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The Prevalence and Role of Low Lying Peroneus Brevis Muscle Belly in Patients with Peroneal Tendon Pathologies: A Potential Source for Tendon Subluxation

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Abstract

A low lying peroneus brevis muscle belly is a rare anomaly. There are few published studies that support presence of this anomaly as an etiology for peroneal tendon tear. However, the association between a low lying peroneus muscle belly (LLMB) and tendon subluxation is not well explored. In this retrospective study, the magnetic resonance imaging (MRI) and intraoperative findings of 50 consecutive patients undergoing a primary peroneal tendon surgery, in a five year period, were assessed. The sensitivity and specificity of MRI, in comparison to intraoperative findings for identifying peroneal tendon disease was investigated. Presence of associated peroneal tendon pathologies in patients with and without LLMB was compared.

Sensitivity of MRI was high in identifying peroneal tenosynovitis (81.58%) and tear (85.71%). Although the sensitivity of MRI for detecting a LLMB (3.23%) and tendon subluxation (10.00%) was low, MRI had high specificity at 94.74% and 100%, respectively. Intraoperatively, LLMB was seen in 62.00% of patients with chronic lateral ankle pain and was associated with 64.52% cases of tenosynovitis, 29.03% cases of tendon subluxation, and 80.65% cases of peroneus brevis tendon tear. While presence of a LLMB did not show any statistically significant association with peroneus brevis tendon subluxation, among the 10 patients with intraoperatively observed tendon subluxation, 9 had a concomitant LLMB. More studies with a larger patient population are needed to better study the role of a low lying muscle belly as a mass occupying lesion resulting in peroneal tendon subluxation.

Keywords

ankle; anomaly; fibula; lateral malleolus; magnetic resonance image; muscle tear; tenosynovitis

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There are no conflicts of interest.

Introduction

Peroneal tendon injuries as a result of lower extremity trauma are well recognized and studied. Advances in magnetic resonance imaging (MRI) system have enhanced our ability to diagnose soft tissue pathologies such as tenosynovitis and tendon tear. A low lying muscle belly (Figure) is a rare anomaly, most commonly associated with peroneus brevis tendon (1–3). A low lying muscle belly is defined as a muscle extending beyond its normal length. In the case of a peroneus brevis muscle, it is expected that the muscle would end in average 1.6–2.0 cm above the distal tip of the fibula (4). Cases of low lying peroneus brevis muscle belly (LLMB) has been documented in the literature (1, 3, 5–9). However, to our knowledge, association between a low lying muscle belly and tendon subluxation is not well studied.

It is recognized that the three primary peroneal tendon disorders include: tenosynovitis, tendon subluxation, and tendon tears (10–11). Peroneal tendon synovitis and tears are a common finding especially as a result of ankle sprains. Prior studies have addressed peroneal tendon tears, highlighting appropriate diagnosis and surgical treatment (10–14). It is well recognized that MRI studies can be a useful tool to assess peroneal tendon tears. However, in the literature, there are reported concerns with false reading of tendon tear when relying on MRI studies as the only source. Khoury et al (15) evaluated the accuracy of MRI findings in surgically proven peroneal tendon tears. There were two false-positives (16.67%) and one false-negative (8.33%) among 12 patients who underwent surgery for a suspected peroneal tendon tear. In another retrospective study by Lamm et al (7) MRI findings of peroneal tendon tears were compared with intraoperative findings in 32 patients. MRI diagnosis of a peroneus brevis tendon tear showed 83% sensitivity and 75% specificity. In their study, they report of 2 false positive (6.25%) and 4 false negative (12.50%) cases of peroneus brevis tendon tear using MRI images. Although the authors include patients with LLMB, it is unclear how many cases of LLMB were identified in imaging studies or intraoperatively (7). In addition, the authors did not clearly discuss the relation of LLMB to any observed peroneal tendon pathology.

The association between tears of the peroneus brevis tendon and the distal extent of its muscle belly are reported by Freccero et al (5). The average distance between the musculotendinous junction to distal fibula was measured at 33.1mm on MR images of 29 patients with surgically confirmed peroneus brevis tendon tear. However, this distance was reported to be 41.2 mm for 30 patients with surgically confirmed intact peroneus brevis tendon (5). Although the authors discussed association between peroneus brevis tears as it relates to the extent of its muscle belly, they did not report of any tendon subluxation relative to a LLMB. Geller et al (1) also discussed the crucial impact of a LLMB on peroneal tendon tears. Using 30 cadaver legs, they reported on the presence of a lower musculotendinous junction on an increased prevalence for peroneal tendon tears. The musculotendinous junction was significantly more distal in torn versus un-torn specimens (1). This study however included a small number of specimens with tendon tears (n=4). The association between LLMB and tendon subluxation was not studied in this cadaveric study. In another study, Pollack et al report one case of a peroneal tendon tear that was missed on

MRI images. Upon exploration of the tendon, a low lying muscle belly was noted and felt to be the possible source of the tendon tear. (2)

There are very limited published studies on the relationship between peroneal tendon subluxation and a low lying peroneal muscle belly. To our knowledge, there is only one single case study reporting on presence of a low lying peroneal muscle belly in the setting of peroneal tendon subluxation (6). In another study, peroneal tendon subluxation was seen as a result of a bifid peroneus brevis tendon, rather than a low lying muscle belly (16).

Even though the presence of a low lying peroneal muscle belly in cases of peroneal tendon tears has been documented in several studies (1–3), the prevalence of a low lying peroneal muscle and its association with peroneal tendon subluxation is not adequately studied in the available literature. In this study, our primary goal was to determine if there was any association between a low lying peroneus brevis tendon muscle belly and tendon subluxation. We hypothesized that a low lying muscle belly may be a contributing factor to peroneal tendon subluxation secondary to its mass affect. Our secondary aim was to determine the prevalence for peroneal tendon pathologies, more specifically a low lying muscle belly, in our patient population. Sensitivity and specificity of MRI in identifying surgically proven tendon pathologies was also studied.

We undertook a retrospective study of patients undergoing lateral ankle surgery to assess reliability of MRI, determine prevalence for peroneal tendon pathology and compare presence of tenosynovitis, tendon tear and subluxation in patients with and without LLMB.

Patients and Methods

A sample size power analysis was completed and it was determined that 50 patients were adequate to provide 80% power ($\alpha = 0.05$). After obtaining approval from the human research review committee at the University of X, which served as the institutional review board (IRB) of record for the X Health Care System, a chart review of 50 consecutive patients who had undergone a peroneal tendon repair was completed.

A data base of patients who had undergone a peroneal tendon repair, in a five year period from 11/2008 to 11/2013, in the author’s practice (RM) was generated using the Common Procedural Terminology (CPT®) codes from the surgical package of the X Health Care System. The CPT® codes used to identify patients with peroneal tendon surgery were: 27659 and 27658. Using the keywords “peroneal” and “peroneus”, the list of operations for these patients was then further narrowed down to specifically identify the patients who had undergone a peroneal tendon repair surgery. Only patients who had undergone a primary peroneal tendon repair with completed preoperative MRI studies of the affected ankle were included. Patients with revision peroneal tendon surgery, prior use of peroneal tendon(s) for lateral ankle ligament reconstruction, prior history of ankle fracture open reduction/internal fixation and incomplete medical records (such as preoperative MRI) were excluded from the study.

Each patient’s chart including progress notes, MRI and operative reports was reviewed by co-authors (CS and DW) for documented clinical, imaging and intraoperative findings of peroneal tendon tenosynovitis, subluxation, tear and presence of a low lying muscle belly. A clinical finding was defined as patient having one or more symptoms of peroneal tenderness, subluxation, snapping, or pain on posterolateral ankle on physical examination. All MR images were reviewed by two musculoskeletal fellowship trained radiologists. Operations were performed by two surgeons at the senior author's (RM) practice.

Peroneal tenosynovitis was defined as the presence of fluid collection within the peroneal tendon sheath, or hypertrophy of the tendon as seen on MRI images or evidenced intraoperatively (11). Subluxation of the peroneal tendon was defined as displacement of the tendon, within the tendon sheath, lateral to the retromalleolar groove. Peroneal tendon tear was defined as documented presence of a longitudinal tear within the tendon seen on MRI or intraoperatively (11). The low lying muscle belly was defined as extension of the muscle belly within the fibular groove. Intraoperative findings were used as a gold standard for identifying noted tendon pathologies and results were compared to imaging findings.

This study was designed to primarily investigate whether presence of a low lying peroneus brevis muscle belly was associated with peroneal tendon tenosynovitis, subluxation and tear. We also aimed to determine the prevalence of common peroneal tendon diseases in our patient population. Using intraoperative findings, sensitivity and specificity of MRI in identifying surgically proven tendon pathologies were also studied.

The sensitivity and specificity of MRI in detecting peroneal tendon disease was calculated using Clopper-Pearson (Exact) test with 95% confidence level. Due to small size of the samples, Fisher's exact test was used to compare the significance for tenosynovitis, tendon tear or subluxation, in patients with or without LLMB. A 2-sided p value of ≤ 0.05 was recognized to be significant.

Results

The medical records of fifty consecutive patients who had a primary peroneal tendon surgery in a 5 year period, from 11/2008 to 11/2013, and met the study criteria were reviewed. There were 8 females and 42 males with mean age of 50.05 (ranging from 24 to 68) years old.

The most common pathologies observed intraoperatively were presence of tenosynovitis (38 cases in 50 patients) and peroneus brevis tendon tear (42 cases out of 50 patients) (Table 1). There were 31 cases of peroneus brevis tendon low lying muscle belly noted intraoperatively, two of which were also identified using MRI. The prevalence for peroneus brevis tendon tear, tenosynovitis, and low lying muscle belly was 84.00%, 76.00% and 62.00%, respectively. Peroneal tendon subluxation was seen in 20.00% of the patients (Table 1).

Using intraoperative findings, the sensitivity and specificity of MRI in identifying peroneal tendon pathologies was investigated. The sensitivity of MRI in identifying peroneal tenosynovitis and peroneus brevis tendon tear was high at 81.58% and 85.71% with specificity of 75.00% and 62.50%, accordingly (Table 2). The MRI had low sensitivity but high specificity in detecting peroneal tendon subluxation (10% sensitive, 100.00% specific)

(Table 2). Of the 50 patients who underwent peroneal tendon surgery, 2 (4.00%) had preoperative MRI findings for the presence of LLMB whereas 31 (62.00%) cases of LLMB were identified intraoperatively (Table 1). MRI was not a sensitive test in diagnosing a low lying muscle belly as there were 29 (93.55%) cases of LLMB missed on MRI images. A diagnosis of a low lying muscle belly had low sensitivity of 3.23% but high specificity of 94.74% using MR images.

Using Fisher's exact test, absence of a low lying muscle belly was significantly (p=0.0182) associated with presence of tenosynovitis (Table 3). In addition, there was no statistically significant association between LLMB and peroneus brevis tendon tear (p=0.693) or subluxation (p=0.067). Tendon subluxation, however, was noted in 10 patients, 9 of which had concomitant low lying muscle belly (Table 3).

Discussion

The literature lacks adequate studies that focus on the relationship between a low lying muscle belly and peroneus brevis tendon pathology. We completed a retrospective study of 50 patients who had undergone a peroneus brevis tendon surgery. The prevalence for peroneal tendon disease, more specifically of peroneus brevis low lying muscle belly, was investigated in our patient population. The most common peroneal tendon disease seen in our patient population was peroneal tenosynovitis and peroneus brevis tendon tear. Our findings are similar to what is reported in the literature. In a study of 40 patients who underwent surgery for chronic pain along peroneal tendons, Dombek et al. (17) noted 88% cases of peroneus brevis tendon tear, 33% low lying peroneus muscle belly and 20% tendon subluxation. Among the 50 patients in our study, the prevalence for peroneus brevis tendon tear and subluxation was 84% and 20%, respectively. However, in our patient population, we had a higher number of patients (62%) with low lying peroneus muscle belly despite using the same definition for LLMB.

In a study by Giza e al. (18), the relationship between peroneus brevis tendon tear as seen on MRI was compared to clinical findings. A clinical finding was defined as patient having one of the following symptoms or presentation for peroneal tenderness, weakness, subluxation, snapping, or pain on posterolateral ankle. Of the 56 patients with positive findings on MRI, only 27 had an associated symptoms on clinical examination. They concluded that MRI images had a positive predictive value of 48% for presence of true tendon tear (18). In our patient population, the positive predictive value for peroneus brevis tendon tear using MRI was 92.31% (Table 2). Our study design was different than Giza since we compared actual intraoperative findings rather than clinical examination to what was observed on MRI.

In addition, in a study by Park et al. (19), MRI was noted to be 83.9% sensitive and 74.5% specific for identifying peroneal tendon pathology. More specifically, the sensitivity for MRI in diagnosing a peroneus brevis tenosynovitis, tendon tear and a low-lying muscle belly was reported at 25%, 54.5% and 91.7%, respectively. The authors conclude that MRI alone should not be relied upon as a source of necessity for surgical intervention (19). Our result differed from their findings as we found MRI to be a less sensitive test, missing more than 90% of LLMB seen intraoperatively. Our reported sensitivity for MRI in detecting peroneus brevis tenosynovitis, and tendon tear was higher at 81.58%, and 85.71%, respectively. This may be due to heightened education and recent advances in MRI technology and availability of a higher resolution image resulting in an increased detection for tendon tear and tenosynovitis. Although, in the study by Park et al, 12 cases of LLMB were encountered intraoperatively, the authors did not explore the impact or association of a LLMB on tendon tear or tenosynovitis. Our study showed that MRI, although a sensitive test to diagnose tenosynovitis and tendon tear, remains a poor imaging study for presence of a low lying muscle belly or tendon subluxation. An MRI is considered a static imaging tool. This may explain why a peroneus tendon subluxation that is usually a dynamic finding is not easily demonstrated using MRI. A low lying muscle belly for peroneus brevis may be missed due to imaging protocol and presence of the magic angle as result of the oblique course of the peroneal tendon.

Freccero (5) reported of a retrospective study on surgically explored peroneus brevis tendon from 1999–2004. Their study focused on MRI measurement of the distance from distal fibular tip to the end of the peroneus brevis musculotendinous junction in patients who had intraoperative findings of a peroneus brevis tendon tear. A positive correlation was noted for occurrence of tendon tear among those with a lower lying muscle belly (5). Freccero felt that the incidence of confirmed tears with associated LLMB warranted more study.

In a cadaveric study of 115 ankles, Unlu et al (20) found that his findings contradicted the findings of Freccero and that increased distance from distal tip actually increased the probability of peroneus brevis tendon tear. In their study, they note 15 cases of peroneus brevis tendon tear among the 115 specimens. There were no cases of LLMB reported in this study.

Although there are few citations in the literature on presence of LLMB placing the patients at higher risk for developing tendon tear, there is inadequate data on association between a LLMB and peroneus brevis tendon subluxation. In our study we hypothesized that the distal extension of the muscle belly within the fibular groove may result in a mass occupying phenomenon. With excessive tissue mass, the peroneal tendons may be at a higher risk for tenosynovitis, tendon subluxation and eventual attritional tear. Although there was no statistically significant difference in presence or absence of a low lying muscle belly on peroneus brevis tendon subluxation, in our patient population, 90% of patients with a peroneus brevis tendon subluxation had a concomitant low lying muscle belly. We also did not find significant difference for presence of peroneus brevis tendon tear among patients with or without a low lying muscle belly. A low lying muscle belly was less likely associated with presence of tenosynovitis. The reason for this is unclear (Table 3). Larger prospective studies are needed to better study the relation between low lying muscle belly and peroneus brevis tendon synovitis.

We believe our study is the first reported series of cases examining the association between a peroneus brevis low lying muscle belly and tendon subluxation. There were several limitations to this retrospective study. Due to retrospective nature of this study, we used CPT® codes 27659 and 27658 to identify patients who had undergone prior peroneus brevis tendon repair. We may have not identified all of the patients in our facility that had undergone a peroneus brevis surgical correction as there is no CPT® code specific for peroneal tendon repair. We had a small size of patients with subluxing peroneus brevis tendon making it difficult to have an accurate analysis. In addition, operations were done by two separate surgeons and the operative records as well as clinical findings were documented by multiple residents.

In conclusion, we believe that MRI alone should not be used as a diagnostic tool for peroneus tendon pathology as MRI may not be the most reliable method to accurately detect all type of tendon pathologies. As presented in this study, MR imaging can miss cases of a low lying muscle belly and tendon subluxation. Clinical findings and ultrasound imaging should be considered as an adjunct to MRI findings if there is concern for presence of a tendon subluxation. Despite the small number of patients in this study, our findings reinforce the need for an increased clinical suspicion of LLMB in patients with lateral ankle pain and peroneal tendonopathy, more specifically tendon subluxation. We believe that a low lying muscle belly may have a direct relation with presence of tendon subluxation. Peroneus brevis tendon subluxation was identified in 10 total patients intraoperatively, 9 of which had concomitant low lying muscle belly. The results of our study can be used in the development of future cohort prospective studies that focus on the role of LLMB in tendon subluxation.

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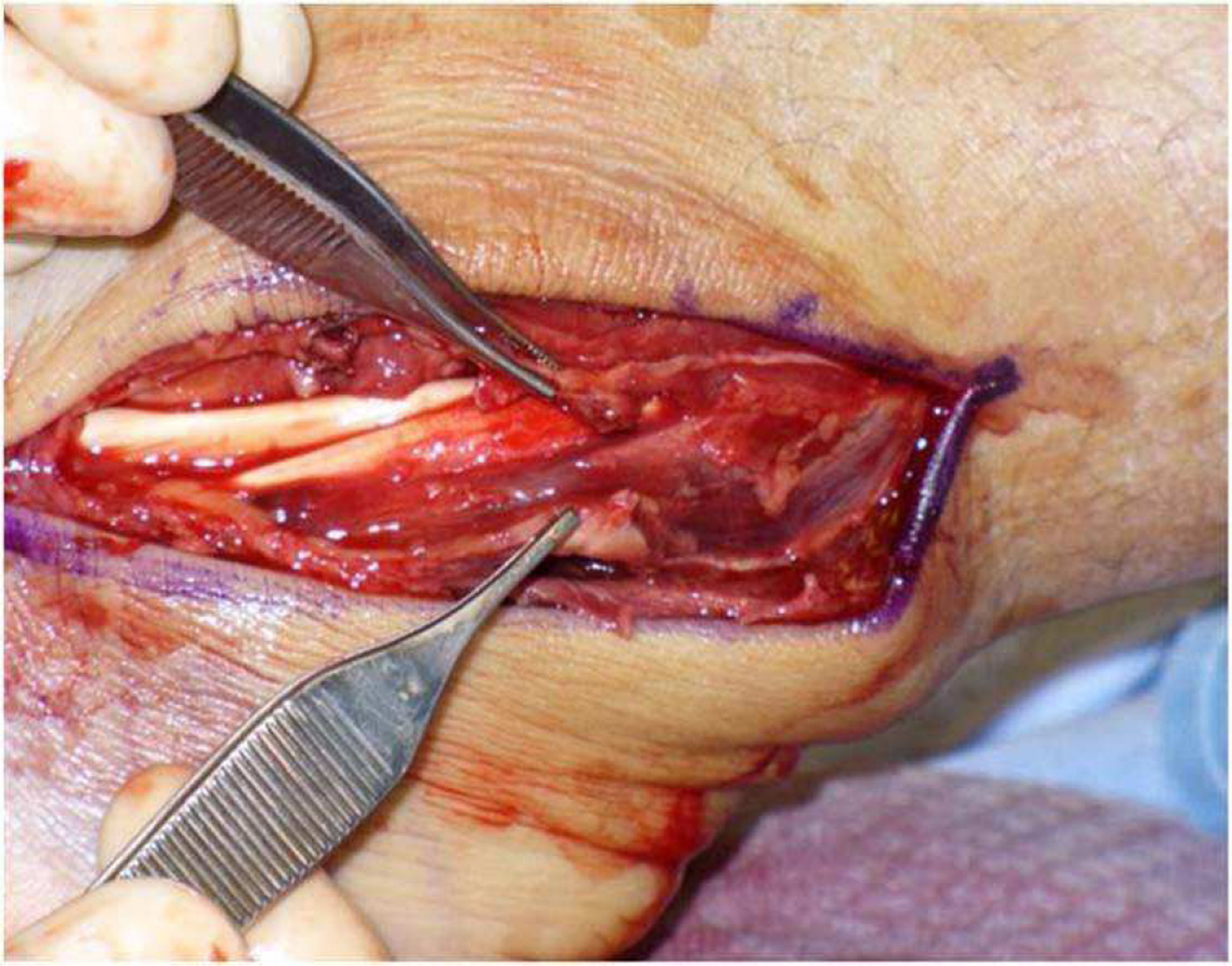

Figure.

This figure shows an intraoperative picture of a peroneus brevis tendon with low lying muscle belly. In our study, a low lying muscle belly was defined as extension of the muscle belly within the fibular groove. As noted in this patient, the muscle belly extended beyond the tip of fibula

Table 1

Table above represents the number of tendon pathologies identified on magnetic resonance imaging (MRI) versus seen intraoperatively among the 50 patients studied. Using intraoperative findings, our patient population had high prevalence for presence of tenosynovitis, peroneus brevis tendon tear, and low lying muscle belly.

Pathology	Seen on MRI[1] (N= 50 patients)	Intraoperative finding (N= 50 patients)	Prevalence (%)
Tenosynovitis	34	38	76.00
PBT[2] tear	39	42	84.00
Subluxation	1	10	20.00
LLMB[3]	2	31	62.00

[1] Magnetic resonance imaging

[2] peroneus brevis tendon

[3] low lying muscle belly

Table 2

This table shows sensitivity and specificity of MRI for each tendon disease using intraoperative findings as standard. The positive and negative predictive value for each pathology is also noted above.

	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
Tenosynovitis	81.58 (n=31/38)	75.00 (n=9/12)	91.18	56.25
PBT[1] tear	85.71 (n=36/42)	62.50 (n=5/8)	92.31	45.45
Subluxation	10.00 (n=1/10)	100.00 (n=40/40)	100.00	81.63
LLMB[2]	3.23 (n=1/31)	94.74 (n=18/19)	50.00	37.50

[1]peroneus brevis tendon

[2]low lying muscle belly

Table 3

Intraoperatively observed peroneal tendon pathologies associated with a peroneus brevis low lying muscle belly (LLMB) are compared to those with normal muscle length. The most common pathology seen was presence of peroneus brevis tendon tear in both groups. Peroneus brevis tendon subluxation was present in 10 total patients in our study, 9 of which had concomitant low lying muscle belly.

	Tenosynovitis (p=0.0182)	**Subluxation (p=0.067)**	**PBT[2] Tear (p=0.693)**
LLMB[1] Present (n=31)	20 (64.52%)	9 (29.03%)	25 (80.65%)
LLMB[1] Absent (n=19)	18 (94.74%)	1 (5.26%)	17 (89.47%)

[1] low lying muscle belly

[2] peroneus brevis tendon