

## Lubricin Surface Modification Improves Tendon Gliding After Tendon Repair in a Canine Model In Vitro

Manabu Taguchi<sup>1</sup>, Yu-Long Sun<sup>1</sup>, Chunfeng Zhao<sup>1</sup>, Mark E. Zobitz<sup>1</sup>, Chung-Ja Cha<sup>2</sup>, Gregory D. Jay<sup>2</sup>, Kai-Nan An<sup>1</sup>, Peter C. Amadio<sup>1</sup>  
<sup>1</sup>Biomechanics Laboratory, Division of Orthopedic Research, Mayo Clinic College of Medicine, Rochester, MN; <sup>2</sup>Department of Emergency Medicine, Rhode Island Hospital and Brown University, Providence, RI  
 pamadio@mayo.edu

**Introduction:** The role of friction as a source of adhesions has been recently investigated, with data suggesting that many strong repairs also have higher friction[1], and that this higher friction is associated with poorer results, at least in animal models[2]. Lubricin is a mucinous glycoprotein responsible for the boundary lubrication of articular cartilage[3,4]. Recent studies have identified lubricin on the surface of FDP tendon[5,6] suggesting that it may play a role in tendon lubrication.

Tendon surface modification with gelatin and hyaluronic acid reduces the gliding resistance of both tendon graft and repaired tendon[7-9]. The purpose of this study was to investigate the effects of lubricin with or without hyaluronic acid (HA) on the gliding of repaired FDP tendon in a canine model in vitro.

**Materials and Methods:** 32 flexor digitorum profundus (FDP) tendons from the 2nd – 5th digits of forepaws from 4 adult mongrel dogs were used. The dogs were sacrificed for other IACUC approved projects. In each digit the proximal and middle phalanges, FDP tendon, flexor digitorum superficialis (FDS) tendon and FDS insertion, and proximal pulley were then harvested as a unit. The proximal interphalangeal joint was fixed in full extension. A complete laceration to the FDP tendon was made 6mm distal to the proximal pulley (analogous to the A2 pulley in humans) and repaired with a modified Pennington technique. After the gliding resistance of the repaired tendon was measured in vitro, the tendons were treated with one of four solutions (n=8 per group): **Saline**; 10% gelatin/1% HA/1% EDC (1-ethyl-3-(3-dimethylaminopropyl) carbodiimide hydrochloride) /1% NHS (N-hydroxysuccinimide) (**cd-HA-gelatin**); 10% gelatin/1% HA/1% EDC/1% NHS + lubricin (**cd-gelatin + lubricin**); 10% gelatin/1% HA/1% EDC/1% NHS + lubricin (**cd-HA-gelatin + lubricin**). Lubricin was purified from bovine synovial fluid[10]. After treatment, tendon gliding resistance was measured for 1000 cycles of simulated flexion/extension tendon motion. The average and peak gliding resistance over the flexion/extension cycle were calculated and compared to baseline. Treatment groups were compared using ANOVA. Following testing, the surface of the repaired tendon and its proximal pulley was also assessed qualitatively for surface smoothness by scanning electron microscopy.

**Results:** The increase in average and peak gliding resistance in cd-HA-gelatin, cd-gelatin+lubricin, and cd-HA-gelatin+ lubricin tendons was significantly less than that of the saline control tendons after 1000 cycles ( $p<0.05$ ) (Figures 1 & 2). The increase in average gliding resistance of cd-HA-gelatin+lubricin treated tendons was also significantly less than that of the cd-HA-gelatin treated tendons. The surface of the repaired tendons and their proximal pulleys appeared smooth even after 1000 cycles of tendon motion for the cd-HA-gelatin, cd-gelatin+lubricin, and cd-HA-gelatin+ lubricin treated tendons, while that of the saline control appeared roughened.

**Discussion:** In this study, the cd-HA-gelatin, cd-gelatin+lubricin and cd-HA-gelatin+lubricin all improved the gliding resistance of the repaired flexor tendon compared to the saline controls. The two lubricin treated groups had the lowest gliding resistance throughout testing. The cd-HA-gelatin+lubricin tendons were significantly lower than the tendons treated with cd-HA-gelatin alone. While not significant, there was clearly a trend for improved results with cd-gelatin+lubricin, as well.

The addition of lubricin to a tendon surface pre-treated with cd-gelatin and HA significantly reduces gliding resistance and maintains a qualitatively smooth tendon and pulley surface after 1000 cycles of simulated flexion/extension tendon motion compared to the carbodiimide derivatized hyaluronic acid (cd-HA-gelatin) preparation alone. These findings may have important implications for the development of tissue engineered tendon surfaces to improve the results after tendon repair.

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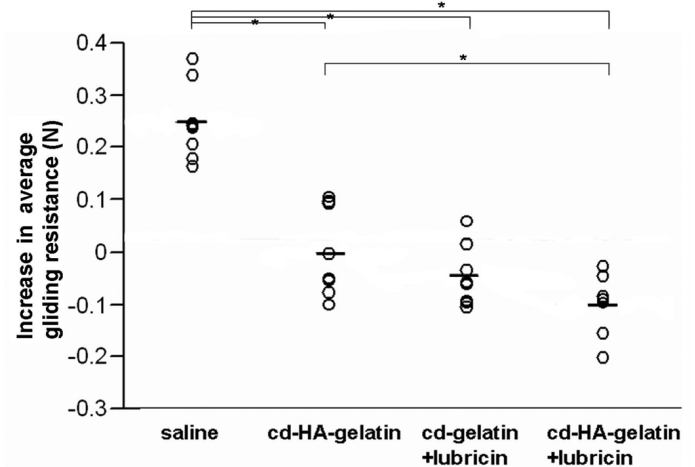


Figure 1: Change in average gliding resistance of repaired FDP tendon after treatment at 1000 cycles.

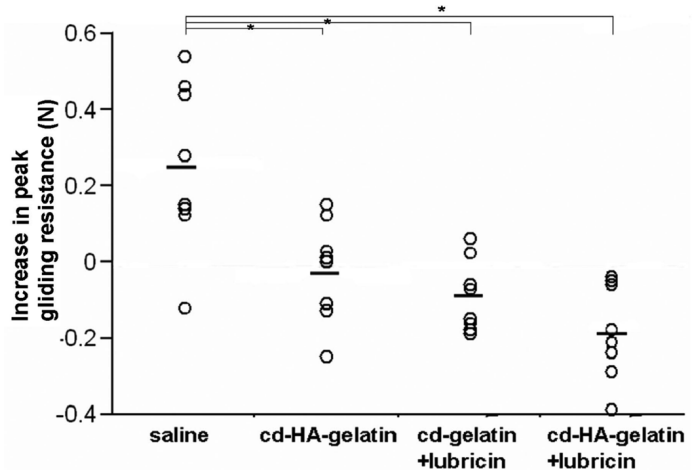


Figure 2: Change in peak gliding resistance of repaired FDP tendon after treatment at 1000 cycles.