

Methods

Seventeen adult New Zealand White rabbits underwent testing at the L5/6 level. The transverse process (TP) were exposed and decorticated at L5 and L6 bilaterally using a high-speed drill. Rabbits received either freeform syringe-injectable or preformed solid-state material. One rabbit was used as a negative control. All rabbits were analyzed using Cone Beam Computed Tomography (CBCT) every three weeks. Selected animals were chosen for biomechanical testing at 3, 6, 10, and 20 weeks. Tensile strength testing was done at both L5/6 (experimental level) and L4/5 (control).

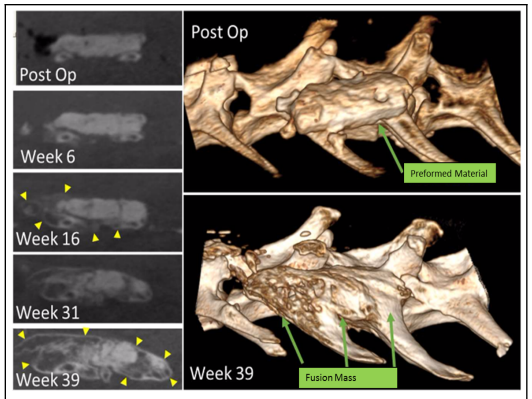


Results

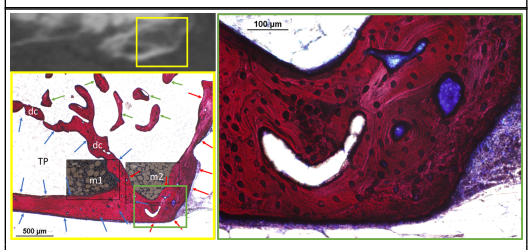
The relative strength of the material-fused vertebrae was 1.39x that of the internal control at t=0. Remarkably, the trend of material-fused relative strength to the control segment increases considerably to 9.1x at 20 weeks.

The CT images show stability was maintained without fracture through week 39. Formation of circumferential radio density, consistent with cortical bone, became detectable at week 16 and dense at week 39.

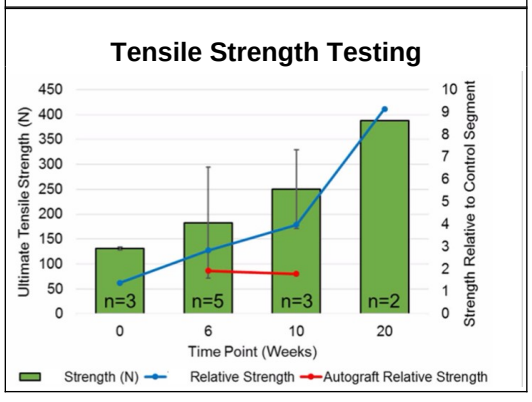
Newly formed bone within the original graft volume showed well defined lamellar cortex with maturing osteons. Additionally, the newly formed marrow space appeared histologically equivalent to the original marrow within the transverse process.



Cortical bone formation (yellow arrows) at week 16, dense at week 39



Adhered region of preformed material to the TP at 39 weeks



Learning Objectives

1) Understand the potential role of the material 2)Conceptualize spinal fusion without the use of instrumentation, 3) Advance knowledge of nanomaterials

Conclusions

In conclusion this material has shown initial promise to provide fixation strength for non-instrumented posterior spinal fusion as evidenced by initial strength testing, imaging and histological data. Ongoing testing will determine what role it may have in future spine surgery

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