Plantaris Excision Reduces Pain in Midportion Achilles Tendinopathy Even in the Absence of Plantaris Tendinosis

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Investigation performed at Fortius Clinic, London, UK

Background: It is becoming increasingly apparent that the plantaris can contribute to symptoms in at least a subset of patients with midportion Achilles tendinopathy. However, the nature of its involvement remains unclear.

Purpose: To determine whether excised plantaris tendons from patients with midportion Achilles tendinopathy display tendinopathic changes and whether the presence of such changes affect clinical outcomes.

Study Design: Case series; Level of evidence, 4.

Methods: Sixteen plantaris tendons in patients with midportion Achilles tendinopathy recalcitrant to conservative management underwent histological examination for the presence of tendinopathic changes. All patients had imaging to confirm the presence of the plantaris tendon adherent to or invaginated into the focal area of Achilles tendinosis. Visual analog scale (VAS) and Foot and Ankle Outcome Score (FAOS) results were recorded pre- and postoperatively.

Results: Sixteen patients (mean age, 26.2 years; range, 18-47 years) underwent surgery, with a mean follow-up of 14 months (range, 6-20 months). The plantaris tendon was histologically normal in 13 of 16 cases (81%). Inflammatory changes in the loose peritendinous connective tissue surrounding the plantaris tendon were evident in all cases. There was significant improvement in mean VAS scores ($P < .05$) and all domains of the FAOS postoperatively ($P < .05$).

Conclusion: The absence of any tendinopathic changes in the excised plantaris of 13 patients who clinically improved suggests plantaris involvement with Achilles tendinopathy may not yet be fully understood and supports the concept that this may be a compressive or a frictional phenomenon rather than purely tendinopathic.

Keywords: Achilles tendon; tendinopathy; plantaris; histology; surgery

Steenstra and van Dijk[22] were the first to suggest involvement of the plantaris tendon in medially located midportion Achilles tendon pain. The plantaris originates from the posterolateral femoral condyle, descends between the gastrocnemius and soleus muscles, and then lies along the medial border of the Achilles tendon. It is frequently described as a vestigial structure absent in 8% to 20% of individuals,[10,11,13,19] but more recent studies suggest that it is present in 98% to 100% of specimens,[16,24] with a variable insertion into the calcaneus or the Achilles tendon.[7,8,24]

Lintz et al[12] demonstrated increased stiffness in the plantaris compared with the Achilles tendon. Constant compression and/or shearing between the triarticulate plantaris and the biarticulate Achilles tendons is thought to provoke a localized inflammatory response leading to adherence to, or invagination into, the highly innervated peritendinous tissue.[1,2,6,15,17,26] This painful frictional syndrome may result in inflammatory change around the Achilles tendon and potentially intratendinous pathology.[6] It has recently been reported as a significant problem in professional athletes, where the annual incidence of injury related to the plantaris tendon was 3.9% to 9.3%, affecting 22% of all sprinters and 18% of endurance runners.[15]

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Image-guided, high-volume injections within the paratenon to strip the neovascularization from the Achilles and break down adhesions aiming to separate the plantaris from the Achilles have been described with variable success.[4,9,27] A small number of case series on the surgical sectioning of the plantaris and stripping of the ventral neovascularization from the Achilles have reported with promising results.[1,14,25]

Spang et al[20] suggested that the plantaris tendon is tendinopathic, similar to the Achilles tendon in midportion Achilles tendinopathy, but there is uncertainty as to whether the plantaris tendon is affected in this way in all cases or if it is histologically normal, causing pathological secondary changes in the Achilles and a resultant focal inflammatory response. This study describes the histological features of the plantaris tendon excised from 16 patients who underwent successful surgical treatment for medially located Achilles tendinopathy. The purpose of this investigation was to identify whether there were tendinopathic changes in the plantaris tendon or only a surrounding inflammatory reaction adjacent to the Achilles tendon. A secondary aim was to assess whether the presence or absence of such tendinopathy affected the clinical outcome of surgery to excise the plantaris tendon.

METHODS

Sixteen patients underwent surgery for medially located Achilles tendon pain and swelling, having failed conservative measures. All patients had magnetic resonance imaging (MRI) and ultrasound (US) scans confirming the presence of a plantaris tendon adherent to or invaginated into the ventromedial edge of the Achilles tendon adjacent to the focal area of Achilles tendinopathy. All patients had failed to improve after a minimum of 6 months' conservative management. At surgery, the plantaris tendon was dissected free from the Achilles tendon through a 3-cm medially placed incision. The plantaris was transected distally and then stripped proximally for 10 cm and excised through a proximal stab. Paratenon adhesions and areas of neovascularization on the ventral surface of the Achilles tendon were removed with sharp dissection. The plantaris tendon and its surrounding soft tissue were placed in 10% buffered formalin solution. After dehydration and subsequent embedding in paraffin wax, 10-μm sections were stained with Mayer hematoxylin and eosin and underwent light microscopy examination to assess tissue morphology. Patients were assessed pre- and postoperatively using a visual analog scale (VAS) and Foot and Ankle Outcome Score (FAOS).

Statistical Analysis

Data were analyzed using SPSS (version 22; IBM Corp). A Shapiro-Wilk test confirmed that the datasets were normally distributed. Paired *t* tests were used to compare pre- and postoperative scores, with significance set at $P < .05$.

A power calculation based on a 10% minimal clinically relevant difference for FAOS determined that a sample size of 16 would provide 80% power and 95% confidence.

TABLE 1
Change in VAS and FAOS Scores After Surgery[a]

	Presurgery Score	Postsurgery Score	*P* Value
VAS	6.4 ± 1.3	1.0 ± 1.5	<.001
FAOS domain			
Pain	75.7 ± 7.4	92.0 ± 10.0	<.001
Symptoms	78.1 ± 11.1	85.3 ± 13.6	.017
ADL	83.4 ± 5.2	92.0 ± 6.8	<.001
Sport	52.2 ± 12.5	88.4 ± 15.7	<.001
QOL	38.1 ± 10.9	83.3 ± 21.9	<.001

[a]Data are reported as mean ± SD. ADL, activities of daily living; FAOS, Foot and Ankle Outcome Score; QOL, quality of life; VAS, visual analog scale.

RESULTS

Sixteen patients underwent surgery (13 males; 9 right side). The mean age was 26.2 years (range, 18-47 years), and the mean follow-up was 14 months (range, 6-20 months). Nine patients were elite athletes competing at the national or international level. All patients had improvement in symptoms after surgery and were able to resume sporting activities to their previous level. There was significant improvement in mean VAS scores for pain from 6.4 (95% CI, 5.8-7.0) preoperatively to 1.0 (95% CI, 0.2-1.8) postoperatively ($P < .001$). There was also a significant improvement in all domains of the FAOS score (Table 1).

Histological examination revealed evidence of inflammatory changes in the loose peritendinous connective tissue surrounding the plantaris tendon in all cases. The plantaris tendon was histologically normal in 13 of 16 patients. Three patients demonstrated abnormality of the plantaris tendon with typical features of mild tendinopathy: The slender and spindle-shaped tenocytes seen in normal tendons were replaced by morphologically abnormal tenocytes with a rounded/widened cells (Figure 1). When the MRI and US scans were reviewed, 2 patients with abnormal histological findings were those with thickened and abnormal looking plantaris tendons (Figure 2). One patient with histological evidence of tendinopathy had normal thickness of the normal plantaris tendon on MRI other than peritendinous inflammatory changes and some tendinopathy in the adjacent Achilles tendon (Figure 3).

DISCUSSION

There is increasing interest in the role of the plantaris tendon in the development of medially located Achilles tendinopathy. Surgical stripping of the plantaris tendon with release of paratenon adhesions and the neovascularization and neoinnervation on the ventral surface of the Achilles tendon has good results reported in several studies.[1,3,14,25] The exact pathophysiology underlying the development of the condition is unclear. Biomechanical causes with compression and the development of a painful fictional syndrome with the development of an inflammatory response is supported by studies reporting increased occurrence in

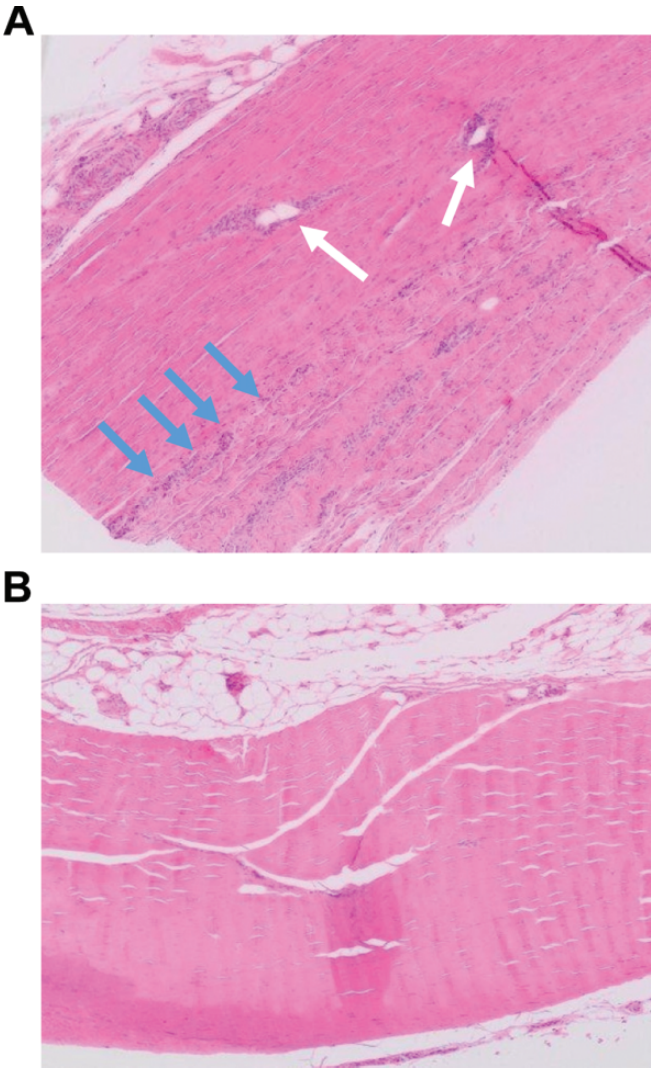

Figure 1. (A) Increased cellularity (blue arrows) and focal fibrinoid and subtle mucoid changes (white arrows) consistent with mild tendinosis (magnification ×40). (B) Normal tendon for comparison (magnification ×40).

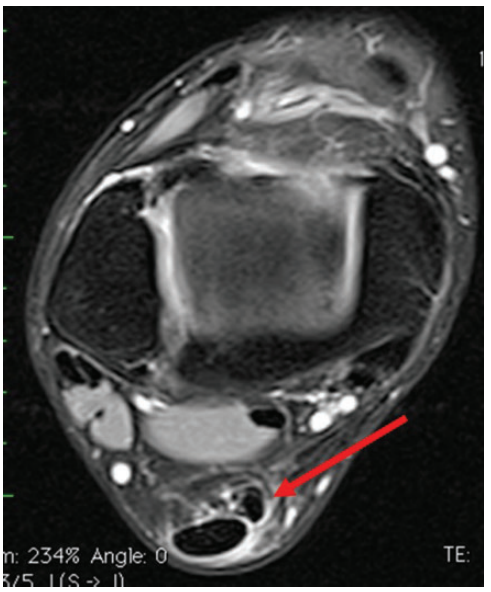

Figure 2. Magnetic resonance imaging scan noting a thickened plantaris tendon (arrow) consistent with tendinosis and surrounding inflammatory changes adjacent to Achilles tendon.

Figure 3. Magnetic resonance imaging scan showing a normal appearance of the plantaris tendon (arrow) adjacent to the Achilles tendon.

endurance runners, with the interesting observation that the right side is affected nearly 4 times as frequently in bend sprinters.[5,15] An alternative view is that insertion of the plantaris into the medial edge of the Achilles leads to a differential traction of the tendons and tendinopathy. The current study demonstrates that the plantaris itself is not necessarily histologically abnormal or tendinopathic. The fact that all patients in this series improved clinically after removal of the plantaris supports the concept that it was involved in the development of focal medial Achilles tendinopathy. All 16 patients had a plantaris tendon attached or very close to the Achilles tendon and surrounding inflammatory changes seen on MRI and US scans, with mild tendinopathic changes in the adjacent Achilles tendon. However, only 3 patients had histological evidence of tendinopathic changes in the plantaris tendon. Two of these patients had evidence of marked thickening and tendinopathy on MRI and US. The remaining 13 patients had no plantaris tendinopathy histologically, and these tendons also appeared morphologically normal on MRI and US. The presence of tendinopathy in the plantaris tendon did not appear to affect the final clinical outcome of surgery. All patients had evidence of inflammatory changes in the surrounding peritendinous tissue, supporting previous studies

reporting compression of the Achilles tendon with inflammation and altered tendon gliding within the "paratendinopathy" as a cause for pain in Achilles tendinopathy.[18,21,23]

It has been postulated that this area of inflammatory change surrounding the midportion Achilles tendinopathy results from a neurogenic inflammation induced by the relatively avascular Achilles tendon.[26] The plantaris tendon is incorporated in this inflamed peritendinous tissue, which contains abundant neovascularization and neoinnervation. The different dynamics between Achilles tendon and plantaris tendon result in a continuous irritation and pain from friction within this inflamed peritendinous tissue. The authors attribute the good results of stripping of the plantaris tendon and the anterior side of the Achilles tendon to the denervation of this area.[26]

One study has previously found tendinopathic changes in the plantaris tendon of such patients, suggesting that this may be a causative factor in the development of this condition.[20] However, it is apparent from the current study that concurrent tendinopathy of the plantaris is not necessarily present. We suggest that although tendinopathic changes may develop in the plantaris, this may be a secondary and later consequence of chronic inflammatory changes. The primary problem is more likely a biomechanical one with either a frictional syndrome between the plantaris and the Achilles tendons or a direct tractional problem with attachment of the plantaris to the medial edge of the Achilles tendon.

Limitations of this study include the specific young active population included, although this is representative of the patient group who develop this condition. It was not possible to differentiate between tendons adherent to or invaginated into the Achilles tendon, and the sample size would be too small to determine whether these 2 insertion patterns display differences in the presence of tendinopathic changes.

CONCLUSION

There is increasing evidence to support that the excision of plantaris results in improved clinical outcomes in a subset of patients with midportion Achilles tendinopathy. This is the first study to demonstrate histologically normal plantaris tendons in the presence of Achilles-plantaris syndrome resistant to conservative treatment. Since patients improved even when the excised plantaris was not tendinopathic supports the concept that this may be a compressive or a frictional phenomenon rather than purely tendinopathic. We hope that this study may stimulate further research investigating the biomechanical causes and possible treatments of plantaris-related Achilles tendinopathy.

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