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Preoperative Assessment of the Peroneal Tendons in Lateral Ankle Instability: Examining Clinical Factors, Magnetic Resonance Imaging Sensitivity, and Their Relationship

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A B S T R A C T

The purpose of our study was to examine the preoperative clinical factors and magnetic resonance imaging (MRI) findings associated with peroneal pathology in chronic lateral ankle instability patients, as well as the clinical factors associated with peroneal lesions being detected on MRI. Peroneal pathology was determined from intraoperative findings. Patients with/without peroneal pathology were compared regarding their preoperative clinical findings. MRI reports were examined to determine the sensitivity of detecting peroneal pathologies. Clinical factors were compared between patients (N = 238) with undetected and detected peroneal lesions on MRI. Conservative treatment, preoperative physical therapy, and lack of a traumatic inciting event were associated with peroneal pathology. MRI had a sensitivity of 61.11% for detecting peroneal pathology. No clinical factors were significantly different between “detected” and “undetected” cases. Certain historical factors were associated with peroneal pathology in patients with chronic lateral ankle instability, and MRI had a high false-negative rate. Surgeons should exercise caution when ruling out peroneal pathology based on preoperative physical examination or MRI.

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Ankle sprains are a very common problem in the general population, occurring at a rate of >750,000 annually in the United States (1). Most are inversion injuries to the lateral ankle (2), more specifically to the anterior talofibular ligament (3), and conservative treatment will fail in approximately 20% of all sprains, which will eventually require operative treatment (4). Although most ligament repair techniques are designed to produce the same final result on the anterior talofibular ligament, surgical approaches and incision types differ (5–7). This is significant because not all approaches allow for direct visualization of the peroneal tendons, which play a large role in stability of the ankle by preventing anterior displacement of the talus (8). These tendons are part of the “lateral ankle triad” (9) and have been reported to be injured in as many as 77% of patients diagnosed with chronic lateral ankle instability (10). Therefore, preoperative assessment of the peroneal tendons by clinical examination and imaging is critical (11), because any decision regarding operative approach or repair technique neglecting their injury may increase risk of recurrence of ankle instability.

Physical examination findings such as lateral retromalleolar ankle tenderness, dislocation/snapping, and eversion weakness are considered indicative of peroneal tendon pathology, but such signs occur in <50% of patients with visible tears on magnetic resonance imaging (MRI) (12). Burrus et al (13) evaluated clinical risk factors for intraoperative peroneal pathology in patients with lateral ankle instability and found only female sex to be significant for increased lesions. Additionally, the study found osteochondral lesions of the talus on MRI to be correlated with a decreased risk of peroneal pathology in these patients. MRI is a commonly used imaging modality for preoperative assessment in patients with chronic lateral ankle instability (11) despite its limited ability to identify lesions to the lateral collateral ligaments (14). Although certain imaging findings have been associated with peroneal tendon injuries (15), MRI has been shown to have limited sensitivity when assessing the peroneal tendons in patients with lateral ankle instability (16). Notably Park et al (16) found sensitivity of MRI for detecting interstitial tears of the

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peroneus brevis and peroneus longus tendons to be 44% (4 of 9) and 50% (1 of 2), respectively, but included a limited number of patients in their study. Finally, although O'Neill et al (17) found surgeon readings of MRI to be more sensitive than those of radiologists, false-negative rates were still 33% when detecting injuries associated with lateral ankle instability.

The purpose of this study was to assess the role of clinical risk factors and MRI in detecting peroneal pathology in a different and larger population of patients with chronic lateral ankle instability than those examined in prior studies. Additionally, we compared the prevalence of clinical risk factors in patients with peroneal pathology with positive and negative MRI findings. To date, no study has examined what clinical factors are associated with the detection of peroneal lesions on MRI reports.

Patients and Methods

Institutional review board approval was obtained before study initiation. We retrospectively reviewed 382 cases of lateral ankle ligament repair surgery in the treatment of chronic lateral ankle instability between June 2006 and November 2016. Medical charts were reviewed for demographics, clinical and operative notes, and radiology reports. Cases of gross trauma and ipsilateral ankle arthrodesis, revision surgery, or total ankle arthroplasty were excluded, as were cases with patients <15 or >70 years of age at the time of surgery and cases with inaccessible electronic medical records. We evaluated findings including age, body mass index (BMI), preoperative historical and physical examination findings, preoperative MRI findings of peroneal pathology, and intraoperative findings of peroneal pathology.

Peroneal Versus Nonperoneal Pathology

Surgical description of peroneal pathology was considered as the definitive diagnosis, and patients were initially divided into 2 groups on the basis of the presence or absence of these injuries. The surgeons at the institution where the study occurred use an extended longitudinal approach for nearly all Brobstrom Gould repairs. This technique allows visualization of the peroneal tendons in almost all cases. Peroneal pathology was further specified as split lesions, interstitial tears, dislocations, complete or partial ruptures, tenosynovitis, or tendinopathy not otherwise specified (NOS) of the peroneal longus or peroneal brevis tendons. Cases with no mention of peroneal pathology or definitive statement of its absence in the operative report were classified as "no peroneal pathology."

Clinical Predictors of Peroneal Pathology

Clinical data from the preoperative visit was collected on each patient. These data included sex, BMI, age at time of surgery, preoperative pain score, history of inciting traumatic injury to the ankle, history of sports participation, duration of symptoms, presence of chronic symptoms ($\geq$1 year), presence of preoperative conservative treatment (ankle stabilizing orthosis, insoles, physical therapy, short leg walking cast, taping, walking boot), presence of preoperative physical therapy, and outcome of anterior drawer or talar tilt test on physical examination. With Poisson regression, a relative risk (RR) was found for all nominal variables with respect to their association with the peroneal pathology group. Continuous variables (BMI, age, pain score, duration of symptoms, duration of conservative treatment, and duration of physical therapy) were compared between the peroneal pathology group and the no peroneal pathology group by use of Student's *t* test.

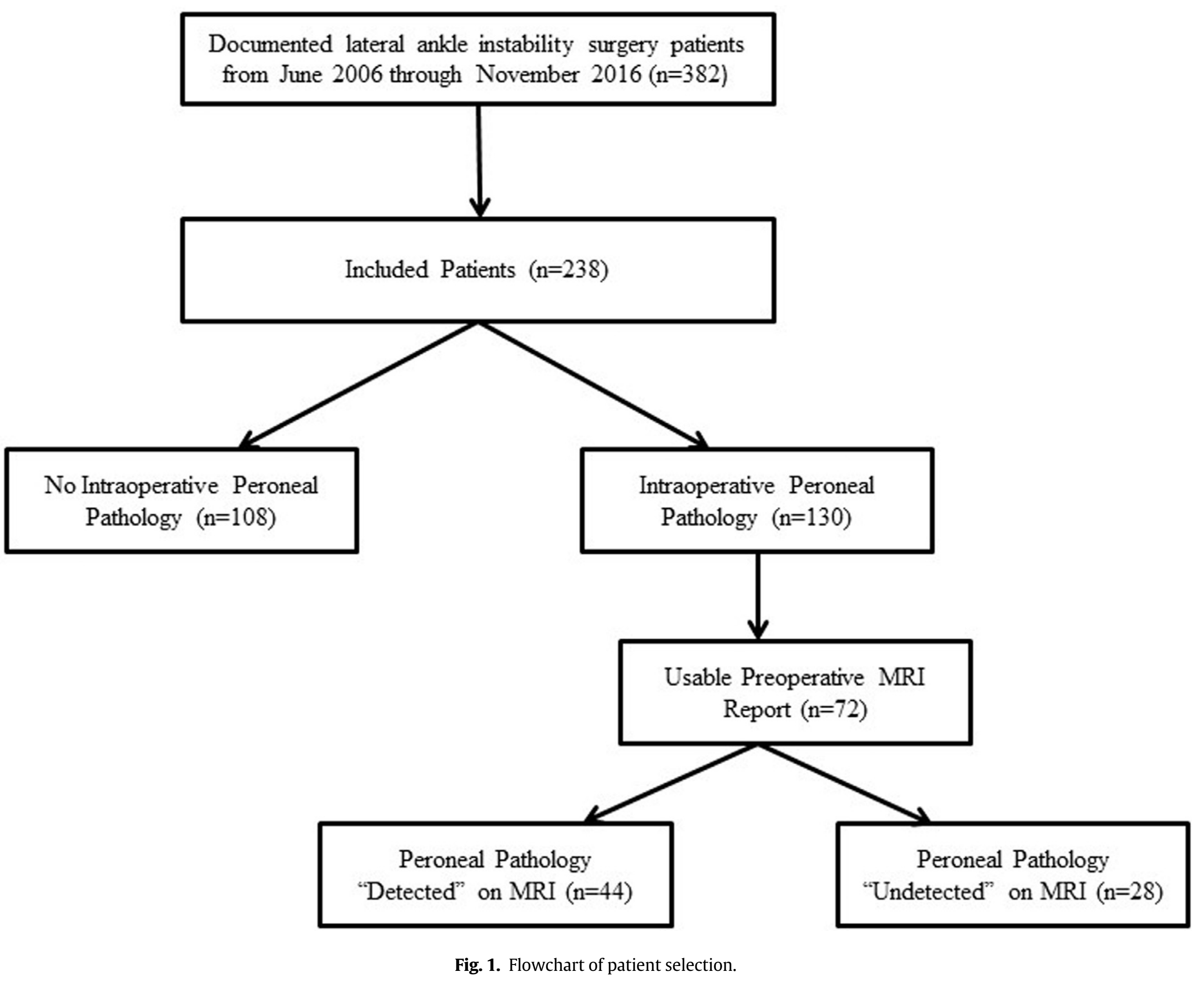

Fig. 1. Flowchart of patient selection.

Table 1
PeronealAU: Per journal style, the boldface has been removed from this table. If certain values should be emphasized, they should be indicated by a symbol and a note added to the table footnote with an explanation. pathology (n = 130) versus no peroneal pathology (n = 108), comparison of clinical preoperative factors

	(+) Per Path (n = 130)	(−) Per Path (n = 108)	RR	95% CI	*p* Value
Age (y)	37.79 ± 14.04	36.03 ± 13.47	–	–	.327
BMI (kg/m²)	31.27 ± 7.84	31.24 ± 7.88	–	–	.979
Preoperative pain (VAS)	3.89 ± 2.73	3.3 ± 2.99	–	–	.179
Duration of symptoms (mo)	30.43 ± 56.49	41.65 ± 70.01	–	–	.254
Duration of conservative treatment (mo)	5.28 ± 7.16	2.32 ± 5.19	–	–	.001
Duration of physical therapy (mo)	1.86 ± 3.75	1.26 ± 4.23	–	–	.287
History of major inciting event			0.736	0.581, 0.932	.011
Yes	66	75			
No	56	32			
History of chronic sprains			1.194	0.924, 1.543	.174
Yes	62	37			
No	43	39			
Anterior drawer test positive			1.186	0.760, 1.850	.453
Yes	67	46			
No	11	11			
Talar tilt test positive			0.979	0.626, 1.530	.926
Yes	42	36			
No	11	9			
Male			0.9211	0.706, 1.203	.546
Yes	35	33			
No	95	75			
Conservative treatment done			1.962	1.478, 2.604	<.0001
Yes	71	29			
No	38	67			
Physical therapy done			1.661	1.312, 2.089	<.0001
Yes	39	12			
No	70	82			
Sports participation			1.35	0.987, 1.852	.061
Yes	28	22			
No	58	62			

Abbreviations: BMI, body mass index; CI, confidence interval; (+) Per Path, peroneal pathology; (−) Per Path, no peroneal pathology; RR, relative risk; VAS, visual analog scale.
Means and standard deviations are reported for continuous variables and RR with 95% CI for nominal variables.

MRI Findings

All MRI reports of the peroneal pathology group were reviewed for identification of the following findings with regard to the peroneus brevis or peroneus longus tendons: split lesions, interstitial tears, dislocations, complete or partial ruptures, tenosynovitis, tendinopathy, and low insertion of the peroneus brevis muscle belly. The presence of each lesion was referenced against the operative report (gold standard) to arrive at the sensitivity of MRI's ability to detect it. This information was used to find the sensitivity of MRI for detecting a specific type of lesion, as well as any peroneal pathology. To reduce variation based on specific-physician verbiage, peroneal splits tears and interstitial tears were grouped together, as well as peroneal tenosynovitis and tendinopathy NOS. Patients with no MRI findings of peroneal pathology mentioned were separated from patients who did have some form of peroneal pathology noted on their MRI report to form "peroneal pathology detected" and "peroneal pathology undetected" groups. Patients from the peroneal pathology undetected group had their lesions counted to identify which were most commonly missed. Finally, the clinical predictors of peroneal injury were compared between the detected and undetected groups with the same methods used in the comparison of peroneal pathology and no peroneal pathology. The flowchart of this study is depicted in Fig. 1.

Results

Peroneal Versus No Peroneal Pathology

Overall, 238 patients met our inclusion criteria. Of these, 130 (54.6%) had an operative report confirming peroneal pathology and 108 (45.4%) had no evidence of peroneal pathology intraoperatively. Patients with peroneal pathology had an average of 5.28 months of conservative treatment before surgery compared with an average of 2.32 months in patients without peroneal pathology ($p = .0009$) (Table 1). Patients who had undergone some form of conservative treatment before surgery were more likely to have peroneal pathology (RR = 1.962; 95% confidence interval [CI] 1.478, 2.604; $p < .0001$), as were patients who had undergone some form of physical therapy (RR = 1.661, 95% CI: 1.312, 2.089, $p < .0001$). Additionally, patients with a history of an inciting traumatic event were less likely to have peroneal pathology (RR = 0.736; 95% CI 0.581, 0.932; $p = .0109$) (Table 1).

MRI Findings

Of the 130 patients with peroneal pathology, 72 (55.4%) had usable preoperative MRI reports. Overall, 44 of 72 patients with peroneal pathology intraoperatively had some form of peroneal pathology noted on their MRI, yielding a sensitivity of 61.11% (the MRI sensitivity for each specific injury can be found in Table 2) and a false-negative rate of 38.89%. Within the undetected peroneal pathology group (false-negative results), peroneus brevis tenosynovitis/tendinopathy NOS was the most common lesion, present in 26 of 28 (92.86%) patients.

Table 2
Preoperative magnetic resonance imaging sensitivities for various peroneal lesions (n = 72)

Specific Pathologies	Detected	Present	Sensitivity
PB tenosynovitis/tendinopathy NOS	24 (33.3)	57 (79.2)	42.11%
PL tenosynovitis/tendinopathy NOS	18 (25)	50 (69.4)	36.00%
PB split/interstitial tear	16 (22)	29 (40.3)	55.17%
PL split/interstitial tear	1 (1.4)	5 (6.9)	20.00%
PB rupture	4 (5.6)	5 (6.9)	80.00%
Peroneal subluxation	2 (2.8)	2 (2.8)	100.00%
LIPBMB	0	41 (56.9)	0.00%
Any peroneal pathology	44 (61.1)	72 (100)	61.11%

Abbreviations: LIPBMB, low insertion of the peroneus brevis muscle belly; NOS, not otherwise specified; PB, peroneus brevis; PL, peroneus longus. Count (%).

Table 3
Undetected (n = 28) versus detected (n = 44) peroneal lesions, comparison of clinical preoperative factors

	Undetected	Detected	RR	95% CI	*p* Value
Age (y)	36.79 ± 14.9	40.68 ± 13.43	—	—	.265
BMI (kg/m^2)	29.74 ± 7.96	30.68 ± 6.90	—	—	.638
Preoperative pain (VAS scale)	4.54 ± 2.77	3.77 ± 3.03	—	—	.323
Duration of symptoms (months)	24.21 ± 13.43	42.47 ± 76.54	—	—	.239
Duration of conservative treatment (mo)	43.22 ± 6.37	48.86 ± 6.85	—	—	.472
Duration of physical therapy (mo)	2.33 ± 2.90	1.66 ± 3.58	—	—	.452
History of major inciting event					
Yes	13	23	0.861	0.472, 1.570	.625
No	13	18			
History of chronic sprains					
Yes	14	23	1.009	0.521, 1.955	.979
No	9	15			
Positive anterior drawer test					
Yes	22	25	0.936	0.398, 2.204	.880
No	3	3			
Positive talar tilt test					
Yes	12	13	0.96	0.43, 2.145	.921
No	4	4			
Male					
Yes	7	12	0.93	0.473, 1.828	.833
No	21	32			
Conservative treatment done					
Yes	22	25	5.617	0.839, 37.598	.075
No	1	11			
Physical therapy done					
Yes	10	13	1.423	0.722, 2.803	.308
No	11	25			
Sports participation					
Yes	6	9	1.236	0.562, 2.718	.598
No	11	23			

Abbreviations: BMI, body mass index; CI, confidence interval; RR, relative risk; VAS, visual analog scale.
Means and standard deviations are reported for continuous variables and RR with 95% CI for nominal variables.

Additionally, 9 of 28 (32.14%) patients had a peroneal split lesion/interstitial tear (7 of the peroneus brevis and 2 of the peroneus longus).

We then compared patients in the detected peroneal pathology group (44 patients) with those in the undetected peroneal pathology group (28 patients) with regard to preoperative clinical findings, using the same variables and statistical methods previously used to compare the peroneal pathology and no peroneal pathology groups. No significant differences were found, although undergoing preoperative conservative treatment was nearly significantly associated with increased risk of undetected lesions (RR = 5.617; 95% CI 0.839, 37.598; $p = .075$) (Table 3).

Discussion

Our study found presence and length of preoperative conservative treatment, as well as presence of preoperative physical therapy, to be associated with peroneal pathology in patients undergoing ligament repair for chronic lateral ankle instability. In addition, the lack of a traumatic inciting event was associated with peroneal pathology. Although a sensitivity of 61.11% was found for preoperative MRI detection of peroneal pathology, no clinical factors were significantly different between the detected and undetected cases of peroneal pathology.

Chronic lateral ankle instability is a very common problem in the western population (2), and surgical repair is often indicated (4). When planning for surgery, preoperative assessment of the peroneal tendons is paramount, because incision type and surgical approach may dictate whether they are addressed intraoperatively. In a prior study of 136 patients, Burrus et al (13) addressed risk factors for peroneal pathology in patients with lateral ankle instability and found the only significant clinical risk factor to be female sex. Conversely, our present study of 238 patients did not find sex to play a significant role in prediction of peroneal pathology in this population but did find significant associations between the presence and duration of preoperative conservative treatment, as well as the presence of physical therapy. Additionally, history of a traumatic inciting event was associated with a lack of peroneal pathology. The findings regarding conservative treatment and physical therapy are novel because this association has not been described in the literature to this point to our knowledge. As well, the finding of an inverse relationship between traumatic etiology and peroneal pathology represents a difference not detected by previous authors and thus is another novel addition to the literature. In combination, these factors suggest an association between chronicity of lateral ankle instability and peroneal pathology; however, our results did not show an increase in duration of symptoms in patients with peroneal pathology. An explanation for this fact may be that patients with more extensive pathology may experience more severe instability and are more likely to agree to participate in conservative modalities such as physical therapy. These patients may be more symptomatic and unstable owing to injury of their peroneal tendons, which function as dynamic lateral ankle stabilizers (8). However, physical therapy focuses on strengthening the peroneal tendons (18), and thus, if they are already injured, these patients will be less likely to succeed in physical therapy and more likely to require surgery.

MRI is often used to assess the ankle before lateral ankle ligament repair surgery (19,20). Despite its near-ubiquitous use, few studies have evaluated its ability to detect coexisting peroneal tendon lesions. Park et al (16) attempted to quantify MRI sensitivity for detection of peroneal lesions; however, the study included <40 patients with intraoperative peroneal pathology. The present study included preoperative MRI findings of 72 patients with lateral ankle instability with confirmed intraoperative peroneal pathology. Sensitivities for specific lesions ranged from 36% for peroneus longus tenosynovitis/tendinopathy NOS to 80% for peroneus brevis rupture. Additionally, a combined 50% sensitivity for peroneus brevis (16 of 29) and longus (1 of 5) split/interstitial tear is significant because operative repair of such lesions is strongly encouraged in patients with concomitant lateral ankle instability (21). Despite this, what we consider to be our most important finding is the nearly 40% false-negative rate of MRI for detection of any peroneal pathology, because this is reasoned to have the largest bearing on operative planning. Likely, some of this deficit may be improved by surgeon evaluation of the MRI, but prior studies suggest that this improvement would result in the reduction but not elimination of false-negative results (17). Of the 28 cases where peroneal pathology was entirely undetected on MRI, most were peroneus brevis or peroneus longus tenosynovitis or tendinopathy NOS (26 and 22, respectively). However, the 9 cases of completely undetected split/interstitial tears and 1 rupture are cause for significant reservation regarding the utility of MRI in preoperative assessment of the peroneal tendons in patients with lateral ankle instability. Given this, it seems the combination of a careful history and individual surgeon judgment based on prior experience should not be discounted when evaluating MRI findings before surgery.

A unique aspect of our study was the comparison of preoperative clinical findings in patients with detected and undetected peroneal pathology. No significant differences in preoperative clinical findings were found when the 2 groups were compared. The first possible explanation for this is that no difference exists. This is reasonable when we consider that clinical findings of a tendon tear are not always associated with its size and appearance on imaging (22,23). Another possible reason for failure to reject the null hypothesis is that a small sample size disallowed for illumination of subtle differences between the 2 groups. Interestingly, the only value that trended toward significance ($p = .0705$) was an increased prevalence of conservative treatment in patients with undetected peroneal lesions. This may be because smaller, inconspicuous lesions were less symptomatic and thus decreased the odds of moving directly to surgical intervention. However, such inferences are beyond the scope of our present work.

Our study has several limitations. Retrospective design does not allow for randomization of patients or collection of all desired data points. Additionally, data obtained from retrospective chart review is subject to possible inconsistencies owing to variations in documentation by different observers. As well, MRI data were obtained from reports rather than through blinded review of images by standardized radiologists. Although we believe that this factor represents a closer depiction of reality for the average practicing surgeon, it has the potential to produce inconsistencies in the data. Finally, although our initial patient sample was quite large, the undetected peroneal pathology group only had 28 patients, making it difficult for significant conclusions to be drawn from this data.

In conclusion, we found duration and presence of preoperative conservative treatment, presence of preoperative physical therapy, and absence of an inciting traumatic event to be associated with an increased risk of peroneal pathology in patients undergoing surgery for chronic lateral ankle instability. Additionally, although MRI carries a false-negative rate of nearly 40% when assessing for peroneal pathology in these patients, there are no reliable preoperative clinical findings associated with undetected peroneal lesions on MRI. Given these findings, we recommend that surgeons exercise extreme caution when ruling out peroneal pathology in patients with chronic lateral ankle instability based on preoperative physical examination or MRI. As well, in circumstances where such patients lack a traumatic etiology and have undergone extensive conservative therapy, intraoperative visualization of the peroneal tendons should be strongly considered.

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