INTRODUCTION
Histologically, plaster of Paris (POP) or calcium sulfate has been used in pellet (dihydrate form) as a bone graft substitute. The setting properties of calcium sulfate can allow this material to be used as a slurry, which has advantages of ease of handling and delivery via injection. The form of POP may have important implications regarding implant resorption and tissue infiltration within a bone defect. This study assessed bone formation and implant resorption rates between these two preparations as well as the defect mechanical properties in a bilateral corticocancellous defect model.

METHODS
Bilateral defects (5 mm wide x 15 mm long) were created 3 mm below the joint line in the proximal tibia in 15 skeletally mature New Zealand white rabbits following ethical approval. Marker pins were placed at the proximal and distal defect margins to identify the central portion. The defects were filled with a calcium sulfate (CS, group 1) slurry (BonePlast, Interpore-Cross International, Irvine, CA) or calcium sulfate in pellet form (Osteoplast pellets group 2, Interpore-Cross International, Irvine, CA; Osteoset pellets, group 3, Wright Medical Technology, Arlington, TN). CS in powder form was mixed in a sterile fashion at the time of surgery and placed into the defect after 2 minutes of mixing. The 6 calcium sulfate pellets were placed into each defect. Empty defects (negative control) or defects filled with morcellised bone autograft from the defect sites (positive control) were also performed. The tibiae were harvested at 3 and 6 weeks, radiographed (standard x-rays and f proxitraxion in the AP and lateral planes. Tibias were processed for torsional testing and quantitative histomorphometry using back scattering SEM. Four additional rabbits (8 tibias) were sacrificed at time zero (n=6 tibias) to determine intact tibia mechanical properties and implant and void percentages at time zero (n=2).

Torsional mechanical testing was performed using an MTS 858 Bionix testing machine. The tibiae were potted in Woods metal using an alignment jig and subjected to cyclic torsional loading (+/− 2° for ten cycles at a rate of 0.7° per second) followed by loading to failure at a rate of 0.7° per second. The samples were fixed in phosphate buffered saline, embedded in polymethylmethacrylate and cut longitudinally through the marker pins to expose the central portion of the defect. Backscatter electron imaging was performed on a Cambridge Instruments S360 scanning electron microscope at 10x to provide an overview of the defect as well as 6 sites at 40x magnification within the defects (3 cortex and 3 canal) for quantification. The percentages of bone ingrowth, remaining implant material and soft tissue voids at each time point were determined using a threshold technique using Global Labview. Image Data was analyzed using a 2-way analysis of variance.

RESULTS
No differences related to the analysis site (cortex or canal) were noted regarding implant resorption or new bone formation. Figure 1 summarizes the implant resorption and bone formation versus time. New woven bone was observed in all groups at 3 weeks which increased 3 fold by 6 weeks. Defects treated with CS pellets had more bone than the those treated with the calcium sulfate slurry at 6 weeks (p<0.05). The CS slurry resorbed more quickly at 3 weeks (p<0.05) but no differences were present by 6 weeks. No differences in implant resorption or new bone formation was found with the calcium sulfate pellet (group 2 vs. 3). Torsional properties were significantly inferior (p<0.05) compared to intact controls. Mechanical properties increased with time but did not differ between and groups.

**Figure 1:** % Implant or bone in the defect (mean +/- se).

**Figure 2a-c:** Low magnification SEM of the defect in the Osteoplast slurry (2a), Osteoplast pellets (2b) and Osteoset pellets (2c) at 3 wks. New woven bone is noted distally in the defect with some residual implant material.

**DISCUSSION**
Implant resorption and new woven bone formation was observed in the defects treated with calcium sulfate that increased with time. Both forms of calcium sulfate had nearly completely resorbed by 6 weeks in this model. Calcium sulfate can be used as a bone graft substitute alone, but does not provide a 3 dimensional matrix for subsequent bone ingrowth which may be a limiting factor.

Placement of a material in a surgical site is often hampered by access and location of the defect that requires greater exposure. It is possible to combine calcium sulfate with other bone graft substitutes to allow them to be injected and set-vivo. No differences were demonstrated in this study with regards to the form of calcium sulfate used (pellets versus slurry). Both forms have different handling properties and as a result can be used in a variety of ways as required to fill open defects or those that are more difficult to access.

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