INTRODUCTION:

A tendon graft is indicated when a flexor tendon repair fails, or when tendon rupture or tendon transfer requires prolongation of the muscle-tendon unit. The effect of hyaluronic acid (HA) on flexor tendon repair has been investigated in many animal and clinical studies. Exogenously applied HA may prevent adhesion formation between the flexor tendon and surrounding tissue following tendon repair, without affecting tendon healing. Recent reports of carbodiimide modified HA (cd-HA) on the surface of extrasynovial tendon noted decreased gliding resistance between the tendon and its pulley system during repeated flexion/extension motion over 500 cycles in a canine model in vitro. Our recent in vivo studies demonstrated that cd-HA-gelatin treatment for graft tendon decreased digit work of flexion, adhesion formation, and tendon gliding resistance (manuscript in press by JBJS). However, this chemically modified HA would alter the tendon mechanical and biological properties are unknown. Therefore, in this study we investigate if cd-HA modification would induce some side effects on tendon to bone healing, tendon mechanical properties, and graft cellularity compared with saline treatment control using canine in vivo model.

METHODS:

A total of 24 dogs were used for this study. The dogs were evenly divided into three groups depending on the time of survival: 1, 3, and 6 weeks. The peroneous longus (PL) tendons from both hind legs (extrasynovial tendons) were harvested and replaced the FDP tendons in each animal. A PL tendon was treated with cd-HA (1% sodium HA, 10% gelatin 0.25% 1-ethyl-3-[3-dimethylaminopropyl) carbodiimide hydrochloride] (EDC), and 0.25% N-hydroxysuccinimide) prior to grafting, while the other one was immersed in saline as a control. The digits were randomly assigned to treatment and control groups. The distal graft was fixed into the distal attachment with interlacing technique. A custom-made slingjacket was used postoperatively to support the operative forelimb on the recipient FDP tendon with interlacing technique. The synergistic motion protocol was performed twice daily, 7 days per week.

At sacrifice, adhesion status was scored 0 (no adhesion), 1 (minor), 2 (moderate), and 3 (severe). The graft was divided into four segments for analysis. The distal attachment and adjacent 10mm of tendon graft was used for pullout testing to evaluate the healing status. The distal one third of the remaining graft for histology was analyzed the cellularity of the specimen were placed immediately in a -80°C freezer, and later thawed for testing.

Data are expressed as mean ± SD. The adhesion score was analyzed by the Mann-Whitney U test. The other data obtained from indentation, ultimate force at distal attachment, and the number of the fibroblast cell were analyzed using two-factor repeated ANOVA, followed by Student’s T test to compare control, cd-HA, and non-saline treated graft digits at 6 weeks. No giant cells were noted in any specimen.

RESULTS:

The ultimate force at the distal attachment at 6 week was significantly higher than that at 1 and 3 weeks (p < 0.05). There was no significant difference between the HA and saline treatments at any term point (Figure 3).

In our study, there was no difference between the HA and saline groups in distal attachment healing, graft cellularity, and graft mechanical properties, but the adhesion status improved with cd-HA surface modification. As the half-life of hyaluronic acid in tissues is short, native HA is probably eliminated too rapidly to maintain a long-lasting physical barrier between opposing tissues. The carbodiimide derivatization reaction of HA seemed did not alter its fundamental effect on preventing adhesion. This chemical modification of HA also did not alter the tendon healing, mechanical, and biological properties.

DISCUSSION:

In our study, there was no difference between the HA and saline groups in distal attachment healing, graft cellularity, and graft mechanical properties, but the adhesion status improved with cd-HA surface modification. As the half-life of hyaluronic acid in tissues is short, native HA is probably eliminated too rapidly to maintain a long-lasting physical barrier between opposing tissues. The carbodiimide derivatization reaction of HA seemed did not alter its fundamental effect on preventing adhesion. This chemical modification of HA also did not alter the tendon healing, mechanical, and biological properties.

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