INTRODUCTION

Flexor digitorum profundus (FDP) avulsions from the distal phalanx are often secured with a pull-out suture of 3-0 Prolene in a modification of the Bunnell technique. Suture anchors of smaller sizes have recently been suggested as alternatives to this type of repair. The behaviour of these two different methods of reattachment of the FDP tendon insertion with 2 different sutures was assessed. Cyclical testing, simulating the first 5 days of a passive mobilization protocol was used to compare the Micro-Mitek bone anchor (Mitek products, Westwood, MA, USA) to the modified-Bunnell pullout suture.

METHODS

Twenty-four fresh-frozen cadaveric fingers (mean age 65) - ring, middle and index - were harvested through the level of the proximal interphalangeal joint to include the FDP tendon proximally to the mid-palm following ethical approval. The flexor digitorum superficialis tendon was removed, with all FDP attachments divided, taking care to preserve a maximal amount of the A4 pulley. The FDP insertion was sharply dissected from the distal phalanx and repaired using four methods: groups 1&3 – modified Bunnell pullout suture group 2&4 – Micro-Mitek anchor loaded with 3/0 Ethibond or 3/0 Prolene inserted into the distal phalanx at a 45° angle towards the distal interphalangeal joint (Figure 1).

Each repaired finger had a 1.6mm K-wire passed in a volar to dorsal direction through the distal phalanx, distal to the site of FDP reattachment, and mounted on a materials testing machine using pneumatic clamps (MTS 858 Mini Bionix, MTS Systems Corp., Eden Prairie, MN). Repairs were cyclically tested between 2 N and 15 N, at 5 N/sec, for a total of 500 cycles. Gap formation at the tendon bone interface was measured every 100 cycles using a calibrated micrometer. At the completion of cyclical testing, samples were tested to failure at 20 mm/min. The failure load and mechanisms were determined. Data was analyzed using ANOVA and a Tukey HSD post hoc testing with SPPS for Windows.

RESULTS

No specimens failed during cyclical testing. After 500 cycles, gap formation of the tendon-bone interface with Prolene was significantly greater in both techniques compared to Ethibond (Figure 1). Concerns related to suture anchors, such as anchor failure or protrusion, joint penetration and anchor-suture junction failure, were not encountered.

Load to failure for the modified Bunnell repairs with Ethibond and Prolene were greater compared to the Micro-Mitek repairs with the same sutures (p<0.05). The failure loads in Micro-Mitek repairs with Ethibond and Prolene did not differ. All of the modified Bunnell repair failed by suture breakage. The Micro-Mitek repairs failed by suture breakage at the anchor eyelet in all cases except for 1 anchor pullout from bone in one of the Ethibond repairs.

DISCUSSION

Early finger mobilization after any hand injury is vital to ensure optimal recovery and return to maximal range of motion. FDP tendon detachment from the distal phalanx can occur through either a lacerating type injury, or via a blunt avulsion mechanism. In order to cope with an early mobilization protocol after FDP tendon reattachment, strong methods of fixation are required. The traditional method of repair, as described by Bunnell, involves a button tie-over repair that requires removal at a later date. New bone anchors allow the tendon to be reattached without the need of unsightly repairs that require later removal and act as a potential source of suture tract infection. The Micro - Mitek anchors (1.3 x 3.7 mm) makes it an attractive and easy method of repair. However, its ability to withstand a post-operative mobilization protocol had previously not been reported.

Passive flexion forces have been estimated to be approximately 9N. However, postoperative swelling and oedema can add as much as 50% to these forces. Therefore, to cover this, we cyclically tested our specimens up to 15 N. The rate of 5 N/sec was chosen, as it is equivalent to 10 cycles/minute. This would be consistent with a passive mobilization protocol rate. The 500 cycles, representing five days of passive mobilization, is based on mobilization performed once every hour, ten hours a day.

The cyclical loading results suggest that the repair achieved with both methods of fixation is sufficient to avoid failure in the first five days of a passive finger mobilization protocol, before any significant tendon healing has occurred. However, significant gap formation at the tendon-bone interface in the modified Bunnell pull-out group using 3-0 Prolene is of concern, suggesting it may not be the ideal method of fixation. The load to failure in this study for the modified Bunnell repair were consistent with other reports. The Micro-Mitek anchor failed at a lower load during static testing compared to the Bunnell repair. Considering that an active mobilization protocol would be subject to even higher forces than the passive protocol examined here, neither technique would be sufficiently strong enough to withstand this type of therapy.

REFERENCES

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