Biomechanical and Histological Analysis after Tenotomy of the Long Head of the Biceps in the Rabbit Shoulder Model

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INTRODUCTION

Tenotomy or tenodesis of the long head of biceps tendon (LHBT) is frequently performed procedure in the shoulder. The reported incidence of cosmetic deformity (Popeye deformity) after tenotomy is variable, ranging from 3% to 63%. This means that not all patients who undergo tenotomy exhibit substantial distal migration of the LHBT, and instead experience the “autotenodesis” phenomenon. But, this phenomenon has never been verified histologically or biomechanically. Especially given that the LHBT has a double-lined synovium at the bicipital groove, there arises a question that the adhesion of the LHBT after tenotomy is possible. Therefore, the purpose of this experimental study was to verify the autotenodesis phenomenon by (1) comparing biomechanical pullout strength of the 6 weeks post-tenotomy group with the immediate post-tenotomy group, and (2) observing the histological characteristics and the gross specimens of the LHBT at the bicipital groove to verify the occurrence of the “autotenodesis” phenomenon in the rabbit model. Our hypothesis was that the adhesion of the tenotomized LHBT would occur at the bicipital groove, therefore, the 6 weeks post-tenotomy group would show different characteristics in biomechanical and histological aspects compared to the immediate post-tenotomy group.

METHODS

All procedures and protocols were approved (IACUC No. 10-9078). The experiments were performed on skeletally mature, New Zealand White male rabbits (24 weeks old, 3.2–3.7 kg).

Study design

The study was designed to compare biomechanical pullout strength and histological differences between the immediate post-tenotomy and 6 weeks post-tenotomy in the rabbit model. To accomplish this, sample size analysis based on pullout strength as the primary outcome variable was completed after pilot study. Finally, 10 experimental subjects and 10 control subjects were included. Three more rabbits were included for histological analysis of the 6 weeks post-tenotomy model (Fig. 1).

Biomechanical testing

For the pullout-strength testing, 20 right shoulders were tested using a custom fixture clamping system and an Instron materials testing machine (Instron 5565A, Instron Corp., Canton, MA, Fig. 2).

RESULTS

Pullout strength of the immediate post-tenotomy group at the bicipital groove was measured to be 5.53 ± 2.22 N and that of the 6 weeks post-tenotomy model was 44.07 ± 7.75 N. The difference between the two was statistically significant (p < 0.001). This could support use of the tenotomy procedure over tenodesis in the diseased LHBT.

Histological analysis

For histological analysis, 6 previously assigned rabbit left shoulders (3 for each group) were harvested after euthanasia. Specimens were fixed in neutral buffered 10% formalin (pH 7.4), and decalcification was done. Paraffin blocks were made in the bicipital groove region and 1 mm-wide serial sections perpendicular to the biceps tendon were cut and stained with Hematoxylin-Eosin and Masson’s Trichrome to measure connective tissue around the LHBT at the groove area. To minimize any bias on the part of the observer during the analyses, all examinations were performed in blinded fashion with respect to the group assignment. Assessment was done by a pathologist who was blind to the study.

DISCUSSION AND CLINICAL SIGNIFICANCE

This is the first study to evaluate biomechanical and histological changes after tenotomy of the LHBT in the rabbit model. The results show that autotenodesis at the bicipital groove is an actual phenomenon that occurs after tenotomy of the LHBT, even in situations where biceps pathology is not present. Pullout strength of the LHBT was statistically higher after 6 weeks post-tenotomy model compared with that of the immediate post-tenotomy model. Histologically, there was marked fibrosis between the LHBT and the bicipital groove area in the 6 weeks post-tenotomy model; therefore, we could conclude that this is the site of adhesion after tenotomy. This could support use of the tenotomy procedure over tenodesis in the diseased LHBT.