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# Management of peroneal tendon disorders

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CHAPTER 6

# Functional outcomes after peroneal tendoscopy in the treatment of peroneal tendon disorders

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## Abstract

*Purpose*

The primary purpose of this study was to evaluate clinical outcomes following peroneal tendoscopy for the treatment of peroneal pathology. Correlation between pre-operative magnetic resonance imaging (MRI) and peroneal tendoscopic diagnostic findings was also assessed.

*Methods*

Twenty-three patients with a mean age of 34 ± 8.8 years undergoing peroneal tendoscopy were pre- and post-operatively assessed with the foot and ankle outcome score (FAOS) and the Short Form-12 (SF-12) outcome questionnaires. Follow-up was over 24 months in all patients. The sensitivity and specificity of MRI were calculated in comparison with peroneal tendoscopy, including the positive predictive value (PPV).

*Results*

Both the FAOS and the SF-12 improved significantly ($p < 0.05$) at a mean follow-up of 33 ± 7.3 months significantly. MRI showed an overall sensitivity of 0.90 (95 % CI = 0.82 – 0.95) and specificity of 0.72 (95 % CI 0.62 – 0.80). The PPV for MRI diagnosis of peroneal tendon pathology was 0.76 (95 % CI 0.68 – 0.83).

*Conclusions*

The current study found good clinical outcomes in patients with peroneal tendon disorders, treated with peroneal tendoscopy. Although a relatively small number of patients were included, the study suggests good correlation between tendoscopic findings and pre-operative MRI findings of peroneal tendon pathology, supporting the use of MRI as a useful diagnostic modality for suspected peroneal tendon disorders.

# Chapter 6. Functional outcomes after peroneal tendoscopy in the treatment of peroneal tendon disorders

## Introduction

Peroneal tendon disorders frequently result in refractory posterolateral ankle and hindfoot pain that disables patients from routine activity and sport.[1,2] Tendon pathology may range from tenosynovitis, tendinosis, stenosis, subluxation, and dislocation to overt tear.[3-5] In certain cases of peroneal tendon pathology, diagnosis can be challenging. Only 60 % of patients with peroneal tendon disorders are diagnosed accurately upon initial clinical examination[2], and the diagnostic accuracy of magnetic resonance imaging (MRI) has been inconsistent.[6-9] The so-called magic angle effect may further reduce the specificity of MRI findings.[10,11] Standard open surgery of the peroneal tendons has been associated with complications including post-surgical scarring with further stenosis and inflammation of the tendons and injury to the sural nerve.[12,13] Post-surgical scaring may cause further stenosis and inflammation of the tendons as they course through their fibro-osseous tunnel. While good results following surgery with traditional open approaches have been documented[14-17], Steel and DeOrio reported that only 46 % of the operatively treated patients were able to return to sports activity at a mean follow-up of 31 months.[18]

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In response to the diagnostic challenges and potential clinical consequences associated with traditional open approaches, recent attention has been directed towards developing less invasive surgery that might afford diagnostic clarity and treatment potential without the inherent risk of these complications during management of common peroneal tendon pathologies. Tendoscopy has been proposed as one such minimally invasive technique that might fulfil this need.[19-21] The primary purpose of the current study was to report on functional outcomes after tendoscopic management of peroneal tendon disorders. In addition, the current study sought to correlate pre-operative MRI diagnoses with intraoperative findings. It was hypothesized that the use of peroneal tendoscopy would lead to good functional outcomes and there is a high correlation between tendoscopic and pre-operative MRI.

## Materials and methods

*Subjects*

This retrospective study was approved by the Institutional Review Board at the Hospital for Special Surgery (Protocol #29124). Twenty-four consecutive patients who underwent peroneal tendoscopy between 2010 and 2013 were identified using the institutional foot and ankle registry. A single surgeon performed all surgical procedures and provided pre- and post-operative care. Surgical intervention was indicated for those who had failed a minimum three months of non-surgical management, including physiotherapy, immobilization, and non-steroidal anti-inflammatory drugs. Contraindications for surgery included any patient identified as a smoker or having associated medical comorbidities such as diabetes, autoimmune disease, and/or active infection.

The inclusion criteria for this study were patients who had (1) a peroneal tendoscopy; (2) an evaluable pre-operative MRI; (3) a minimum post-operative follow-up time of 24 months, and (4) an age between 16 and 70 years at the time of surgery. Patients were excluded if they had (1) a peroneal tendoscopy as part of a combined procedure and (2) a subsequent surgery that confounded meaningful post-operative outcome analysis.

*Clinical evaluation*
Patients were assessed pre- and post-operatively using patient-reported and general health outcome questionnaires, including the foot and ankle outcome score (FAOS) and Short Form-12 (SF-12), respectively.[22,23] All patients in the study had 24-month questionnaires available in the database, so no further patient contact was necessary because all data were retrievable from existing records.

*MRI assessment*
MRI was acquired with the foot and ankle in a neutral position using a 3-Tesla clinical imaging system (GE Healthcare, Milwaukee, WI, USA). The senior musculoskeletal radiologist reviewed all MRI images and was blinded to both surgical findings and clinical outcome. Musculoskeletal morphology of peroneal tendon pathology was evaluated using a combination of T1, high-resolution proton density, fat-suppressed T2-weighted, and fast spin echo inversion recovery sequences performed in coronal, sagittal, and trans-axial planes. Diagnoses provided from the MRI reports were compared to tendoscopic findings as part of the current study. Any discrepancy between the presence of tenosynovitis, tendinosis, or tendon tears was considered as disagreement between diagnostic modalities. No patient underwent tendoscopy if the MRI report showed no evidence of peroneal pathology.

*Surgical technique*
All patients underwent a standard surgical procedure. Patients were placed in a lateral position, allowing access to the anterior and posterior aspects of the ankle were an open procedure to be required. A two-portal technique with a skin bridge of greater than 30 mm was standard in all cases. Portals were made in accordance with the area of pathology identified on MRI. In this regard, a 22-gauge needle was used to identify the peroneal sheath and 5.0 cc of saline was injected to confirm correct placement and orientation of the proposed portal. A 15-gauge blade was then used to open the skin, and two skin hooks were used to lift the subcutaneous tissue from the tendon. Once the tendon was protected from the blade, the tendon sheath was opened and the 2.7-mm obturator was inserted (Smith & Nephew, Inc., Memphis, TN, USA). A low-pressure, low-flow pump of 50 – 70 mmHg was used in all cases.

Once the area of pathology was visualized, a 22-gauge needle was used to guide the second portal in exactly the same fashion as the first one. A small vincula was typically seen initially, and where appropriate this was shaved with a 2.9 mm shaver to allow better visualization and access. Once full visualization was established, areas of pathology were divided into three regions (figure 1).[24] The fourth zone, from the cubital tunnel into the plantar surface of the foot, was not evaluated in the current study.[25] All pathologies were evaluated by the senior surgeon and entered into the operative report.

**Figure 1**
Areas of peroneal tendon pathology divided into four anatomic regions




In patients with stenosis, subluxation, and tendon tear, peroneal groove deepening was performed using a 3.5 mm burr in the retromalleolar groove. The burr was used to create a concavity to allow the peroneus brevis tendon to lie within the groove. Sharp edges were smoothened to prevent tendon fraying, and tendons were held out of the way with two Kirschner wires. After burring, the ankle and subtalar joints were moved to assess tendon stability within the bony trough. Any evidence of subluxation prompted further burr resection until the tendon was stable and secure.

A longitudinal peroneal tendon tear was found in four patients. The two patients with less than a 10 mm tear were treated with debridement under tendoscopy. The other two patients had tears greater than 10 mm and therefore underwent a mini-open incision using an extended portal. The tendon was brought into the wound, debrided of any remaining degenerative debris and sutured with a 4-0 prolene suture using buried sutures knot and a running technique.

Platelet-rich plasma (PRP) was used to augment biologic healing in all cases. PRP was obtained from the patient at the time of surgery, with whole blood being drawn and then centrifuged in a standard fashion for fifteen minutes using a commercially available system (Arteriocyte, Inc., Hopkinton, MA, USA). The supernatant, a buffy coat containing a leucocyte-depleted PRP, was obtained. Twenty-six milliliters of whole blood was typically procured to produce 2 – 3 mL of PRP, with 1.5 mL used for tendon injection. PRP was injected into the site of tendon pathology with a 22-gauge needle under tendoscopic visualization. The needle was withdrawn and reinserted every 2 – 3 mm along the length of the affected tendon. At the time of wound disclosure, the remaining PRP was injected into the tendon sheath. At the time of surgery, note was made regarding the area of intervention related to the different zones of pathology (figure 3).

*Post-operative treatment*
All patients were instructed to utilize a standardized post-operative protocol. For those who underwent peroneal tear debridement, a soft dressing was applied in the acute phase. Sutures were removed seven –ten days after surgery. Patients advanced their weight bearing as tolerated. Physiotherapy included phased muscle firing, balance, and proprioceptive training. Once the patient demonstrated competence, they were progressed to sport-specific training. For patients receiving tendon repair, a lower leg splint was applied for two weeks, followed by weight bearing that progressed by 10 % bodyweight each day. At the four-week time point,

sport-specific physiotherapy was initiated to regain full range of motion and strength. Patients were allowed to return to sport after six to ten weeks, depending on individual progression and sporting demands.

*Statistical analysis*
All analyses were performed using SAS software version 9.3 (SAS Institute, Inc., Cary, NC). Paired t-tests were used to determine significant difference between the pre- and post-FAOS and SF-12 scores. Linear regression was performed to determine whether the mean pre- or post-FAOS/SF-12 scores and the mean change between pre- and post-FAOS/SF-12 scores differed by age. Means and standard deviations were calculated for descriptive statistics of the cohort or were reported in frequencies. Significance level was set at a $p$-value $< 0.05$ for all analyses. Sensitivity and specificity of MRI and arthroscopic findings were assessed. In addition, positive and negative predictive values were calculated.

## Results

Of the 24 patients who satisfied the inclusion criteria of the study, one female patient was excluded because she declined entry to the study for personal reasons, but at latest clinical follow-up was reported a good post-surgical outcome. Twenty-three patients were therefore included in the study. Patient demographics and clinical characteristics are shown in table 1.

**Table 1**
Patient demographics and clinical characteristics

| Demographic | Value |
|---|---|
| Patients (n) | 23 |
| Males/females (n) | 10/13 |
| Age, year (mean ± SD) | 34 ± 8.8 |
| Follow-up, month (mean ± SD) | 33 ± 7.3 |
| Duration symptoms, month (mean ± SD) | 14 ± 7.6 |
| Injured leg (n, left/right) | 14/9 |
| History of trauma (percentage) | 48 % |

*Clinical evaluation*
The FAOS score improved from a pre-operative mean of 57 ± 14 points to a post-operative mean of 86 ± 8.4 points at final follow-up ($p < 0.01$). The mean SF-12 score improved from 54 ± 14.4 points pre-operatively to 81 ± 7.8 points post-operatively at final follow-up ($p = 0.01$). The pre- and post-operative scores and the differences between them for both SF-12 and FAOS did not differ by gender, age, or duration of symptoms ($p > 0.05$) (table 4).

Post-operative complications were identified in only two patients, including one who had persistent lateral ankle pain and did not return to play soccer by two years. No further follow-up beyond two years was available for this patient. A second patient reported hypertrophic scar formation over the wound after a mini-open repair. Four months after surgery, however, the complaint was resolved.

*Correlation between tendoscopic findings and MRI*

Twenty-one patients were eligible for comparison of MRI and tendoscopic findings. Two patients with external MRIs were excluded from analysis because comparison between MRI qualities did not allow for meaningful analysis.

Zone A, including the superior peroneal retinaculum (SPR) and distal fibula, had the greatest degree of pathology (table 2). This was followed by zone B, including the inferior peroneal retinaculum (IPR) at the level of the peroneal tubercle. The least amount of pathology was found in zone C, located at the level of the cubital tunnel.

**Table 2**

Pathologies identified on peroneal tendoscopy (*n* = 21)

**PB = Peroneus Brevis, PRP = Platelet-Rich Plasma, SPR = Superior Peroneal Retinaculum, CBAM = Concentrated Bone Marrow Concentrate Aspirated*

| Location | Pathology | Number of patients | Treatment |
|---|---|---|---|
| Zone A | Tenosynovitis | 10 | Debridement |
| (n=12) | Tendinopathy | 10 | Debridement, PRP injection |
| | Stenosis | 4 | PB muscle debridement, SPR partial resection, fibular groove deepening |
| | Subluxation | 2 | Debridement, fibular groove deepening |
| | Tear < 1 cm | 2 | Debridement, PRP inject, fibular groove deepening |
| | Tear > 1 cm | 1 | Mini open repair, PRP injection, fibular groove deepening |
| Zone B | Tenosynovitis | 6 | Debridement |
| (n=6) | Tendinopathy | 6 | Debridement, PRP/BMC injection |
| | Stenosis | 2 | Resection of tubercle with a burr |
| | Tear > 1 cm | 1 | Mini-open repair with PRP |
| | Prominent suture | 1 | Removal of suture knot |
| Zone C | Tenosynovitis | 2 | Debridement |
| (n=3) | Stenosis | 1 | Debridement, burr of cubital tunnel |

Close correlation was found between the presence or absence of pathology within the peroneal tendons and MRI findings, indicating a high MRI sensitivity in detecting peroneal pathology (table 3). Compared to tendoscopic findings, MRI showed 0.90 sensitivity (95 % CI 0.82 – 0.95), 0.72 specificity (95 % CI 0.68 – 0.83), 0.76 positive predicative value (95 % CI 0.68 – 0.83), and 0.88 negative predictive value (95 % CI 0.78 – 0.94) (table 4). The one pathology that showed poor sensitivity and specificity on MRI was stenosis with 0.33 (95 % CI 0.23 – 0.43) and 0.66 (95 % CI 0.56 – 0.75), respectively. Specificity remained the same between the three zones, indicating that the magic angle effect in zone A was not a factor in masking peroneal pathology in this cohort.

**Table 3**
Sensitivity and specificity for MRI detection of peroneal tendon pathologies
**PB = Peroneus Brevis, PL = Peroneal Longus, 95 % CI = 95 % Confidence Interval*

| Pathology | Sensitivity (95 % CI) | Specificity (95 % CI) | Positive predictive value (95 % CI) | Negative predictive value (95 % CI) |
|---|---|---|---|---|
| Overall | 0.90 (0.82 – 0.95) | 0.72 (0.62 – 0.80) | 0.76 (0.68 – 0.83) | 0.88 (0.78 – 0.94) |
| PB Tear | 0.77 (0.67 – 0.84) | 0.90 (0.82 – 0.95) | 0.89 (0.80 – 0.94) | 0.80 (0.71 – 0.86) |
| PL Tear | 0.80 (0.71 – 0.87) | 1.00 (0.96 – 1.00) | 1.00 (0.95 – 1.00) | 0.83 (0.7 – 0.89) |
| Tenosynovitis | 1.00 (0.96 – 1.00) | 0.90 (0.82 – 0.95) | 0.90 (0.83 – 0.96) | 1.00 (0.96 – 1.00) |
| Tendinopathy | 0.88 (0.80 – 0.94) | 1.00 (0.96 – 1.00) | 1.00 (0.96 – 1.00) | 0.89 (0.82 – 0.94) |
| Stenosis | 0.33 (0.23 – 0.43) | 0.66 (0.56 – 0.75) | 0.49 (0.37 – 0.61) | 0.49 (0.41 – 0.58) |

**Table 4**
Patient clinical outcomes (*n* = 23)
*Preop. = pre-operative, Postop. = Post operative

| Outcome | | Mean (SD) | *P value* |
|---|---|---|---|
| FOAS | Preop. | 57 (14) | |
| | Postop. | 86 (8.4) | |
| | Change pre- to postop | 30 (11) | < 0.01 |
| | Female | 31 (12) | |
| | Male | 25 (11) | |
| SF-12 | Preop. | 53 (14) | |
| | Postop. | 81 (7.8) | |
| | Change pre- to postop | 28 (7.7) | < 0.01 |
| | Female | 29 (9.7) | |
| | Male | 27 (6.2) | |

## Discussion

The most important finding of the current study was that peroneal tendoscopy is an effective treatment in improving functional outcome scores for a variety of peroneal tendon pathologies. Peroneal tendon pathology is often misdiagnosed, partly due to difficulty in clinical differentiation between a range of posterolateral ankle pathologies and interpreting conventional MRI and ultrasound findings of the lateral ankle.[13,26-29] While traditional open surgical techniques have shown good outcomes across a range of peroneal tendon pathologies, these are associated with a degree of post-operative morbidity that can frustrate uniformly good outcomes for many peroneal tendon pathologies.[2,14-18] Post-operative stenosis, adhesions, tendon luxation, synovitis, and nerve damage can all occur following open surgical exposure.[2,16-18] In contrast, tendoscopic intervention in peroneal pathology offers a minimally invasive method of surgical intervention that can potentially reduce the risk of these complications and confer unique advantages including shorter hospital stays, reduced cost, improved cosmesis, and earlier recovery than seen in traditional open procedures.[20,30-34]



In the current study, the most common pathology identified was tenosynovitis. This is in agreement with the literature.[20,30-34] Typically, tenosynovitis was associated with concomitant pathology of stenosis, tendon hypertrophy, or small tendon tears. Synovitis was addressed with arthroscopic debridement of the inflamed synovium. In nine of twenty cases, a fibular groove deepening was also performed. When tears were seen, a fibular groove deepening was performed in addition to biologic augmentation of the tendon and mini-open repair when necessary. Previous cadaveric studies have shown that groove deepening of the middle and distal peroneal grooves significantly reduces pressure on the tendons running within the groove, thereby reducing pain in patients with inflammation or small tendon tears.[35] The authors advocate that this supplemental treatment thus addresses not only the symptom generator at the time of tendoscopy but also the presumed primary pathology. Contrary to other studies reported, no evidence of tearing within the superior peroneal retinaculum was identified in this series, either via MRI or tendoscopy. This was a curious observation in the study cohort and might only be explained by a lack of patients with defined peroneal subluxation. Guillo and Calder have reported successful endoscopic retinaculum repair when a tear is identified, and this technique has shown promising results when required.[30]

The use of PRP to treat tendon pathology has been substantiated by in vivo and in vitro systematic reviews.[36] Both a neoangiogenic response to PRP and a tenoproliferative effect mediated by tenocyte growth factor have been demonstrated.[37] The technique of multiple stab incisions to promote tendon healing has also been previously established.[38,39] In the current study, small tears less than 1 cm in length were treated with a combination stab incision technique and intratendinous injection of 1 – 2 mL of leucocyte-depleted PRP. The outcome from those patients with tendon tears was found to be uniformly excellent, with no recurrence of symptoms. Unfortunately, however, this study cannot establish that PRP, multiple stab incisions, or decompression of the tendon by fibular groove deepening was the primary cause of such good outcomes.

MRI correlated well in this study with overall tendoscopic findings. This is at variance with several previous studies. O'Neill et al demonstrated that just 56 % of peroneal tendon tears diagnosed at the time of surgery were seen on pre-surgical MRI.[7] Giza et al found a PPV of only 48 %.[6] The variance between these outcomes may in part be due to the 3-Tesla MRI scanning equipment used with the current study due to its improved sequencing and visualization. It may also be due to differences in patient selection between the studies. Peroneal pathology was investigated alone in the current study, whereas in previous reports, peroneal pathology was part of a spectrum of lateral ankle pathology; inherent bias could therefore be conferred when comparing the two outcomes. In two separate studies by Park et al, evaluating solely peroneal pathology with MRI and clinical findings, the outcomes were in greater agreement with the current study's findings.[8] In a study of 97 patients, Park et al found that MRI sensitivity to peroneus brevis and longus tears was, respectively, 44 % and 50 %, and specificity, respectively, 99 % and 96 %.[9] In another study, Park et al demonstrated that sensitivity and specificity to peroneal pathology using MRI and clinical correlation was 84 % and 75 %, respectively.[8] These findings are in accordance with the current study's finding of 90 % sensitivity and 72 % specificity. No study to date has commented on any correlation between clinical peroneal stenosis and MRI evidence of this pathology. The current study demonstrates 33 % sensitivity for this pathology, indicating that MRI may not be the best modality to diagnose what may be a dynamic pathology that requires real-time dynamic testing such as ultrasound. However, this suggestion is based on a relatively small number of included patients in the current study and with the surgeon unblinded to pre-operative MRI findings. Therefore, further research study is needed to investigate the correlation between MRI and tendoscopic findings.

Limitations of this study should be considered. The retrospective study design carries possible inherent bias. While lack of a control group is unfavourable, adding a control group would mean exposing a healthy population to tendoscopic surgery, which was considered unethical. A third limitation is the absence of ultrasound images, since this diagnostic method is gaining popularity as the test of choice for dynamic tendon pathology.

## Conclusion

This current study found that peroneal tendoscopy is an effective minimally invasive technique in the treatment of a variety of peroneal tendon pathologies. Moreover, the current study revealed the possibility of good correlation between tendoscopic findings and pre-operative MRI findings of peroneal tendon pathologies, with the exception of peroneal tendon stenosis.

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