Introduction: Hand injuries lead to loss of function and lost days from work (1). A large number of these injuries require tendon surgery, including tendon-to-bone reconstruction. Our previous flexor tendon studies in a clinically relevant canine model demonstrated that the tendon-to-bone insertion site has a poor capacity to heal (2). Other tendon-to-bone studies have shown a similarly poor healing response, with poor integration of tendon into bone (e.g., 3-4). Recent studies in other animal models have shown that magnesium based adhesives have the potential to improve tendon-to-bone healing (5, 6). Therefore, we hypothesized that a magnesium based bone adhesive will: 1) improve the initial biomechanical properties of the repair and 2) improve the functional (i.e., range of motion) and biomechanical properties in the early period after repair.

Materials and Methods: Flexor digitorum profundus (FDP) tendons were injured and repaired into bone tunnels in the distal phalanx in canines (2). Animals were sacrificed at 21 days. FDP tendons from canine cadavers were injured and repaired and served as time zero controls. Each dog had the second and fifth FDP tendons injured and repaired. To examine the effect of the magnesium-based adhesive (MBA) (Bone Solutions Inc.), the bone tunnels were either filled with the adhesive prior to completing the repair or left empty (CTL). Post-operatively, forelimbs were subjected to passive motion rehabilitation. Range of motion (rotation at the distal interphalangeal joint and tendon excursion) and tensile properties (ultimate load, stiffness, and rigidity) were determined as described previously (N=8-14 per group) (2). Bone density of the distal phalanges (N=9 per group) was assessed after biomechanical testing using peripheral quantitative computed tomography (2). Tendon stumps and bones were processed for histology after biomechanical testing (N=8 per group), blinded, and evaluated under bright-field. For quantitative measures, the MBA group was compared to the CTL group using a paired t-test. Comparisons between all groups (i.e., effect of time and compared to normal) were made using an analysis of variance (ANOVA) followed by a Fisher’s least squares differences post-hoc test. Significant changes are noted for p<0.05 and trends are noted for p<0.10.

Results:

Histology- There was no evidence of acute inflammation in any samples (Table 1). There were more mast cells in the MBA group than in the CTL group (Figure 1). Chronic inflammatory infiltrate and fibrosis was slightly higher in the MBA group compared to the CTL group.

Biomechanical Properties: Biomechanical properties at time zero were significantly higher in the MBA group compared to the CTL group (Figure 2). However, biomechanical properties were significantly lower in the MBA group compared to the CTL group at 21 days. Properties decreased over time in both groups.

Functional properties: Range of motion was significantly lower in the MBA and CTL groups compared to normal tendons at 21 days (Figure 3). No difference was seen when comparing MBA to CTL. Range of motion in the MBA group was slightly lower in the MBA and CTL groups compared to normal at 21 days (Figure 2). No difference was seen when comparing MBA to CTL.

Discussion: We found that the initial biomechanical properties of flexor tendon-to-bone surgical repairs can be improved with MBA. However, MBA use in vivo led to a decrease in the biomechanical properties of the tendon-to-bone repair. There was no effect of MBA on bone density or range of motion in the early period after repair. Our histologic analysis suggests that the poor healing response in the MBA group may have been due to an allergic response or to increased chronic inflammation due to the foreign material. However, further in vivo study is necessary to determine the cause of the negative effect on early healing.

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References: