Quantitative-MRI analysis of the effect of Krackow whip stitch suture repair on patella tendon vascularity

Brian Joseph Page[1], Trenton Thomas Stevens[2], Kathryn Barth, Craig Klinger[3], Jonathan P Dyke[4], Steve Brian Behrens[2], Daniel Richard Dziadosz[5], John P Lyden[6], Gregory Scott DiFelice[7], William M Ricci[5]
[1]Orthopaedic Trauma, Hospital for Special Surgery, [2]Orthopaedic Trauma, [3]Hospital for Special Surgery, [4]Weill Cornell Medical College, [5]Hospital For Special Surgery, [6]Hosp for Special Surgery, [7]Orthopaedic Trauma, Hospital For Special Surgery

INTRODUCTION:

A Krackow whip stitch through the patellar tendon is commonly used in the management of extensor mechanism injuries, specifically in the setting of patellar tendon ruptures, inferior pole patellar fractures, and augmentation of other patellar fractures. Previous studies have examined the biomechanical strength of this suture technique. However, this technique may exert significant tension upon the patellar tendon, compromising arterial blood supply. To our knowledge, no study has investigated the effect of Krackow stitches on the blood supply to the patellar tendon which may negatively impact the tendon's healing potential and ultimately contribute to failures of such repairs. The purpose of this study was to assess the effects of Krackow suture placement on the vascularity of the patellar tendon. We hypothesized that Krackow suture placement would lead to a significant decrease in arterial contributions to the patellar tendon.

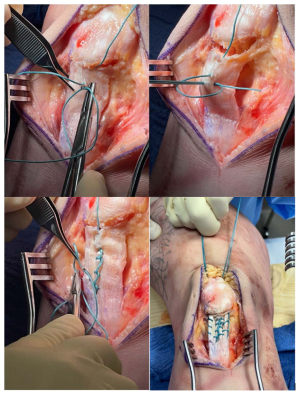
METHODS:

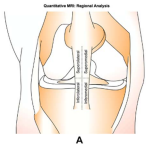
Six fresh-frozen cadaveric knee specimens and their respective matched pairs were utilized. One knee from each matched pair was randomly assigned to be the experimental knee and the contralateral served as a matched control. All knees had cannulation of the superficial femoral artery. The experimental knee underwent an anterior approach, patellar tendon transection from the inferior pole of the patella, double row Krackow whip stitch placement with patellar tendon repair via three bone tunnels, and a standard skin closure (Figure 1). The control knee underwent the identical procedure without Krackow stitching. All specimens then underwent gadolinium-enhanced quantitative magnetic resonance imaging (qMRI) assessment. Region of interest (ROI) analysis was performed to assess for variation in signal enhancement between the experimental and control limbs in various patellar tendon regions and subregions (Figure 2A). The weighted average signal intensity of the ROI's were compared pre and post-contrast. Following MRI, latex infusion and anatomical dissection was performed to further evaluate vessel integrity and provide an anatomical map of the vascularity of the patellar tendon. Reductions in arterial contributions in the experimental versus control limb are reported as mean and standard deviation (SD), and as the median, interquartile range (IQR, 25% to 75%), and range. Mann-Whitney U tests were used to compare quantitative MRI findings between regional arterial contributions.

RESULTS: qMRI analysis results demonstrated no statistically significant difference in overall tendon arterial contributions (Table 1). In the experimental group, a small but non-significant decrease of 7.5% (SD ±7.1%; median 1.1%; IQR 0.3-7.3%; and range, 0.0-18.0%) in arterial contributions to the entire tendon was observed. Small regional decreases throughout the tendon were also detected but were not statistically significant (Table 1). In the regional analysis, the largest to smallest decreases in arterial contributions following suture placement were found in the inferomedial (mean and SD; 9.3±21.7%), superomedial (9.2%±10.5%), lateral (8.1%±8.5) and inferior (8.1%±5.2%) subregions. In the anatomical dissection following latex infusion (Figure 3), several dorsal nutrient arterial branches were observed from a network of vessels (Figure 3A) in all experimental specimens. This was especially pronounced along the inferior tendon, which arose from the inferomedial genicular artery, superior lateral genicular artery, and anterior tibial recurrent artery. A nutrient branch deriving from the transverse infrapatellar artery, which coursed through the infrapatellar fat pad, was identified in three experimental specimen (50%), and entered the tendon along the posterocentral aspect approximately 1cm distal to the inferior pole of the patella (Figure 3B).

DISCUSSION AND CONCLUSION:

In our cadaveric model of patella tendon rupture, the vascularity of the patellar tendon was not significantly affected by Krackow stitch placement. Each region and subregion evaluated demonstrated small and not statistically significant decreases in arterial contributions suggesting this technique does not significantly compromise arterial perfusion. Finally, the medial and lateral double row Krackow technique utilized in our study may avoid the posterocentral contributions from the transverse infrapatellar artery to the patellar tendon.





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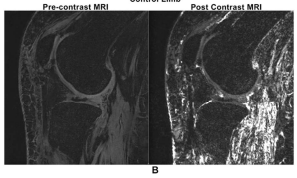

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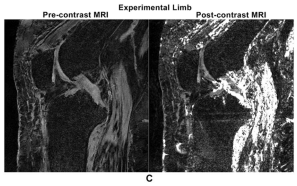

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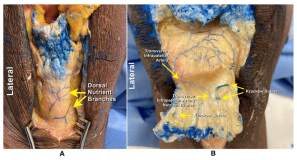

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Table 1. Quantitative-MRI results. Comparison of control to experimental groups.

	Additional reduction in contribution in experimental versus control limb*				
Patellar Tendon Region	**Mean and Std. Dev.**	**Median**	**IQR**	**Range**	**P Value****
Full patellar tendon	**7.5% ± 7.1%**	**1.1%**	**0.3-7.3%**	**0.0-18.0%**	**0.699**
Inferior	8.1% ± 5.2%	2.0%	0.0-6.7%	0.0-13.4%	0.818
Superior	6.8% ± 5.3%	0.5%	0.0-6.1%	0.0-13.4%	0.699
Medial	6.9% ± 10.6%	6.3%	2.1-13.5%	0.0-26.9%	0.699
Lateral	8.1% ± 8.5%	4.9%	0.0-13.0%	0.0-17.9%	0.818
Inferomedial	9.3% ± 21.7%	0.0%	0.0-15.5%	0.0-53.6%	0.818
Inferolateral	6.9% ± 6.7%	5.9%	2.4-10.4%	0.0-15.7%	0.589
Superomedial	4.5% ± 7.0%	0.0%	0.0-9.4%	0.0-15.1%	0.818
Superolateral	9.2% ± 10.5%	6.4%	2.4-12.9%	0.0-27.1%	0.818

*Mean decreases in regional quantitative-MRI signal enhancement in Krackow-suture specimen compared to contralateral controls.
**Mann-Whitney *U* test; significance set at p<0.05.