Introduction:
Since the original description by German and Black of a vein patch side-wall canine aneurysm model in 1954 and our subsequent expansion of the technique to include bifurcation and terminal aneurysm geometries, experimental canine aneurysms have been widely used both for the development and the preclinical evaluation of endovascular devices and techniques and for, studies of aneurysm flow characteristics. (1,2) In an attempt to develop a model that would replicate the hemodynamic conditions present in very large or giant aneurysms we have developed a method techniques that allow the sizes of the canine aneurysms to be enlarged significantly.

Methods:
All procedures were performed under an institutional approved protocol. Anesthesia was induced with propofol 10 mg/kg intravenously injection, and maintained using 1.5% isoflurane and 100% oxygen. After the neck was prepped and draped, bilateral 10cm incisions were made medial to each external jugular vein. 30 mm segments of both external jugular veins were ligated, removed, and placed in heparinized saline (1000 U heparin / 100 ml saline). The left common carotid artery (CCA) was divided at its mid-portion after it was ligated proximally and clamped distally with a temporary vascular clamp. A tunnel was created under the trachea. Through this the distal segment of the left CCA was sewn into the opening between the right and left CCA. All vascular sutures were performed using 7-0 prolene suture. The opened segments of the jugular veins were then anastomosed to form a single cylinder using a running suturing technique. Once this was done the resulting vein pouch was passed to the right side of the trachea. Temporary clamps were placed proximally and distally on the right CCA. An 8 mm arteriotomy was made on the right CCA midway between the clamps. The distal segment of the left CCA was then anastomosed to the base of the right CCA. Both external jugular vein segments were opened longitudinally and angled (arrowhead shaped) incisions were made into both vein segments so that they would match the arterial opening where the right and left CCAs had been anastomosed. The opened segments of the jugular veins were then anastomosed to form a single cylinder using a running suture technique. Once this was done the resulting vein pouch was sutured into the opening between the right and left CCA. All vascular sutures were performed using 7-0 prolene suture. The temporary vascular clamps were removed, and hemostasis was established. (Figure 2) Incisions were closed using absorbable suture. Animals were allowed to recover. No anticoagulation or anti-platelet medications were employed. Angiograms were performed at an interval averaging 4.5 weeks after the aneurysm creation. To further increase the aneurysm size the width of the vein patch used to form the aneurysm was increased by incorporation of a segment of Gortex® into the vein patch wall.

Results:
On average, the surgical procedure took 2.5 hours. No significant complications occurred. Follow-up angiograms performed at 4.5 weeks on the initial 7 aneurysms showed 6 of them fully patent. (Figure 1) The sizes of these aneurysms are shown in Table 1. In the one animal with a thrombosed aneurysm, necropsy done 3 months post aneurysm creation showed organized thrombus filling the entire aneurysm cavity. No cause for this thrombosis was identified. For the Gortex® - Incorporated aneurysm an angiogram was performed 6 weeks post creation. (Figure 3) This revealed full patency of the aneurysm. Dimensions of the aneurysm were tabulated.

Discussion:
We have demonstrated the feasibility of creating very large or giant bifurcation or terminal aneurysms in the canine vein patch model. Seven of 8 aneurysms made with a composite vein patch remained patent for 3 months; 1 of 1 aneurysm made with a combination of vein patch and Gortex® remained patent for 1.5 months. No post-surgical anticoagulation or anti-platelet medications were used. To avoid spontaneous thrombosis of these large or giant aneurysms it is critical that the area of the ostium be larger than that of the usual canine vein patch aneurysm. (3) Because of this, we purposely increased the size of the arteriotomy on the parent artery from 6 mm to 10 mm. The size of aneurysms made from the composite vein patch is limited by the dimensions of the jugular vein. To increase the size further in one animal we added a Gortex® patch to the vein graft. We are encouraged with our results in this single animal and will continue exploration of this technique. Our view of animal aneurysm models is that they replicate well the hemodynamic forces that occur in human aneurysms. For many reasons (location, structure of the aneurysm, genetics) they do not replicate the biological features associated with aneurysm formation, growth or rupture. Still, the inclusion of graft material in an experimental model likely compromises histopathological evaluation of implantable devices.

Conclusion:
We showed that giant aneurysms can be successfully created in a one-stage surgical procedure taking on average 2.5 hours. It is worth continuing trying to advance these surgical models.

References: