INTRODUCTION:
Flexor tendon reconstruction plays an important role in reconstruction to restore finger function when the primary repairs can not be performed or failed. Although intrasynovial grafts have shown the better outcomes compared to the extrasynovial grafts, potential sources of intrasynovial tendons available for use as tendon autografts are limited. However, allograft intrasynovial tendon sources are readily available, which permits easy clinical application. A recent study demonstrated that carbodiimide-derivatized hyaluronic acid with gelatin (CHG) improved the allograft surface properties that had been damaged by the techniques of preserving allografts. Therefore, the purpose of the current study was to investigate the effects of CHG modification of allograft-intrasynovial tendon for flexor tendon reconstruction using a novel, clinically relevant model for flexor tendon graft, i.e. a failed primary flexor repair in a canine in vivo model.

METHODS:
Preparation of Intrasynovial Allograft Tendons: 24 flexor digitorum profundus (FDP) tendons were obtained from the dogs that were sacrificed for other IACUC approved protocols. The tendons were immediately immersed into liquid nitrogen for 1 minute and then thawed for 5 minutes in warmed saline solution at 37°C. This procedure was repeated five times to induce tenocyte necrosis. The tendons were then lyophilized with a custom-made lyophilizer for preservation and sterilization. The graft was rehydrated in a 0.9% NaCl bath in a closed, sterilized container for 24 hours in an incubator at 37°C prior to graft surgery.

Creation of Flexor Primary Repair Failure Model: 24 FDP tendons from 2nd and 5th digits of 12 dogs were first lacerated at zone II and repaired with modified Kessler technique with 3/0 Ethibond suture and a simple running suture with 6/0 nylon. Two small metal markers were embedded into the repaired tendon with the repair site in the middle. The distance between the two metal markers was measured using a fluorescent scope to evaluate repair gap. Following surgery, the dogs were allowed free cage activities for 6 weeks.

Flexor Tendon Reconstruction with Intrasynovial Allografts: Six weeks after primary repair, the previously operated forelimb was again prepared for FDP tendon reconstruction. The FDP tendons were approached through previous incisions. The repair status and adhesions were observed and recorded during careful dissection. A tunnel was created by removing the repaired FDP tendon along with scar and adhesion tissues and preserving the proximal pulley in Zone II. Following the recipient digit preparation, the prepared allografts were pulled through the tunnel and sutured to the recipient digit with a modified Kessler technique with 3/0 Ethibond suture. The allografts were then disinfected with a 10% glutaraldehyde solution for 24 hours in an incubator at 37°C.

Outcomes of Allograft Reconstruction:
Outcomes of Allograft Reconstruction: The nWOF of the CHG treated allografts was significantly lower than that of the saline treated allografts (p<0.05) (Fig. 1). The results of the gliding resistance were same as the nWOF (p<0.05) (Fig. 1b). There was no significant difference in maximal failure strength at the distal graft/phalanges' conjunction between graft treated with CHG and saline.

DISCUSSION:
We have successfully developed a failed primary repair model which is clinically relevant for flexor tendon reconstruction. This model is reproducible, uniform and reliable. We have also demonstrated that the CHG surface modification of allografts improved digit function, reduced adhesions and decreased gliding resistance compared to the allograft without treatment. These results are similar to the outcomes when CHG was used in autografts in a previous report. Compared to previous published data using CHG treated extrasynovial autografts, CHG treated intrasynovial allografts have fewer adhesion and better digit function, but weak tendon/bone healing. If this adverse effect could be overcome, CHG treated intrasynovial allografts could become a clinically useful alternative to the current benchmark of extrasynovial autografts for reconstruction of failed tendon repairs in the hand.

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