Qualitative and Quantitative Anatomic Investigation of the Lateral Ankle Ligaments for Surgical Reconstruction Procedures

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Background: Lateral ankle sprains are common sports injuries that may require surgery for chronic lateral ankle instability. Anatomic repair or reconstruction is desired, yet there is a scarcity of quantitative information regarding the origins and insertions of the lateral ligaments related to surgically pertinent osseous landmarks.

Methods: Fourteen ankle specimens were dissected to isolate the anterior talofibular ligament, calcaneofibular ligament, posterior talofibular ligament, and cervical ligament. A three-dimensional coordinate measurement device was used to determine the origins, insertions, footprint areas, orientations, and distances from osseous landmarks.

Results: A single-banded anterior talofibular ligament was identified in seven of the fourteen specimens, and a double-banded anterior talofibular ligament was identified in the remaining seven. The single-banded anterior talofibular ligament originated an average of 13.8 mm (95% confidence interval [CI], 12.3 to 15.3) from the inferior tip of the lateral malleolus at the anterior fibular border and inserted an average of 17.8 mm (95% CI, 16.3 to 19.3) superior to the apex of the lateral talar process along the anterior border of the talar lateral articular facet. The calcaneofibular ligament originated an average of 5.3 mm (95% CI, 4.2 to 6.5) from the inferior tip of the lateral malleolus at the anterior fibular border and inserted an average of 16.3 mm (95% CI, 14.5 to 18.1) from the posterior point of the peroneal tubercle. The posterior talofibular ligament was the largest ligament and originated an average of 4.8 mm (95% CI, 3.7 to 5.9) superior to the inferior tip of the lateral malleolus in the digital fossa to insert an average of 13.2 mm (95% CI, 11.5 to 14.9) from the talar posterolateral tubercle. The cervical ligament originated on the superior part of the calcaneus and inserted at a point that was approximately 50% of the talar neck anteroposterior distance.

Conclusions: Consistent distances from the anterior talofibular ligament, calcaneofibular ligament, posterior talofibular ligament, and cervical ligament footprint centers to osseous landmarks were identified.

Clinical Relevance: Footprint center distances from surgically relevant osseous landmarks identified in this study can be used during reconstructive surgery of the lateral ankle ligaments and may result in more anatomically accurate placement of the reconstructed ligaments.

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Lateral ankle sprains are common, reportedly comprising 15% to 20% of all athletic injuries[1,2]. Most lateral ankle sprains are treated nonoperatively with rest, ice, compression, elevation, anti-inflammatory medication, physical therapy, bracing, and proprioceptive training. However, 10% to 20% of patients with a severe ankle sprain develop mechanical lateral

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TABLE I Morphology of Lateral Ankle Ligament Origins and Insertions*

Ligament	Fibular Footprint (Origin)		Talar Footprint (Insertion)	
	Area *(mm²)*	Distance *(mm)*	Area *(mm²)*	Distance *(mm)*
Ant. talofibular				
Sup. band	38.4 (31.5, 45.3)	To inf. tip lat. malleolus: 16.3 (15.5, 17.1)	47.0 (39.1, 54.9)	To anterolat. corner trochlea: 11.5 (10.7, 12.3); to apex lat. talar process: 21.1 (20.0, 22.2)
Inf. band	29.4 (25.4, 33.4)	To inf. tip lat. malleolus: 10.2 (8.9, 11.5)	42.0 (35.8, 48.2)	To anterolat. corner trochlea: 22.1 (21.3, 22.9); to apex lat. talar process: 10.2 (8.9, 11.5)
Single band	56.8 (38.9, 74.7)	To inf. tip lat. malleolus: 13.8 (12.3, 15.3)	60.7 (48.6, 72.8)	To anterolat. corner trochlea: 11.3 (10.1, 12.5); to apex lat. talar process: 17.8 (16.3, 19.3)
Calcaneofibular	29.8 (24.4, 35.2)	To inf. tip lat. malleolus: 5.3 (4.2, 6.5)		
Post. talofibular	94.0 (79.1, 108.9)	To inf. tip lat. malleolus: 4.8 (3.7, 5.9) (sup.)	154.7 (129.1, 180.3)	To talar posterolat. tubercle: 13.2 (11.5, 14.9); to subtalar artic. cartilage: 2.7 (2.4, 3.0) (sup.)
Cervical			53.0 (45.0, 61.0)	To distal point talar neck; talonavicular joint line: 7.0 (5.7, 8.3) (post.); to prox. point talar neck: 8.0 (6.5, 9.5) (ant.); to talar edge: 12.8 (11.7, 14.0)

*All values are given as the mean of fourteen specimens with the parametric 95% confidence interval in parentheses. †Anterior-posterior orientation is relative to the coronal plane, superior-inferior orientation is relative to the transverse plane, and medial-lateral orientation is relative to the sagittal plane.

ankle instability after unsuccessful nonoperative treatment and may require surgical reconstruction[1,3-8].

Various surgical procedures, both anatomic and nonanatomic, have been described[7,9-16]. Generally, the key features of dependable ligament reconstruction are anatomic graft placement, use of tissue that closely replicates the native tissue, strong fixation, and early rehabilitation. Secondary repair by imbrication as described by Broström has good results with few complications[7,10,11,17]. Nevertheless, there are circumstances in which this procedure may not be feasible, including cases of long-standing instability when the available native tissue is inadequate, patients who are obese or hyperflexible, and patients for whom prior Broström procedures have failed[7,17-21]. Furthermore, the Broström procedure may not be compatible with early rehabilitation, as strength at the time of repair is <50% of that of the intact anterior talofibular ligament[22,23].

Anatomic lateral ankle reconstruction requires knowledge of the native location of the lateral ankle ligaments, which include the anterior talofibular ligament, calcaneofibular ligament, and posterior talofibular ligament. It is also necessary to consider the anatomic position of the cervical ligament because subtalar instability occurs in 10% to 25% of patients with lateral ligament injury[24-27]. Despite the importance of graft tissue in anatomically accurate positions, there has been limited research on the quantitative anatomy of the lateral ankle ligaments. A better understanding of this anatomy may give the surgeon more confidence that an anatomic surgical repair or reconstruction has been achieved.

The purpose of this study was to describe the qualitative and quantitative anatomy of the anterior talofibular, calcaneofibular, posterior talofibular, and cervical ligaments with reference to pertinent surgically identifiable osseous landmarks. It was hypothesized that definable and consistent identification of the lateral ankle ligament attachments in relation to these osseous landmarks was possible to help guide future lateral ankle surgical repair and reconstruction protocols.

Materials and Methods

Specimen Preparation

Fourteen nonpaired, fresh-frozen cadaveric specimens (eight left and six right feet) from donors (six female and eight male) with a mean age of 50.4 years (range, twenty-seven to sixty years) at the time of death, an average foot length (and standard deviation) of 25.2 cm ± 2.3 cm (average adult foot length, 24.7 cm[28]), and no history of injury were used in the study. Dissection allowed for identification of the anterior talofibular, calcaneofibular, posterior talofibular, and cervical ligaments. The specimen was loaded into a custom fixture, where a bicortical bone screw was placed through the calcaneus and talus and the distal phalanges were secured with plastic ties to a plate to ensure rigid fixation of the ankle to prevent movement during testing. The tibia and fibula were then secured

TABLE I (*continued*)

Calcaneal Footprint (Insertion for Calcaneofibular Ligament/Origin for Cervical Ligament)			
Area (*mm²*)	Distance (*mm*)	Orientation (Origin to Insertion)† (*deg*)	Length (*mm*)
		Ant.: 75.2 (68.8, 81.6); sup.: 8.8 (2.3, 14.8); med.: 80.2 (74.7, 85.7)	16.4 (14.4, 18.4)
		Ant.: 54.4 (38.4, 70.4); inf.: 16.3 (6.2, 26.4); med.: 69.2 (62.2, 76.2)	14.7 (12.7, 16.7)
		Ant.: 73.3 (62.5, 84.1); inf.: 16.9 (6.1, 27.7); med.: 73.1 (62.3, 83.9)	16.3 (15.0, 17.6)
91.7 (77.5, 105.9)	To peroneal tubercle (trochlear process): 16.3 (14.5, 18.1) (total), 4.4 (1.4, 7.4) (sup.), 14.1 (11.7, 16.5) (post.)	Post.: 28.0 (21.8, 34.2); inf.: 67.2 (63.3, 71.1); med.: 22.8 (18.9, 26.7)	24.7 (23.7, 25.7)
		Post.: 45.0 (34.1, 55.9); sup.: 20.2 (14.0, 26.4); lat.: 69.3 (63.5, 75.1)	17.4 (15.9, 18.9)
60.0 (48.4, 71.6)	To calcaneocuboid joint line: 9.0 (7.9, 10.1) (post.); to calcaneal artic. surface: 23.4 (21.2, 25.7) (ant.); to calcaneal edge: 7.2 (6.0, 8.4)	Ant.: 8.3 (1.3, 15.3), sup.: 43.6 (36.4, 50.8), med.: 46.5 (39.3, 53.7)	15.2 (14.0, 16.4)

to a stabilizing tower with rigid screws. Neutral alignment in plantar/dorsal flexion was achieved with a goniometer. Three local coordinate frames were rigidly attached to the calcaneus, tibia, and fibula. The tibia and fibula were then disarticulated from the foot and positioned in a rigid clamp to allow access to the ligament attachments on each bone.

Anatomic Measurements

The ligamentous centers were identified, and the peripheries of the central fibers were measured with a three-dimensional (3D) coordinate measuring device (MicroScribe-MX; GoMeasure3D, Amherst, Virginia). Three-dimensional positional data on the ligament attachments and osseous landmarks on the disarticulated tibia, fibula, and foot were collected with use of the coordinate measuring device relative to the local coordinate frames. The periphery of each ligament attachment site was measured with points collected in approximately 1-mm increments.

The anatomic ankle joint coordinate system was defined by the International Society of Biomechanics (ISB) recommendations for the calcaneal coordinate system in neutral stance[29]. The anatomic ankle joint coordinate system was created with the center positioned midway between the tips of the lateral and medial malleoli and orientated superiorly, anteriorly, and laterally. The superior-inferior axis was aligned with the line coincident with the long axis of the tibia/fibula, which was defined with use of circumferential points around the tibia, since the tibial plateau was not present in the ankle joint specimens. The anterior-posterior axis was created perpendicular to the superior-inferior axis and a line connecting the medial and lateral malleoli. The medial-lateral axis was then defined perpendicular to the superior-inferior and anterior-posterior axes. Each of the local coordinate frames was then transformed to the ankle joint coordinate frame to reconstruct the joint after testing. All measurements reported in this study were made in the ankle joint coordinate frame. Footprint areas were calculated with use of Heron's formula[30,31]. All reported measurements were performed by the same individual (K.J.C.) to eliminate interobserver variability.

System Validation

As an assessment of accuracy for the coordinate measuring device used in this study, the manufacturer (GoMeasure3D) performed a single point articulation performance test (SPAT) based on the B89.4.22 American Society of Mechanical Engineers (ASME) standard. The SPAT result reflected twice the standard deviation for repeatability of measurements. At ten locations spanning the system's reachable workspace, ten points were recorded while a hard probe was placed in a kinematic seat and the arm of the device articulated through a range of motion. The average volumetric SPAT result was found to be ±0.01 mm.

Statistical Methods

Data were assessed for symmetry and normality, and no evidence was found for deviations from normality. Continuous variables were reported as the mean and parametric 95% confidence interval (CI).

Source of Funding

There were no external sources of funding for this study.

Results

Table I lists the quantitative data for the anterior talofibular, calcaneofibular, posterior talofibular, and cervical ligaments, including the ligament length, orientation, attachment site footprint areas, and 3D distance to osseous landmarks. Figure 1 provides an anatomic illustration of the lateral ankle ligaments

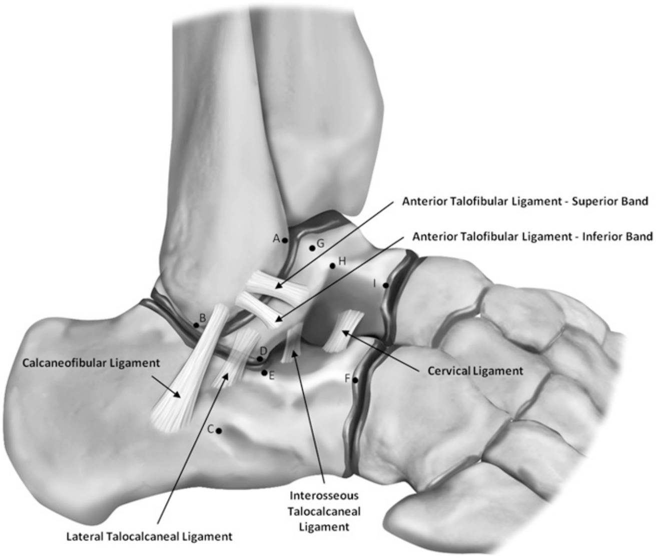

Fig. 1
Lateral view of a right ankle in neutral plantar flexion and dorsiflexion, demonstrating the anatomic attachment sites of the lateral ankle ligaments. A = anterior fibular tubercle, B = inferior tip of lateral malleolus, C = posterior point of peroneal tubercle, D = apex of lateral talar process, E = calcaneal articular surface; posterior border of sinus tarsi, F = calcaneocuboid joint line, G = anterolateral corner of trochlea, H = proximal point of talar neck, and I = distal point of talar neck; talonavicular joint line.

with reference to osseous landmarks. The calcaneofibular, posterior talofibular, and cervical ligaments were found in all fourteen specimens. A single-banded anterior talofibular ligament was found in seven of the fourteen specimens, and a double-banded anterior talofibular ligament was found in the other seven specimens.

Single-Banded Anterior Talofibular Ligament

The single-banded anterior talofibular ligaments were flat and quadrilateral in shape. The ligament blended with the anterolateral aspect of the capsule and originated on the anterior colliculus of the lateral malleolus to insert immediately anterior to the talar lateral articular facet (see Appendix).

The fibular footprint averaged 13.8 mm (95% CI, 12.3 to 15.3) from the inferior tip of the lateral malleolus at the anterior fibular border. The single-band anterior talofibular ligament inserted at a point that was, on average, 49.8% (95% CI, 37.9 to 61.7) of the distance along the anterior fibular border from the inferior tip of the lateral malleolus to the fibular anterior tubercle (anteriormost point of the fibula near the tibial plafond)[32]. With regard to its talar attachment sites, the footprint center averaged 17.8 mm (95% CI, 16.3 to 19.3) from the apex of the lateral talar process and 11.3 mm (95% CI, 10.1 to 12.5) inferior to the anterolateral corner of the trochlea[33] along the anterior border of the talar lateral articular facet. The single-band anterior talofibular ligament inserted, on average, at 81.8% (95% CI, 71.4 to 92.2) of the distance from the apex of the lateral talar process to the anterolateral corner of the trochlea along the anterior border of the talar lateral articular facet.

Double-Banded Anterior Talofibular Ligament

The double-banded anterior talofibular ligaments had two distinct (superior and inferior) fibrous bands. Overall, the course of the double-banded anterior talofibular ligament was similar to that of the single-banded anterior talofibular ligament, originating on the anterior aspect of the lateral malleolus to insert slightly anterior to the talar lateral articular facet. The individual fascicles were flat and quadrilateral in shape and allowed for vascular branches of the perforating peroneal artery with its connection to the lateral malleolar artery[34]. The bands had a divergent course from their fibular origin to their talar insertion sites (Fig. 2 and Appendix).

The fibular footprint centers of the superior and inferior bands of the double-banded anterior talofibular ligament averaged 16.3 mm (95% CI, 15.5 to 17.1) and 10.2 mm (95% CI, 8.9 to 11.5), respectively, from the inferior tip of the lateral malleolus at the anterior fibular border. Their footprint centers were separated by an average of 6.9 mm (95% CI, 6.1 to 7.7) on the fibula. The superior and inferior bands of the anterior talofibular ligament inserted at an average of 54.6% (95% CI, 51.4 to 57.9) and 30.1% (95% CI, 26.2 to 34.0), respectively, of the distance along the anterior fibular border from the inferior tip of the lateral malleolus to the fibular anterior tubercle. With regard to their talar attachment sites, the superior band averaged 21.1 mm (95% CI, 20.0 to 22.2) and the inferior band averaged

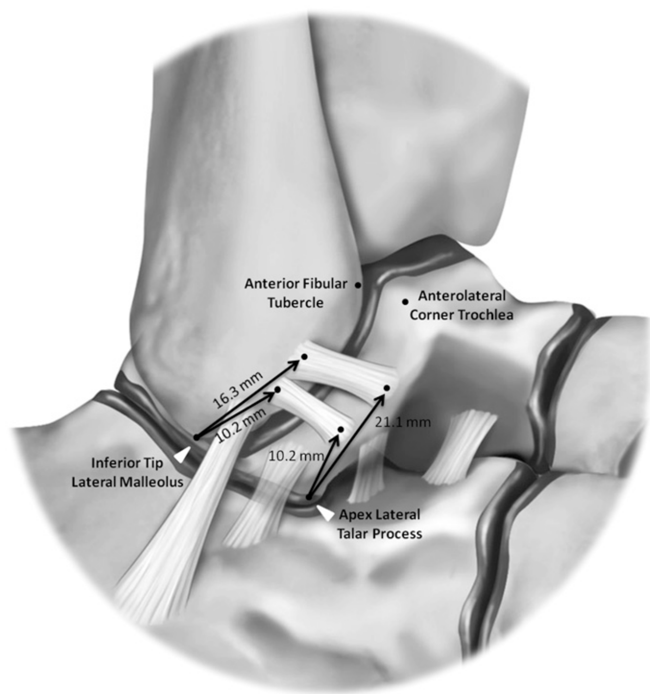

Fig. 2
Lateral view of a right ankle showing the attachment sites and distances from the inferior tip of the lateral malleolus and the apex of the lateral talar process for the double-banded anterior talofibular ligament.

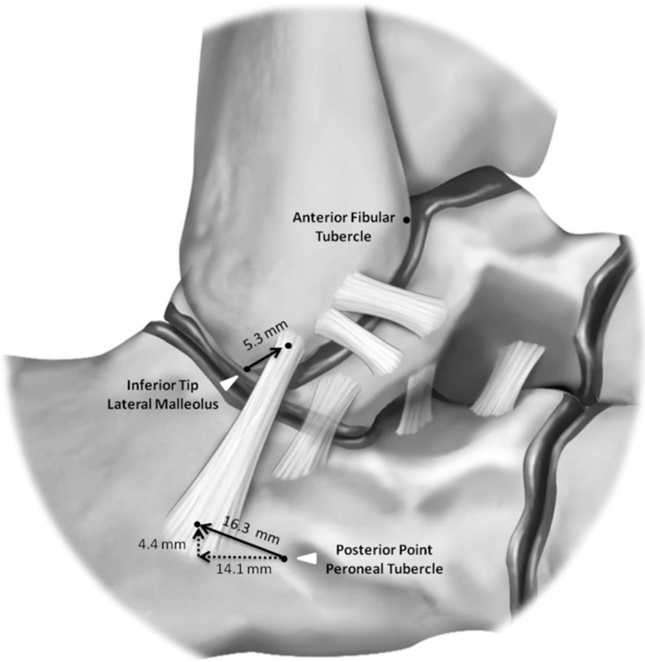

Fig. 3
Lateral view of a right ankle depicting the anatomic attachment sites and distances from the inferior tip of the lateral malleolus and the posterior point of the peroneal tubercle for the calcaneofibular ligament.

10.2 mm (95% CI, 8.9 to 11.5) from the apex of the lateral talar process, whereas the superior band averaged 11.5 mm (95% CI, 10.7 to 12.3) and the inferior band averaged 22.1 mm (95% CI, 21.3 to 22.9) from the anterolateral corner of the trochlea along the anterior border of the talar lateral articular facet. Their talar footprint centers averaged 11.4 mm (95% CI, 10.9 to 11.9) from each other, a distance that is slightly larger than their separation distance on the fibula. The superior and inferior bands inserted at 65.7% (95% CI, 64.1 to 67.3) and 33.7% (95% CI, 30.6 to 36.8), respectively, of the distance from the apex of the lateral talar process to the anterolateral corner of the trochlea along the anterior border of the talar lateral articular facet.

Calcaneofibular Ligament

The calcaneofibular ligament ran from the anterior-inferior aspect of the anterior colliculus, just below the inferior band of the double-banded anterior talofibular ligament, and inserted onto the lateral surface of the calcaneal body on a small tubercle (tuberculum ligamenti calcaneofibularis) posterior and superior to the posterior point of the peroneal process (trochlear process)[33], crossing both the talocrural and the subtalar joints (Fig. 3 and Appendix).

The fibular distance of the footprint of the calcaneofibular ligament was 5.3 mm (95% CI, 4.2 to 6.5) from the inferior tip of the lateral malleolus at the anterior fibular border. The calcaneofibular ligament inserted, on average, at 16.2% (95% CI, 11.9 to 20.6) of the distance along the anterior fibular border from the inferior tip of the lateral malleolus to the fibular anterior tubercle. With regard to its calcaneal attachment, its footprint center was an average of 16.3 mm (95% CI, 14.5 to 18.1) in the posterior-superior direction from the posterior point of the peroneal tubercle (14.1 mm [95% CI, 11.7 to 16.5] posterior and 4.4 mm [95% CI, 1.4 to 7.4] superior).

Posterior Talofibular Ligament

The posterior talofibular ligament coursed from the lower segment of the digital fossa on the medial side of the lateral malleolus to insert in a long fan-like fashion on the posterior-lateral portion of the talus immediately lateral to the talar posterolateral tubercle (Fig. 4 and Appendix).

Its fibular footprint center was an average of 4.8 mm (95% CI, 3.7 to 5.9) superior to the inferior tip of the lateral malleolus along the fibular axis within the digital fossa. On the talus, its footprint center was an average of 13.2 mm (95% CI, 11.5 to 14.9) from the center of the talar posterolateral tubercle and 2.7 mm (95% CI, 2.4 to 3.0) superior to the subtalar articular cartilage.

Cervical Ligament

The cervical ligament forms a distinct band of fibers located within the sinus tarsi, originating from the anterior third of the superior surface of the calcaneus (anterior calcaneal tubercle) to insert onto the talar neck (tuberculum cervicis)[33] (Fig. 5 and Appendix).

On average, its attachment site on the calcaneus was 23.4 mm (95% CI, 21.2 to 25.7) anterior to the articular surface of the calcaneus, 9.0 mm (95% CI, 7.9 to 10.1) posterior to the

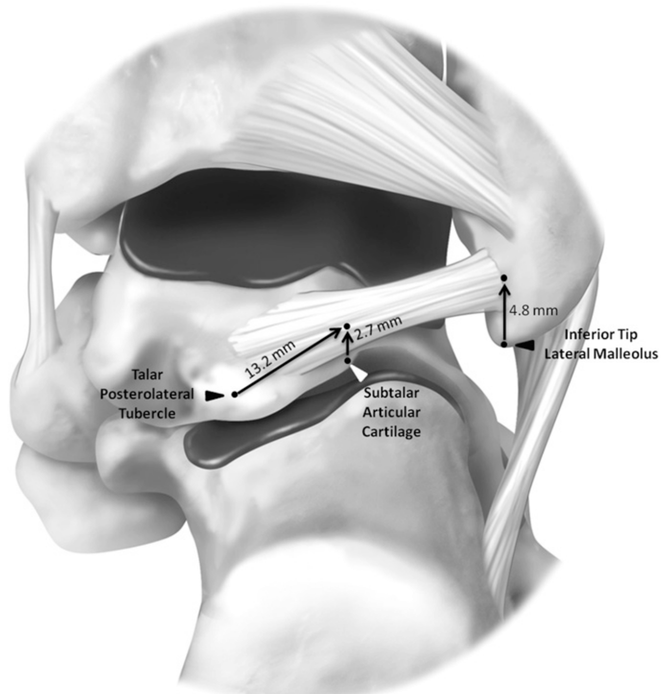

Fig. 4
Posterior view of a right ankle illustrating the posterior talofibular ligament connections to the digital fossa and the talus with distance references to the inferior tip of the lateral malleolus and the talar posterolateral tubercle.

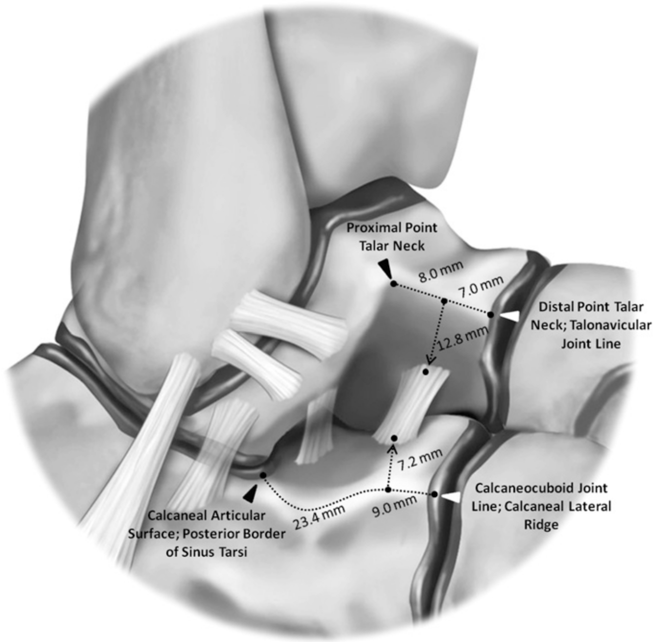

Fig. 5
Anterolateral view of a right ankle illustrating the anatomic locations of the talar and calcaneal attachment sites of the cervical ligament in reference to the talar neck and calcaneal sinus tarsi.

calcaneocuboid joint line along the calcaneal lateral ridge of the sinus tarsi, and 7.2 mm (95% CI, 6.0 to 8.4) perpendicular to the calcaneal lateral ridge of the sinus tarsi. Its talar attachment site was an average of 8.0 mm (95% CI, 6.5 to 9.5) anterior to the proximal point of the talar neck adjacent to the anterior border of the trochlea, 7.0 mm (95% CI, 5.7 to 8.3) posterior to the distal point of the talar neck at the talonavicular joint line, and 12.8 mm (95% CI, 11.7 to 14.0) perpendicular to the line connecting the proximal and distal points of the talar neck.

Discussion

Anatomic reconstruction of injured lateral ankle ligaments requires a clear understanding of anatomic relationships. In this report, we confirm our hypothesis and present consistent distances from ligament footprint centers to surgically relevant osseous landmarks for the anterior talofibular, calcaneofibular, posterior talofibular, and cervical ligaments. Given the prevalence of anterior talofibular and calcaneofibular ligament injuries, the most important findings in this report are that, in specimens with a single-banded anterior talofibular ligament, the fibular footprint originated an average of 13.8 mm (95% CI, 12.3 to 15.3) from the inferior tip of the lateral malleolus at the anterior fibular border and attached an average of 17.8 mm (95% CI, 16.3 to 19.3) superior to the apex of the lateral talar process along the anterior border of the talar lateral articular facet. The calcaneofibular ligament attached an average of 5.3 mm (95% CI, 4.2 to 6.5) from the inferior tip of the lateral malleolus at the anterior fibular border and inserted an average of 16.3 mm (95% CI, 14.5 to 18.1) in the posterior-superior direction from the posterior point of the peroneal tubercle (14.1 mm [95% CI, 11.7 to 16.5] posterior and 4.4 mm [95% CI, 1.4 to 7.4] superior).

While it is not surgically feasible to achieve such small measured parameters, values were reported to ±0.1 mm because the measurement technique used in this study was accurate to that scale. As an example, we found that the single-band anterior talofibular ligament originated an average of 13.8 mm from the inferior tip of the lateral malleolus. This information will help surgeons place the graft tissue approximately 14 mm from the tip, as opposed to 25 mm from the tip. Alternatively, a surgeon could use a percentage measurement, particularly in a patient who is much smaller or larger than average, and place the anterior talofibular ligament origin at 50% of the distance along the anterior fibular border. This may allow more accurate graft placement when chronic injury, arthritic changes, and/or prior surgery have obscured the normal anatomy. Using such detailed quantitative anatomic information will enable future biomechanical studies to either support or refute the hypothesis that the more anatomic the repair or reconstruction, the more normal the contact stresses and kinematics of the ankle joint.

Currently, there are several surgical procedures for the treatment of mechanical lateral ankle ligament instability, with the most common being the original Broström repair[35]. While the Broström repair is the present gold standard[17], it depends on the quality of the remnant tissue for reliable results. Frequently, the anterior talofibular ligament tissue is not of sufficient quality for secondary repair, and this has led to the use of various augmentation and reconstructive techniques, including the Gould procedure[11], Watson-Jones procedure[14], Evans procedure[12], Larsen procedure[26], and Chrisman-Snook modification of the Elmslie procedure[36,37]. Unfortunately, both basic and clinical outcome studies have demonstrated restricted ankle motion and early arthritic changes after these reconstructive procedures[19,38-44]. With a surgical emphasis on "anatomic procedures" that may better approximate the native joint mechanics, positive outcomes have been reported[16,21,38,44-49]. We believe that the results of our study may lead to more anatomic placement of reconstructions and possibly contribute to improving outcomes following lateral ankle ligament surgery.

The importance of identifying surgically relevant osseous landmarks for reference during anatomic reconstruction procedures cannot be understated. Use of these landmarks facilitates consistent and anatomic placement, and ensures proper positioning and alignment during treatment of basic ligamentous injuries and complex situations in which the native ligament centers are not visible. For the anterior talofibular ligament, we describe surgically relevant osseous landmarks, including the inferior tip of the lateral malleolus for the fibular origin and the apex of the lateral talar process for the talar attachment. As discussed in previous literature, identifying a pertinent osseous landmark reference for the calcaneofibular ligament attachment on the calcaneus is challenging, and there is no consensus on a reproducible and consistent osseous landmark[21,49-51]. Burks and Morgan reported the distance to the subtalar joint on a line perpendicular to the joint[50]. Taser et al. reported the distance of the footprint from the posterior border of the sinus tarsi[32]. In the present study, we report the distance from the posterior point of the peroneal tubercle. Neuschwander et al. also reported the distance from the calcaneofibular ligament calcaneal attachment to the peroneal tubercle, in their computed tomography (CT) study[51]. Their reported distance of 27 mm is longer than our reported distance of 16.3 mm (95% CI, 14.5 to 18.1); however, we measured the distance from the most posterior point of the peroneal tubercle, whereas they did not provide a specific reference point on their chosen landmark. Overall, we believe that the posterior point of the peroneal tubercle is the most reproducible reference landmark because it is easily palpated during lateral ankle surgical exposures and is in close proximity to the calcaneofibular ligament attachment site on the lateral aspect of the calcaneus. Finally, we introduce a convenient method of identifying the talar and calcaneal attachment sites of the cervical ligament (Fig. 5 and Appendix). As shown in the figures, one can follow the superolateral border of the talar neck as well as the calcaneal lateral ridge of the sinus tarsi to accurately identify the footprint centers of the cervical ligament within the sinus tarsi with distance measurements to pertinent osseous landmarks.

A strength of this study includes the use of fresh-frozen, nonpaired specimens, which allow a more accurate representation of in vivo anthropometry than is possible with embalmed specimens and increases the applicability of the results to the population. Also, all dissections and data collection were done by the same individual, eliminating interobserver variability.

This study did have limitations. A mean age of 50.4 years for the specimen donors is relatively young compared with the donor ages in other cadaveric studies, but it is older than the patient population in which injuries to the lateral ankle are most prevalent[4]. In addition, there may be differences between cadaveric tissue and that of living patients, although the use of fresh-frozen, non-embalmed specimens helped to limit those differences. Finally, fourteen cadavers may not be truly representative of the general population, but the use of nonpaired specimens helped diversify the anthropometric measurements reported.

The information and anatomic illustrations provided in this report may provide surgeons with an anatomic guide to the origins and insertions of the lateral ankle ligaments in reference to easily identifiable osseous landmarks during ankle ligament reconstruction.

Appendix

eA Figures showing the attachment sites of the ligaments in the specimens are available with the online version of this article as a data supplement at jbjs.org. ■

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