INTRODUCTION: The treatment of large diaphyseal defects remains a formidable clinical challenge. Currently available treatment modalities, such as distraction osteogenesis, vascularized bone transfer or repeated bone grafting, have however major limitations. Cylindrical mesh titanium cages filled with bone graft have been successfully used in the spine to replace and/or fuse vertebral bodies.[1] Recently we have reported initial clinical experience with cylindrical mesh titanium cages for the treatment of segmental diaphyseal defects.[2] Objective of the study was to grossly establish bone regeneration across a segmental diaphyseal defect in the canine femur treated with a mesh titanium cage in combination with canine allograft composite and stabilized with an intramedullary nail.

MATERIAL & METHODS: Twenty-one dogs (hounds, age 2-3 years, weight 22-26 kg) were used in the experiment. Experiment guidelines and animal care were approved by the Institutional Review Board. Under general anesthesia a 3-cm osteoperiosteal segmental defect was created in the mid-diaphysis of one canine femur using an oscillating saw. In eighteen experimental dogs, a cylindrical mesh titanium cage (DePuy-Acromed, J&J, IN) with a diameter of 20 mm and length of 40 mm, was packed firmly with allograft composite consisting of fresh-frozen canine cancellous croutons (Veterinary Transplant Services, Seattle, WA) mixed with canine demineralized bone matrix (Dynagraft, GenSci J&J) an implanted in the defect. The femur canal was reamed through the cage and IM nail inserted. These dogs were divided into three groups (6 dogs each) and followed for 6, 12, and 18 weeks post surgery, respectively. The experimental dogs were compared with a control group consisting of 3 dogs with the defect packed with the same volume of allograft composite, but without the cage. All femora were stabilized with a titanium statically locked IM nail (DePuy ACE). Plain radiographs, 3D-CT reconstructions (Vitrea, Vital Images, MN) and SPECT (Tc 99m MDP uptake) were performed in all specimens.

RESULTS: Full-weightbearing on the operated legs in all dogs was noted at one week post surgery. At the time of euthanasia, there were no signs of infection in any of the specimens. By 3D-CT reconstructions all dogs in the control group did not heal, and the bone graft demonstrated massive resorption, and frank nonunion as assessed at 18 weeks post surgery (Fig.1). Dogs in the experimental (cage) group demonstrated progressive reconstitution of the bone graft within and upon the outer surface of the cage (Fig.2). The biological activity of new bone progressed from the bone ends towards the middle of the defect as assess from SPECT at 6, 12 and 18 weeks. There was significantly lower uptake of Tc 99m in control group at 18 weeks (atrophic nonunion).

DISCUSSION: Segmental diaphyseal 3-cm defect in the canine femur was successfully treated with the cylindrical titanium mesh, IM nail, and allograft composite. The cage allowed for uniform reconstitution of the bone graft and provided initial mechanical stability. It also provided immediate osseous continuity which permitted early functional limb recovery and allows for defect healing. Further biomechanical and histological studies are required to assess the mechanical properties and the biological nature of the bone formed in the defect.

REFERENCES: