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Original article

Biomechanical evaluation of the long head of the biceps brachii tendon fixed by three techniques: a sheep model☆

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ABSTRACT

Objective: To evaluate the biomechanical properties of the fixation of the long head of the biceps brachii into the humeral bone with suture anchors, interference screw, and soft tissue suture, comparing strength, highest traction load, and types of fixation failure.
Methods: Thirty fresh-frozen sheep shoulders were used, separated into three groups of ten for each technique. After fixation, the tendons were subjected to longitudinal continuous loading, obtaining load-to-failure (N) and displacement (mm).
Results: The mean load-to-failure for suture anchors was 95 ± 35.3 N, 152.7 ± 52.7 N for interference screw, and 104.7 ± 23.54 N for soft tissue technique. There was a statistically significant difference ($p < 0.05$), with interference screw demonstrating higher load-to-failure than suture anchor fixation ($p = 0.00307$) and soft tissue ($p = 0.00473$). The strength of interference screw was also superior when compared with the other two methods ($p = 0.0000127$ and $p = 0.00000295$, respectively). There were no differences between suture anchors and soft tissue technique regarding load-to-failure ($p = 0.9420$) and strength ($p = 0.141$).
Conclusion: Tenodesis of the long head of the biceps brachii with interference screw was stronger than the suture anchors and soft tissue techniques. The other two techniques did not differ between themselves.

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Avaliação biomecânica da fixação do tendão da cabeça longa do bíceps braquial por três técnicas: modelo em ovinos

Palavras-chave:
Bíceps braquial
Úmero

RESUMO

Objetivo: Avaliar biomecanicamente a fixação da cabeça longa do bíceps braquial no úmero com âncoras ósseas, parafuso de interferência e sutura em partes moles e comparar resistência, força máxima de tração e tipos de falha na fixação.

☆ Study conducted at the Centro Universitário (UniBrasil), at the Pontifícia Universidade Católica do Paraná, and at the Universidade Federal do Paraná, Curitiba, PR, Brazil.

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Biomecânica
Tendões

Métodos: Foram usados 30 ombros de ovinos frescos, divididos em três grupos de dez para cada técnica. Após fixação, os tendões foram submetidos a tração longitudinal contínua até falha do sistema e obtiveram-se força máxima de tração (N) e deslocamento (mm).
Resultados: A força máxima de tração foi em média 95 ± 35,3 N para âncoras ósseas, 152,7 ± 52,7 N para parafuso de interferência e 104,7 ± 23,54 N para partes moles. Houve diferença estatisticamente significativa ($p < 0,05$): o parafuso de interferência demonstrou força máxima de tração superior às fixações com âncoras ósseas ($p = 0,00307$) e partes moles ($p = 0,00473$). A resistência com parafuso de interferência também foi superior à dos outros dois métodos ($p = 0,0000127$ e $p = 0,0000029,5$ respectivamente). Âncoras ósseas e partes moles não apresentaram diferenças, tanto para força máxima de tração ($p = 0,9420$) quanto para resistência ($p = 0,141$).
Conclusão: A tenodese da cabeça longa do bíceps braquial com parafuso de interferência demonstra maior resistência quando comparada com as técnicas com âncoras ósseas e partes moles. As duas últimas técnicas não diferem.

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Introduction

Disorders of the long head of biceps brachii tendon (LHBBT) are frequent causes of shoulder pain. Treatment should be conservative (analgesics, anti-inflammatories, and physiotherapy, among others); however, when conservative treatment is unsuccessful, surgery is indicated. The recommended procedure is tenotomy of the long head of the biceps (sectioning the tendon at the level of its insertion in the glenoid cavity) with or without tenodesis of the long head of the biceps (fixating the biceps tendon into the bicipital groove of the humerus). Tenodesis has been suggested as advantageous over isolated tenotomy, as it maintains the length/tension ratio and the flexion and supination strength of the elbow, preventing atrophy, pain at the site, and cosmetic deformity. Recent advances have allowed tenodesis to be preferably performed arthroscopically, which, despite promoting results similar to open surgery, offers advantages such as smaller surgical wound, lower post-operative pain, preservation of the deltoid muscle, and earlier return to activities, especially when associated with simultaneous repair of the rotator cuff.[1–3] Among the arthroscopic fixation methods, the most frequently used are bone anchors, interference screw (IS), and soft tissue suture without the need for implants.[1,2,4–8] Early postoperative mobilization of the upper limb is important for recovery, but may endanger tenodesis with possible release of the tendon. To avoid this issue, the system that provides the highest resistance should be used. Another aspect is the increased cost of the procedure when implants are used; soft tissue technique is cheaper. Identifying which method is more resistant would justify the use or non-use of implants, defining the most cost-effective technique. There is no consensus in the literature regarding which fixation method is more resistant.[9–24] This study aimed to compare three techniques for fixation of the LHBBT in the humerus (bone anchors, IS, and soft tissue suture) regarding resistance of the fixation, load-to-failure (LTF), and system failure.

Materials and methods

After approval by the Research Ethics Committee of the Hospital do Trabalhador of Universidade Federal do Paraná, 30 fresh shoulder specimens from skeletally immature Texel sheep, aged between six and 12 months, were acquired from a specialized company. The specimens were frozen immediately after slaughter and were kept at −20 °C until 24 h before preparation. Samples were then thawed at room temperature to undergo tenodesis. Samples were prepared with dissection of the humeral bone; only the biceps and the anterior portion of the rotator cuff inserted into the greater tuberosity of the humerus were preserved. The proximal biceps tendon was sectioned at the glenoid labrum in the upper portion of the glenoid cavity (scapular bone), maintaining its distal insertion into the cubitus bone (Fig. 1). The specimens were divided into three groups of ten, according to the type of tenodesis; ten pieces were thawed at a time, with an interval of 15 days between each test.

Tenodesis with bone anchors

After two holes were made in the humeral metaphyseal region (bicipital groove), two bone anchor screws, made of titanium, with a diameter of 4.0 mm, positioned with an Ethibond 2® suture (braided polyester) were inserted with a distance of 5 mm between them (Fig. 2). Then, the biceps tendon was fixated into the humerus with a single stitch in each anchor (Fig. 3).

Tenodesis with interference screw

The metaphyseal humeral region (biceps groove) was drilled at 2 cm from the apex of the humeral head with a bone drill that matched the diameter and length of the screw

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