INTRODUCTION
Adhesions after tendon surgery are a major clinical problem. Recent research has suggested a role for lubricin in blocking adhesions, but to date most therapeutic studies demonstrating a role for lubricin have used lubricin purified from bovine synovial fluid. Recently, it was established that bovine synovial fluid lubricin is a multimeric network. However, human synoviocyte lubricin obtained from cell culture is a dimer and therefore similar to recombinant lubricin which may serve as a biologic anti-adhesive. We wished to compare the effectiveness of human synoviocyte lubricin with bovine synovial fluid lubricin in a relevant animal model, in which a canine peroneus longus (PL) tendon was treated with lubricin and the gliding resistance was then measured over 1000 cycles of repetitive motion against a normal tendon pulley. We hypothesized that the two sources of lubricin would have similar ability to reduce gliding resistance in this model.

MATERIALS AND METHODS
Twenty six fresh frozen canine hind-limbs obtained under the approval of our Institutional Animal Care and Use Committee were thawed at room temperature immediately prior to testing. Twenty PL tendons were isolated from the limbs and the surrounding paratenon was carefully removed. In addition, the proximal phalanx of the second or fifth digit with its pulley was removed and cleared of any membranous tissue. The PL tendons were then randomly assigned to one of four treatment groups: 1) 0.9% NaCl 0.1 M saline solution (Sigma, St. Louis, MO) control, 2) bovine synovial fluid lubricin (courtesy of Gregory Jay, MD, PhD, Providence, RI) at 260 μg/mL bound to a carbodiimide derivatized solution of 10% gelatin (Sigma, St. Louis, MO) with 95% 1.5 x 10^-5 MW hyaluronic acid (Acros, Geel, Belgium) (b-lubricin), 3) human synoviocyte lubricin (SBI Sciences, Natick, MA) at 260 μg/mL also bound to a carbodiimide derivatized gelatin with hyaluronic acid (h-lubricin), and 4) a group with just the carbodiimide derivatized gelatin with hyaluronic acid (cdHA) respectively. Six flexor digitorum profundus (FDP) tendons were isolated by removing the proximal phalanx from the remaining limbs and immersing the phalanx into a saline solution. The FDP tendons were used as a normal intrasynovial tendon control.

Each of the tendons was mounted into a custom-made frictional testing machine consisting of a mechanical actuator, a linear potentiometer, two transducers, a pulley, a 4.9 N weight and a saline bath, maintained at 25º C that the tendons were immersed in throughout testing. The tendons were positioned so that the proximal end of the tendon was placed at a = 30º while the distal end of the tendon was placed at β = 20º in accordance to previous studies that utilized the same equipment (Fig. 1). Once mounted, the tendons were subjected to 1000 cycles of flexion-extension motion at a rate of 2 mm/s over a 7.5 mm excursion distance during which 54 data points of the frictional force were recorded. In order to calculate the mean gliding resistance over each cycle the following equation was employed:

\[ \frac{F_{\text{Mean Gliding Resistance}}}{} = \frac{F_{\text{Forward}}}{} - \frac{F_{\text{Reverse}}}{} \]

Data Analysis:
The results were analyzed using a one-factor ANOVA with repeated measures, followed by a Tukey-Kramer post-hoc test.

RESULTS

Mean Gliding Resistance (MGR):
After 1000 cycles of tendon motion, the mean gliding resistance and standard deviation for the FDP saline, PL saline, PL b-lubricin, PL h-lubricin and PL cdHA were 0.052 ± 0.005 N, 0.358 ± 0.178 N, 0.069 ± 0.020 N, 0.062 ± 0.0065 N, and 0.055 ± 0.012 N respectively.

The MGR of the PL in saline solution was significantly higher than the MGR of the other treatment groups. As expected, the MGR of the FDP tendon in saline solution was the lowest of all the treatment groups. The MGR of the PL tendons treated with b-lubricin, h-lubricin and cdHA were not statistically different, but all groups showed a significant improvement relative to the PL saline control. The data obtained for each of the groups was averaged together and plotted to demonstrate the relative difference in mean gliding resistances (Fig. 2).

Statistical Variation in Mean Gliding Resistances:
In order to further analyze the results, the mean gliding resistance of each tendon was displayed after 100 and 1000 cycles of FE motion on a scatter plot to demonstrate the relative statistical variation of each treatment group (Fig. 3). The tendons of the PL saline group showed the greatest statistical variation while the tendons of the FDP saline group showed the least.

DISCUSSION
The data obtained suggests that there is little difference between the mean gliding resistance of the PL tendons treated with h-lubricin, b-lubricin or cdHA. These data support that dimeric and a multimeric lubricin network provides similar anti-adhesion activity. Dimeric lubricin can be manufactured. Despite the lack of a significant difference in MGR between the lubricin and cdHA treatment groups, further studies should investigate the other functions of lubricin such as its anti-adhesive properties using an in vivo model.

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