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Original Article

Biomechanical evaluation between the modified Mason-Allen stitch and the locked double-tie stitch on the infraspinatus of sheep☆,☆☆

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ABSTRACT

Objectives: To evaluate and compare the *in vitro* biomechanical results from two stitches: the Mason-Allen stitch, as modified by Habermeyer; and the locked double-tie stitch developed at our service, on tendons of the infraspinatus muscle of sheep.
Methods: Twenty tendons from the infraspinatus muscle of sheep were randomly divided into two groups: LDT, on which the locked double-tie stitch was performed; and MA, with the modified Mason-Allen stitch. The evaluation was performed in the mechanics laboratory, using a standard test machine with unidirectional traction, constant velocity of 20 mm per second and a 500 N load cell, without force cycling.
Results: We observed that LDT was superior to MA, for the force needed to form spaces of both 5 mm ($p = 0.01$) and 10 mm ($p = 0.002$) and also for the maximum traction resistance ($p = 0.003$).
Conclusion: We confirmed our hypothesis that LDT stitches are superior to MA stitches from a biomechanical point of view. This is a further stitching option for surgeons, when fragile and poorly vascularized tendons need to be sutured, and it improves the quality of fixation without increasing the "strangulation" and, consequently, the ischemic area.

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Avaliação biomecânica de ovinos entre o ponto Mason-Allen modificado e o ponto com duplo-laço bloqueado em infraespinal

RESUMO

Objetivos: Avaliar e comparar os resultados biomecânicos *in vitro* de dois pontos: o Mason-Allen modificado por Habermeyer e o ponto duplo-laço bloqueado (DLB), desenvolvido no nosso serviço em tendões de músculos infraespinais de ovinos.

Métodos: Vinte tendões do músculo infraespinal de ovinos foram divididos aleatoriamente em dois grupos: o DLB, no qual foi confeccionado o ponto duplo-laço bloqueado; e o MA, com o ponto Mason-Allen modificado. A avaliação foi feita no laboratório de mecânica, com uma máquina de teste padrão, de tração unidirecional, com velocidade constante de 20 mm por segundo, com uma célula de carga de 500 N, sem ciclagem de força.

Resultados: Evidenciamos uma superioridade do DLB sobre o MA, tanto na força necessária para formar 5 mm de espaço (p = 0,01) como 10 mm (p = 0,002) e também na resistência máxima de tração (p = 0,003).

Conclusão: Confirmamos nossa hipótese de que o ponto com DLB é superior ao MA do ponto de vista biomecânico. Essa é mais uma opção de ponto para o cirurgião, quando precisa suturar tendões frágeis e pouco vascularizados, e melhora a qualidade da fixação sem aumentar o "estrangulamento" e, consequentemente, a área isquêmica.

Palavras-chave:
Técnicas de sutura
Ombro
Bainha rotadora

Introduction

Suturing of rotator cuff injuries (RCIs) is one of the biggest challenges for shoulder surgeons. There are high dehiscence rates, especially in relation to extensive injuries, and the incidence can range from 13% to 94% of the cases.[1,2]

The aim of surgical treatment is to mechanically produce a firm and secure suture of the tendon at its insertion site so that healing can take place. The surgical materials used are today highly reliable and for this reason, according to Cummins, the major cause of repair failure is the interface of the suture thread with the tendon.[3] Gerber et al.[4] suggested that the ideal repair should withstand a high traction force during the initial period of fixation, enable formation of the minimum space between the tendon and bone and maintain mechanical stability until healing takes place. The type of stitch used for the suture is a crucial part of the success or failure of the surgical procedure.

Arthroscopic RCI repairs require a refined operative technique and knowledge and skill on the part of the surgeon in order to pass the thread through the tendon. The suturing can be performed using different types of stitches, which were developed to withstand traction forces without undoing the tendon repair.[5] The Mason-Allen stitch is the most resistant type.[4] It can be performed arthroscopically and is then known as the modified Mason-Allen stitch, as described by Scheibel and Habermeyer.[6]

With regard to tendon suturing performed as an open procedure, the technique developed by Krackow et al.[7] is generally recognized as the most resistant and secure method, but it is almost impossible to perform it arthroscopically. Moreover, because it involves stitches that are transverse to the direction of the tendon, it may compromise the vascularization of the tendon and thus the healing of the injury.

Based on the Lasso-Loop stitch described by Lafosse et al.,[8] the senior member of our group (SLC) sought to develop a technique that could be combined with the resistance of the suture developed by Krackow et al.[7] and which could be performed arthroscopically while only minimally compromising the vascularization. This new technique is performed using doubly locked longitudinal stitches, which we have name locked double-tie (LDT) stitches.

In addition to describing the technique for constructing LDT stitches, done on the tendon of the infraspinatus muscle of sheep, we compare it biomechanically with the modified Mason-Allen stitch, which is considered to be the most resistant method performed arthroscopically.[6]

This study using animals was approved by our institution's ethics committee.

Materials and methods

Surgical technique

The LDT stitch is simples, but like all techniques, it needs to be practiced and assistants need to be trained. Use of knotless anchors facilitates construction of these stitches but is not essential. The six steps in making these stitches are as follows:

First: After placing the suture anchor in the appropriate position, using an arthroscopic suturing needle, one of the ends of the thread is passed through the tendon from the articular to the subacromial face, approximately 20 mm medially to the lateral border of the tendon, close to the muscle–tendon transition. The thread should run through the anchor and not be trapped (Fig. 1A).

Second: The length of the thread is equalized and then the suturing needle is used to make another partial passage of