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Predictors of Osteochondral Lesions of the Talus in Patients Undergoing Broström-Gould Ankle Ligament Reconstruction

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ABSTRACT

Chronic ankle instability is associated with intra-articular and extra-articular ankle pathologies, including osteochondral lesions of the talus. Patients with these lesions are at risk for treatment failure for their ankle instability. Identifying these patients is important and helps to guide operative versus nonoperative treatment. There is no literature examining which patient characteristics may be used to predict concomitant osteochondral lesions of the talus. A retrospective chart review was performed on patients (N = 192) who underwent a primary Broström-Gould lateral ankle ligament reconstruction for chronic ankle instability from 2010 to 2014. Preoperative findings, magnetic resonance imaging, and operative procedures were documented. Patients with and without a lesion were divided into 2 cohorts. Fifty-three (27.6%) patients had 1 lesion identified on preoperative magnetic resonance imaging. Forty (69.0%) of these lesions were medial, 18 (31.0%) were lateral, and 5 patients had both. Female sex was a negative predictor of a concomitant lesion (p = .013). Patients were less likely to have concomitant peroneal tendinopathy (30.2% vs 48.9%; p = .019) in the presence of a lesion. However, sports participation was a positive predictor of a concomitant lesion (p = .001). The remainder of the variables (age, body mass index, smoking, trauma, duration, contralateral instability, global laxity) did not show a significant difference. In patients who underwent lateral ankle ligament reconstruction, females were less likely to have a lesion than males. Patients with peroneal tendinopathy were less likely to have a lesion compared with patients without. Additionally, athletic participation was a positive predictor of a concomitant lesion.

Chronic ankle instability is a common pathology among active patients in the United States. Although 80% of ankle sprains respond favorably to conservative treatment, the remaining 20% will progress to chronic ankle instability (1). There are an estimated 30,000 ankle sprains diagnosed daily in United States emergency rooms, and therefore orthopaedic surgeons will encounter and treat ankle instability regularly (2).

Chronic ankle instability is rarely an isolated pathology, as studies have demonstrated that up to 95% of patients will have additional intra-articular or extra-articular pathology (3,4). Although synovitis appears to be the most common, peroneal tendon pathology, anterior ankle impingement, loose bodies, and osteochondral lesions of the talus (OLTs) are commonly encountered and should not be overlooked (5–8).

OLTs occur in 7% to 38% of patients with ankle instability, with 1 series reporting that 63% of patients with ankle instability developed OLTs (4,6,7,9). In the setting of chronic ankle instability, the etiology for such lesions is repetitive microtrauma, as the talus undergoes unrestrained rotational and translational motion within the ankle mortise. Medial OLTs are more commonly associated with ankle instability and lateral lesions with a single traumatic event, but both have been described in patients with ankle instability (5,7,10).

Isolated OLTs can be asymptomatic and do not necessitate treatment (40,42). However, in the setting of persistent ankle instability, they must be carefully evaluated to determine the appropriate treatment course (20). If the decision is made to treat the lesions, there are several surgical options. Surgical management is directed at preservation of the articular cartilage or replacement of defects with a hyaline-like cartilage. Most surgical treatment options for talar lesions were initially developed for focal knee cartilage defects such as osteochondritis dissecans and have been adapted for use in the ankle. Fragment fixation, debridement and microfracture, osteoarticular autograft or allograft transfers, bone marrow–derived cell implantation, and autologous

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chondrocyte implantation have been well described as treatment options (11−17).

In patients with chronic lateral ankle instability, identifying patients with OLTs is important, because it will likely change management and possibly the long-term outcome of the patient (18,41). For example, athletes with OLTs have slower return to play, and subjective outcome scores in patients who undergo Broström-Gould ligament reconstructions with a combined microfracture generally are lower than those without OLTs (4,19,20).

To date, there have been no studies examining which patient characteristics other than ankle instability may predict concomitant OLTs. The purpose of the current study is to review a cohort of patients who underwent Broström-Gould lateral ankle ligament reconstruction and investigate various preoperative imaging, physical examination, and history findings that will encourage the practitioner to look more closely for OLTs. Our hypothesis is that duration of ankle instability symptoms, concomitant peroneal tendon pathology, and athletic participation will be significant predictors of OLTs in patients with chronic ankle instability.

Table 1
Preoperative characteristics (N = 192)

Preoperative Patient Characteristics		n or Mean ± SD	%
Age, y		35.9 ± 14.4	n/a
Female		111	57.8
Weight, kg		87.3 ± 22.5	n/a
BMI, kg/m^2		29.8 ± 6.9	n/a
Smoking		21	10.9
Sport participation		66	34.4
Global hyperlaxity		14	7.3
Traumatic ankle injury		149	77.6
Duration of symptoms, mo		35.9 ± 64.4	n/a
Clinical examination	2+ rotational instability	123	64.1
	3+ rotational instability	44	22.9
	Positive anterior drawer	115	59.9
Preoperative MRI	ATFL tear	124	64.6
	CFL tear	86	44.8
	Peroneal tendinopathy	84	43.8
	Deltoid tear	24	12.5
	Medial OLT	40	20.8
	Lateral OLT	18	9.4

Abbreviations: ATFL, anterior talofibular ligament; BMI, body mass index; CFL, calcaneofibular ligament; MRI, magnetic resonance imaging; n/a, not applicable; OLT, osteochondral lesion of the talus; SD, standard deviation.

Methods

After institutional review board approval, all patients who underwent a lateral ankle ligament reconstruction by 2 foot and ankle specialists (J.P. and V.P.) from January 2010 to January 2014 at a single institution were identified. All had undergone a minimum of 6 weeks of conservative management (bracing or splinting and physical therapy for peroneal and proprioceptive exercises).

The inclusion criteria were 1) patients who underwent a primary Broström-Gould lateral ankle ligament reconstruction and 2) age 15 to 65 years. Exclusion criteria were 1) a lateral ankle ligament reconstruction technique other than a Broström-Gould, 2) prior ankle surgery of any type, or 3) no preoperative magnetic resonance imaging (MRI) available for review. The indication for Broström-Gould lateral ankle ligament reconstruction was clinical instability (anterior drawer and/or talar tilt test) and persistent symptoms despite conservative treatments. A total of 242 patients were identified using these inclusion criteria. However, 13 patients were excluded for undergoing an allograft ligament reconstruction technique, 26 were excluded for having prior ankle surgery, and 11 patients did not have an MRI for review. Therefore, there was a final population of 192 patients.

One of 4 fellowship-trained musculoskeletal radiologists read all MRI studies, and the primary surgeon verified these reports. Data were collected for the following findings: OLT; peroneal tendinopathy; and tears of the deltoid ligament, calcaneofibular ligament (CFL), or anterior talofibular ligament (ATFL). All peroneal tendon MRI abnormalities were grouped into "peroneal pathology." Additionally age, sex, body mass index (BMI), active tobacco use, duration of symptoms, contralateral ankle instability, generalized hyperlaxity (Beighton score ≥6), and current or recent athletic participation (participation in an organized sport with routine training) were recorded. These variables were chosen because all may have an impact on outcomes in this patient population.

Using SPSS version 22 (IBM Corporation, Armonk, NY), univariate analysis was performed using Student's t test and the chi-square test. Statistical significance was defined as $p < .05$.

Results

The perioperative patient demographics and imaging findings are detailed in Table 1. Of note, 53 (27.6%) patients had at least 1 OLT identified on preoperative MRI. Forty (69.0%) of these lesions were on the medial talus, 18 (31.0%) were lateral, and 5 patients had both a medial and lateral OLT.

Additionally, preoperative MRI demonstrated 124 (64.6%) ATFL tears, 86 (44.8%) CFL tears, and 24 (12.5%) deltoid ligament tears, and 84 (43.8%) patients had peroneal tendinopathy (including tears, subluxation [which may be under-represented on static MRI], or dislocation).

The results of univariate analysis comparing preoperative characteristics of patients with and without OLTs are presented in Tables 2 and 3. Additionally, there are selected radiographic and intraoperative arthroscopic images listed in Figs. 1 and 2. Patients with OLTs were less likely to be female; 43.3% of patients with an OLT were female, whereas 63.3% of patients without an OLT were female (p = .013). Patients were less likely to have concomitant peroneal tendinopathy (30.2% vs 48.9%; p = .019) in the presence of an OLT. However, patients currently participating in sporting activities (or patients who discontinued sport participation due to ankle pathology) were significantly more likely to have an OTL (52.8% vs 38.0%; p = .001). For the remainder of the variables, no significant difference could be detected.

Discussion

During the initial evaluation of patients with chronic ankle instability, recognizing the presence of concomitant pathology is extremely important. OLTs are one such associated lesion and are present in as many as 63% of patients with ankle instability (4,6,7,9). Previous investigations have demonstrated poor clinical outcomes after undergoing ligament reconstruction for chronic ankle instability when an OLT is not addressed (19,20). There are many surgical options for treating these lesions, including fragment fixation, debridement and microfracture, osteoarticular autograft or allograft transfers, bone marrow−derived cell implantation, and autologous chondrocyte implantation (1,11−17,21). The current study reveals that female sex is a negative predictor for the presence of an OLT, and athletic participation is a positive predictor for the presence of an OLT.

The lateral ankle ligament complex consists of the ATFL, CFL, and posterior talofibular ligament. The bony anatomy of the talus, as it is positioned in the plafond, is also an important contributor to ankle stability. The peroneal tendons also play a role as secondary dynamic stabilizers in lateral ankle stability, and damage to these structures may play a role in advanced ankle instability (22).

Multiple studies have examined the biomechanics of the ankle and the association between chronic instability and the bony and ligamentous morphology of the joint. Instability has been broken down into mechanical instability and functional instability, which both may contribute to OLT formation (23). Focusing specifically on OLT formation, there are multiple possible causes, including trauma; vascular compromise; and metabolic, degenerative, or genetic causes. Trauma to the talar articular surface is widely accepted as a major cause of OLTs, because it is thought that a small fracture of the articular cartilage and underlying subchondral bone can occur during an acute ankle sprain. Another possible mechanism is repeated microtrauma, which causes excessive stress in a particular region of the talus leading to cellular degeneration and death of the chondral cells (24). A combination of

Table 2
Preoperative patient characteristics in patients with and without an OLT

Preoperative Patient Characteristic	OLT		No OLT		
	n	%	n	%	*p* Value
	53	27.6	139	72.4	n/a
Female	23	43.4	88	63.3	.013*
Age (>35 y compared with ≤35 y)	25	47.2	65	46.8	.960
BMI (>29.5 kg/m^2 compared with ≤29.5 kg/m^2)	24	45.3	62	44.6	.937
Tobacco	3	5.7	18	12.9	.148
Trauma	38	71.7	111	79.9	.225
Duration (>6 mo compared with ≤6 mo)	39	73.6	110	79.1	.374
Contralateral instability	15	28.3	27	19.4	.183
Global laxity	3	5.7	11	7.9	.591
Sport participation	28	52.8	30	38.0	.001*
Varus hindfoot alignment (>0° compared with ≤0°)	8	15.1	17	12.2	.628
2+ instability	31	58.5	93	66.9	.276
3+ instability	13	24.5	32	23.0	.826
Anterior drawer	34	64.2	82	59.0	.514
ATFL tear	30	56.6	94	67.6	.153
CFL tear	21	39.6	65	46.8	.374
Peroneal tendinopathy	16	30.2	68	48.9	.019*
Deltoid tear	3	5.7	21	15.1	.077

Abbreviations: ATFL, anterior talofibular ligament; BMI, body mass index; CFL, calcaneofibular ligament; n/a, not applicable; OLT, osteochondral lesion of the talus.
* *p* value < .05.

Table 3
Preoperative patient characteristics in patients with and without an OLT

Preoperative Patient Characteristic	OLT Pathology		No OLT		
	Mean	SD	Mean	SD	*p* Value
Age, y	37.1	14.7	35.5	14.4	.494
Weight, kg	90.8	25.6	86	21.2	.183
BMI, kg/m^2	30	7.3	29.8	6.8	.809
Duration of symptoms, mo	41.6	69.7	33.7	62.7	.454
Varus, °	−1.6	3.5	−1.7	3.0	.857

Abbreviations: OLT, osteochondral lesion of the talus; SD, standard deviation.

both may be present in the setting of chronic ankle instability in which repeated sprains and prolonged altered joint biomechanics may prohibit healing of an initial articular insult and thus leads to the formation of an OLT.

The location of the OLT may be related to the mechanism of injury. Cadaveric studies have suggested that anterolateral lesions are created by dorsiflexing and inverting the ankle, whereas posteromedial lesions are created by inversion and external rotation of a plantarflexed ankle (2). However, previous studies have demonstrated that anywhere from 18% to 36% of medial-sided lesions could be atraumatic in origin (25−27). A possible explanation is that there is higher pressure on the medial talar dome compared with that on the lateral side in general that may lead to damage to normal articular cartilage over an extended period of time (28).

In the current study, men with chronic ankle instability were more likely to have an OLT than females (p = .0013). There is no consensus in the existing literature as to which sex more commonly is at risk for developing an OLT. Other studies focusing on chronic ankle instability and OLT did not find sex to be a predictor of OLT (29). A previous study by Orr et al (30) discussed the overall incidence of OLT in the U.S. military. One of the significant demographic risks factors was female sex, which is contrary to what was found in the present study. However, Orr et al focused on a very young, athletic population with unique occupational requirements rather than the average female who is not in the U. S. military. Other studies also mention a female's tendency toward increased ligamentous laxity and ankle instability as a potential cause for an increased incidence of OLT (3,19,31). This tendency along with the expectation that female service members perform the same rigorous physical training as their male counterparts may contribute to a higher incidence of OLT compared with that in the average female. Regarding ligamentous laxity, the results of the current study demonstrate that of the 23 females with an OLT, 9 had contralateral ankle instability (69%) and 3 had ligamentous laxity (13%). In comparison, of the 88 females without an OLT, 19 had contralateral instability (15%) and 10 had ligamentous laxity (11%). These values were not significant.

Athletic participation was the only positive predictor of concomitant OLT in chronic ankle instability; 53% of patients with OLTs were active participants in sports or were recently active but had to stop secondary to symptoms of chronic ankle instability. The study of Orr et al (30) focuses on an athletic population, and they found an overall incidence

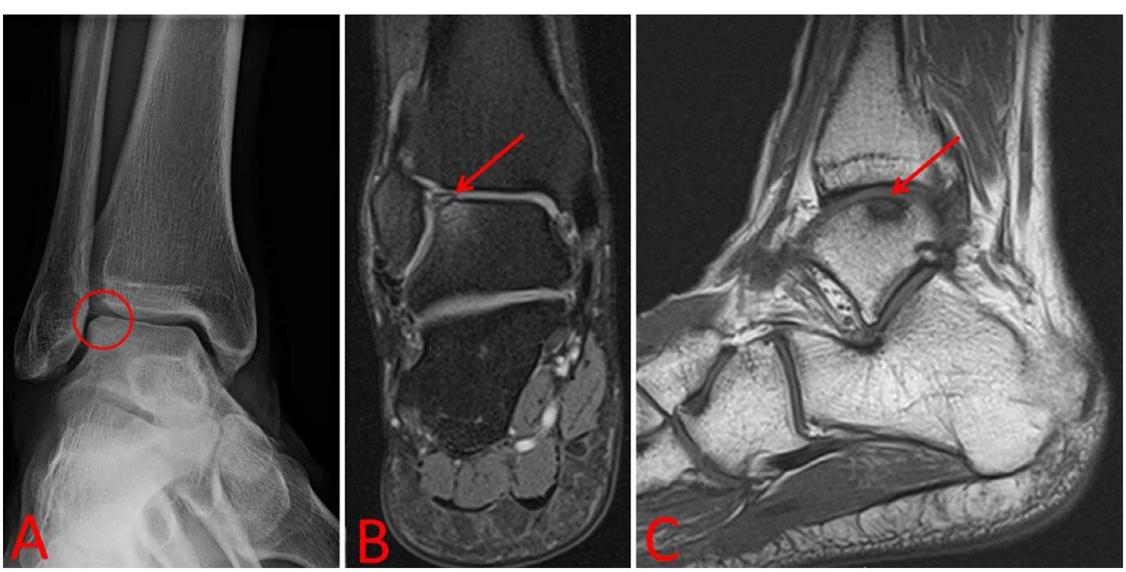

Fig. 1. Radiographic image (*A*) and T2-weighted coronal (*B*) and T1-weighted sagittal (*C*) magnetic resonance scans showing a lateral osteochondral lesion of the talus with subchondral collapse.

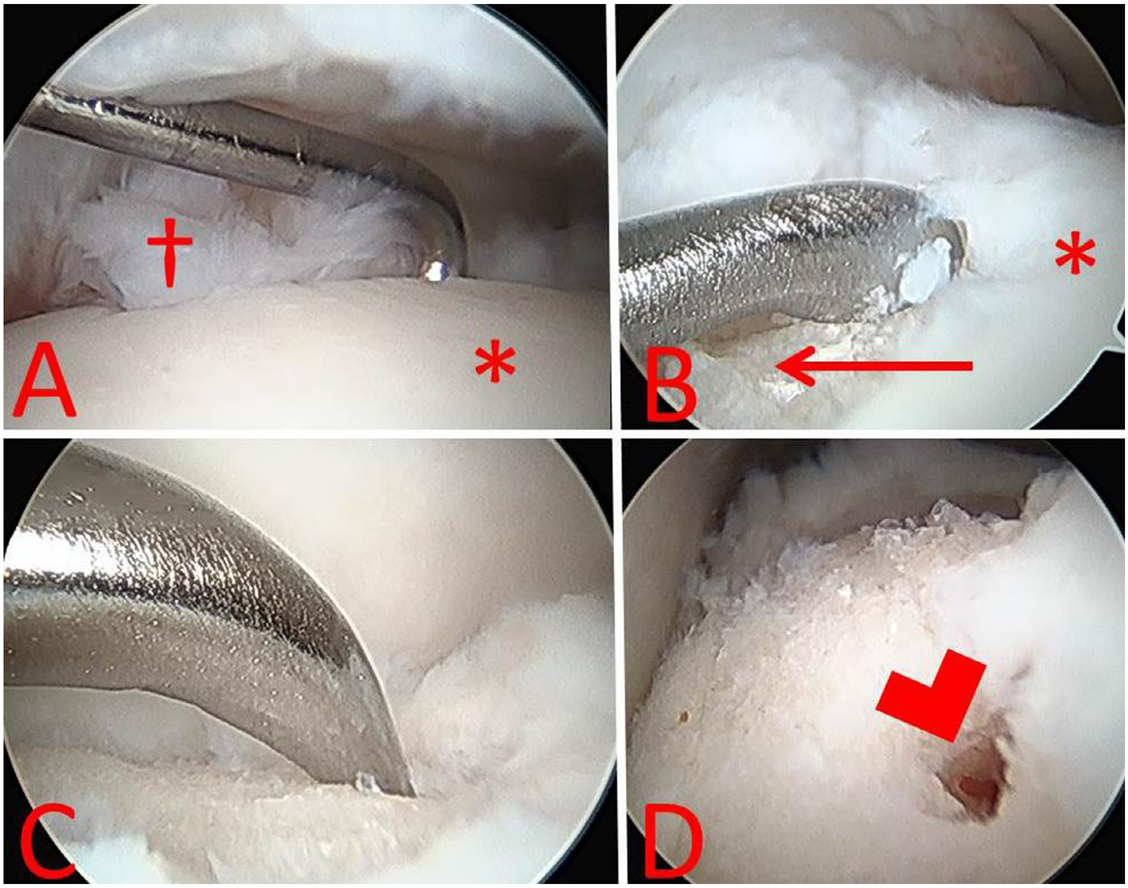

Fig. 2. (*A*) Intraoperative arthroscopic image of a probe finding margins of an osteochondral lesion of the talus (*) with an associated anterior talofibular ligament tear (†). (*B*) Removal of an unstable articular surface using a micro curette. (*C*) Creating a microfracture site. (*D*) The microfracture site (bold arrow).

of 27 new diagnoses of OLT per 100,000 military personnel per year. They also found an increased incidence of OLT from 2002 to 2008. However, this work did not specifically look at ankle instability as a cause of OLT, and unfortunately there are no current studies looking at the incidence of OLT in the setting of chronic ankle instability in the general public. Patients who are more active and participate in sporting activity generally are at higher risk of damaging their ankles and thus may have a higher risk of developing an OLT. Additionally, these patients may have the desire to continue participation in athletic activity despite ankle pain, which may result in repetitive insults to the articular cartilage. This association has not yet been fully explained by the existing literature.

Age did not reveal a significant association with OLT in the present study. The average age of all patients from both cohorts was 35.9 $\pm$ 14.5 years, which was similar to the average patient ages seen in previous studies on ankle instability (3,5,19,20). The average age of all patients from both cohorts in this study was 35.9 $\pm$ 14.5 years. This average age is similar the average patient ages seen in previous studies on ankle instability. Although age was not a significant finding, it does appear to play a role in outcomes after arthroscopic intervention for OLTs. Previous research has focused on the outcomes of operative intervention in patients of varying age with OLTs and has used arbitrary age limits as cut-offs to determine the possible success in operative intervention (29,32–36). Results by Choi et al (37) demonstrated that age was not an independent predictor of clinical outcomes after arthroscopic treatment of OLT. However, trends in patients from 20 to 50 years of age demonstrated the greatest increase in clinical outcomes, although they were not statistically significant. Further studies are needed to determine appropriate surgical candidates with OLTs.

Surprisingly, BMI did not correlate with an increased incidence of OLT (p = .809). The average BMI of an individual with an OLT was 30.0 kg/m^2 versus 29.8 kg/m^2 without. Although we hypothesized that BMI would cause increased repeated pressure on the talus potentially leading to the formation of an OLT, this association was not demonstrated.

Global laxity also did not correlate with an increased incidence of OLT (p = .591). Generalized hyperlaxity, as defined by Beighton's criteria (38), may predispose the ankle to increased instability and thus more subluxation and/or dislocation events leading to the formation of an OLT. Although using contralateral instability as a proxy for global laxity was closer to being a predictor of OLT, it still did not reach significance (p = .183). It may be that the study was not powered enough to find a significant difference with either variable.

MRI findings of peroneal tendinopathy or an ATFL, CFL, or deltoid tear did not reveal a significant association with the presence of an OLT. Regarding peroneal pathology, this may be related to the reliability of MRI findings related to peroneal pathology in chronic ankle instability. Park et al (39) found MRI to have a sensitivity and specificity of peroneal pathology of 83.9% and 74.5%, respectively. They also found a positive predictive value of only 66.7%, a negative predictive value of 88.4%, and an accuracy rate of 78.0%. Their results state that MRI is a useful diagnostic tool for detecting chronic ankle instability, but there are instances where the pathology may not be appreciated. Similar to peroneal pathology, ankle ligament tears are difficult to diagnose on MRI. Chronic ligament tears often scar into the surrounding tissue or heal in an elongated manner that may be identified as "attenuated" on MRI. Considering that only tears were included in this study, these attenuated ligaments were not captured during the data collection (39).

OLTs are a negative predictor for peroneal pathology (p = .019). A study by Burrus et al (5) demonstrated similar findings, and they felt that this was related to ankle positioning during the injury with peroneal pathology occurring with the ankle in dorsiflexion and eversion. However, OLTs are thought to occur with the ankle in plantarflexion and inversion. Additionally, symptomatic OLTs may restrict their activity and actually protect them from developing further peroneal pathology (5).

One surprising variable that did not demonstrate a significant difference was duration of symptoms (p = .374). Duration of symptoms for an individual with an OLT was 41.6 $\pm$ 69.7 months compared with 33.7 $\pm$ 62.7 months without. In the setting of chronic ankle instability, one would think a longer duration of symptoms would preclude the patient to more instability events and eventual formation of an OLT. However, patients with symptomatic OTLs may modify their activity to reduce the likelihood of instability events that may negate any effect of duration. Additionally, the large variance in duration within each group may have precluded reaching statistical significance.

One of the main strengths of this study was the large number of patients (N = 192) who were included in the data analysis. To our knowledge, there have been no studies of this size regarding chronic ankle instability and demographic factors associated with concomitant OLTs. Another strength was demonstrating athletic participation as a positive predictor of OLTs in chronic ankle instability that has not been established in the general public. This work also calls into question as to whether the female sex is truly a negative or positive predictor of OLT. Finally, this work also further confirms that in the setting of chronic ankle instability, peroneal tendinopathy was a negative predictor for the presence of an OLT. These findings will hopefully stimulate further research in this area.

A major weakness of this study is that it was likely underpowered to detect any additional associations than the 2 that were uncovered. There were not enough OLTs to determine if there were any different associations between a medial or lateral OLT, which is largely why we grouped them together. Additionally, all levels of athletic participation were grouped together to include recreational (9.2%), high school (6.9%), college (8.6%), semiprofessional (0.6%), and professional (0.6%) athletes. There were not enough athletes in each category to subdivide them into separate cohorts for analysis. Although this may confuse the results seen in this population, sports participation might be more useful as a proxy for increased physical activity in general.

In conclusion, the presence of OLT in the setting of chronic ankle instability has become increasingly recognized, but predicting which patients will have this pathology has not been studied adequately. Patients with concomitant OLT may have poorer clinical outcomes if not appropriately addressed. In the present study, females with chronic ankle instability were less likely to have an OLT than males. Patients with chronic ankle instability and peroneal tendinopathy were less likely to have an OLT than patients without, and athletic participation was the only positive predictor of concomitant OLT in chronic ankle instability. Given these results, future prospective trials may be valuable to further explore the relationship between chronic ankle instability and the presence of an OLT.

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