

# EARLY RADIOLOGICAL RESULTS WITH A BIO-ENGINEERED DEGRADABLE BONE GRAFT SUBSTITUTE FOR BONE TUMORS

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# Early Radiological Results With A Bio-Engineered Degradable Bone Graft Substitute For Bone Tumors

## PRE-CLINICAL STUDY<sup>1</sup>

### INTRODUCTION

A tri-phasic CaSO<sub>4</sub>-based cement (PRO-DENSE™) was engineered, incorporating a matrix of CaSO<sub>4</sub> and dicalcium phosphate dihydrate (CaSO<sub>4</sub>-DCPD) with a distributed phase of β-tricalcium phosphate (β-TCP) granules.

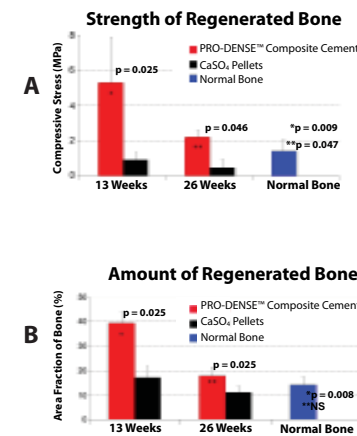
### PURPOSE

We hypothesized that the amount and compressive strength of restored bone would be significantly greater and the material resorption profile slower when defects were treated with PRO-DENSE™ composite cement compared to conventional CaSO<sub>4</sub> pellets and to normal bone of canine proximal humeri.

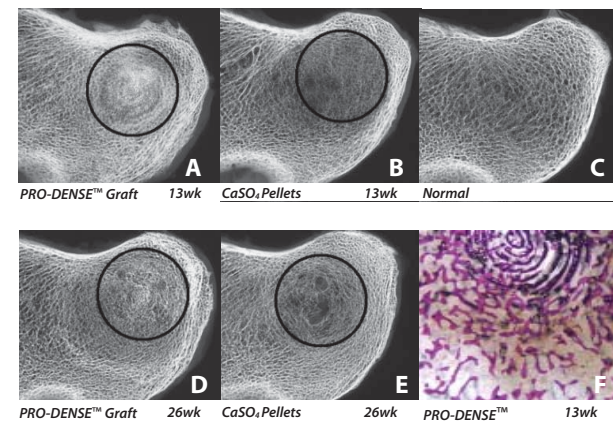
### STUDY DESIGN

- Animal Model: 10 adult male dogs, 25-32 kg
- Critical-size Defects: 13x50 mm, bilateral humeri
- Test Article: 6 cc of PRO-DENSE™ injectable composite cement (Wright Medical)
- Control Article: 50 pellets of conventional medical grade CaSO<sub>4</sub> (Wright Medical)
- Study Periods: 13 weeks (N=5) and 26 weeks (N=5)

## RESULTS



**Figure 1.** The ultimate compressive stress (A) and area fraction of mineralized new bone (B) was greater in defects treated with PRO-DENSE™ composite cement compared to defects treated with conventional CaSO<sub>4</sub> pellets at 13 and 26 wks and also greater compared to normal bone.

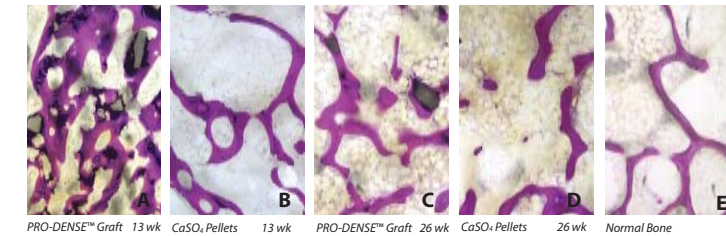


**Figure 2.** Transverse section radiographs of the 13-week (A and B) and the 26-week specimens (D and E). A normal humerus is shown for comparison (C). Histological section stained with basic fuchsin and toluidine blue, X20 (F).

### REFERENCE:

<sup>1</sup> Urban RM, Turner TM, Hall DJ, Inoue N, Gitelis S. Increased Bone Formation Using a Calcium Sulfate and Calcium Phosphate Composite Graft. *Clin Orthop Relat Res.*, IN PRESS

- All of the defect sites (black circles) contained bone trabeculae that blended with the adjacent medullary bone at both 13 and 26 weeks.
- The highly radio-dense DCPD matrix and β-TCP material, often in a pattern of concentric rings, remained at 13 weeks (A) and to a much lesser extent at 26 weeks (D).
- The concentric ring pattern in the contact radiographs corresponded in the stained histological sections to bands of new bone layered on the surfaces of residual PRO-DENSE™ material (F).
- Residual CaSO<sub>4</sub> pellets were not apparent at 13 weeks (B) or at 26 weeks (E).



**Figure 3.** The typical nature of bone in a defect treated with PRO-DENSE™ composite cement at 13 weeks with incorporated matrix (dark-stained) and β-TCP granules (grey) (A), compared to a defect treated with conventional CaSO<sub>4</sub> pellets at 13 weeks without residual material (B), and compared to normal bone of the canine proximal humerus (E). At 26 weeks there were fewer β-TCP granules (grey) (C) with PRO-DENSE™ Composite cement and no residual material in defects treated with conventional CaSO<sub>4</sub> pellets (D). (Undecalcified ground sections stained with basic fuchsin and toluidine blue, X100).

### CONCLUSION

The injectable PRO-DENSE™ composite cement increased the amount and strength of restored bone when compared to conventional CaSO<sub>4</sub> pellets after 13 and 26 weeks in a canine critical-sized bone defect model and when compared to specimens of normal bone.

## DISCUSSION

PRO-DENSE™ Tri-Phasic Cement:

- Engineered biomaterial
- Exploits different resorption rates of three Ca-based materials
- Majority of the CaSO<sub>4</sub>/CaPO<sub>3</sub> matrix resorbed early
- Promoted vascular infiltration and new bone formation into the cement
- Distributed granules provided a scaffold, incorporated into the new bone, and then slowly resorbed

This cement holds promise for clinical applications where a strong, injectable and highly biocompatible bone graft substitute would be advantageous.

## BONE TUMOR APPLICATION

### METHODS

- **12 Patients with benign bone tumors**
  - Unicameral Bone Cyst (UBC): 4
  - Non-Ossifying Fibroma (NOF): 4
  - Aneurysmal Bone Cyst (ABC): 2
  - Osteoid Osteoma: 2
- **Tumor Locations:**
  - Tibia 3      - Fibula 2
  - Humerus 3      - Talus 1
  - Femur 3
- **Follow-up: 7.25 months (4 - 12 mos.)**

### RESULTS

- **Radiological Follow-up**
  - Resorption of PRO-DENSE™ cement between 3 - 6 mos.
  - Resorption occurred peripherally
  - New bone formation at edges of resorbing cement
  - Consistent results for all patients
- **Clinical Follow-up**
  - All patients: full functional recovery
  - No additional surgery
  - No fractures

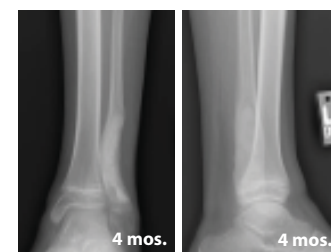
### CASE 1: ABC - FIBULA



**Figure 1.** Aneurysmal bone cyst in distal fibula. **Figure 2A:** Excision and curettage of the cyst. **Figure 2B:** Injection of PRO-DENSE™ cement into the fibula defect area.

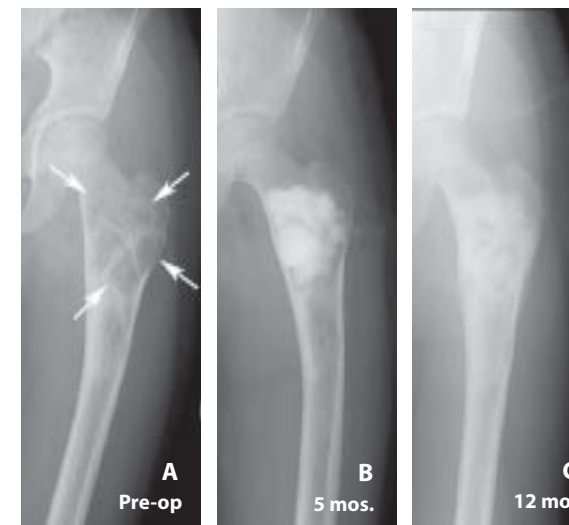


**Figure 3.** Anterior and lateral views at 1 month post-op. Some resorption of PRO-DENSE™ cement is evident, but substantial cement remains.



**Figure 4.** Anterior and lateral views at 4 months post-op. Some PRO-DENSE™ cement persisting, but radiopacity of defect is approaching that of the surrounding bone.

### CASE 2: UBC - Femur



**Figure 5.** Series of radiographs of a unicameral bone cyst (A) treated with PRO-DENSE™ cement. At 5 months post-op, resorption of the cement is evident at the peripheral edges of the defect (B). By 12 months, the PRO-DENSE™ cement is substantially resorbed and the radiopacity of the defect resembles that of the surrounding bone (C).

### DISCUSSION

PRO-DENSE™ Tri-Phasic Cement:

- Injectable, packable
- Early return to joint motion
- Numerous applications
- Early restoration of function

### CONCLUSION

This early clinical and radiological study of PRO-DENSE™ cement revealed promising outcomes and closely resembled the pre-clinical testing.

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