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The anterior talofibular ligament: A detailed morphological study

Bader Khawaji [a,b,*], Roger Soames [a]

[a] Centre for Anatomy and Human Identification, College of Art, Science and Engineering, University of Dundee, Dundee DD1 5EH, UK
[b] College of Medicine, King Saud bin Abdulaziz University for Health Sciences, Jeddah, Saudi Arabia

HIGHLIGHTS

- Anterior talofibular ligament (ATFL): one (22.9%), two (56.3%) and three (20.8%) band forms.
- ATFL originates 10.37 mm anterosuperior to the fibular lateral malleolar tip.
- ATFL inserts to the talar body 3.92 mm anterior to the anterior lateral malleolar line (ALML).
- ATFL is most taut in plantarflexion (length: 21.06 mm) and inversion (length: 20.26 mm).

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ABSTRACT

The anterior talofibular ligament (ATFL) is commonly injured and may result in ankle instability. Good results from ATFL reconstruction have been reported; however complications and movement restrictions have also been observed. ATFL differences have been reported; however details of its precise bony attachment are lacking. This study provides a detailed morphology of the ATFL with respect to surgical and clinical applications. ATFL morphology, number of bands and the exact insertion points were studied in 50 formaldehyde embalmed feet. ATFL length was measured in different joint positions to assess its functional role: ATFL length varied from 18.81 mm in dorsiflexion to 21.06 mm in plantarflexion: mid-length width and thickness were 4.97 mm and 1.01 mm respectively. The bony attachment lengths were also measured: mean proximal and distal bony attachment lengths were 4.68 mm and 3.1 mm respectively, while 13.04 mm had no bony attachment. One (22.9%), two (56.3%) and three (20.8%) band morphologies were observed originating 10.37 mm anterosuperior to the lateral malleolar tip and inserting 3.92 mm anterior to the anterior lateral malleolar line (ALML). Detailed morphology of the ATFL may help in restoring injured ATFL function by appropriate ligament reconstruction, as well as aid the understanding of the mechanism of ligament injury.

1. Introduction

Ankle sprain is considered one of the more common injuries affecting ligaments of the ankle. In the UK approximately 5000 ankle sprains occur every day with some 27,000 occurring in the USA [1,2]. Injury to the lateral collateral ligament (LCL) due to ankle inversion comprises about 85% of ankle sprains [3–5]. Moreover, isolated anterior talofibular ligament (ATFL) injury and combined ATFL and calcaneofibular (CFL) injuries occur in 80% and 20% of cases respectively. It has been reported that an ankle sprain may involve avulsion fracture or soft tissue injury [2,6], in which two thirds of cases also have an isolated ATFL injury. It is estimated that 30–40% of untreated ankle sprains later result in chronic ankle instability [7], which is also pathologically common in individuals with serious ankle sprain or repetitive injury and may cause difficulty in some physical activities. Osteoarthritic changes in the ankle joint may also result from chronic ankle lateral instability [8].

Acute ankle injuries are usually diagnosed and their prognosis assessed on clinical examination, although magnetic resonance imaging (MRI) may help in assessing the healing process following ligament injury [9]. Accurate assessment of LCL injuries using MRI requires a good knowledge of the anatomy of the LCL and adjacent tissues [10]. Moreover, arthroscopy is used in visualising the ligament in reconstruction procedures [11]. A less invasive arthroscopic technique has been reported to have good results in treating chronic ankle instability with ATFL injury [12].

Different surgical techniques and approaches to reconstructing injured lateral ankle ligaments are available. Good results have

* Corresponding author. Tel.: +44 7760398770.
E-mail addresses: b.khawaji@dundee.ac.uk, bader@khawaji.com (B. Khawaji).

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been reported with some techniques: for example, a modified Brostrom approach produces good subtalar and ankle joint stability with a success rate of 85–95% [13,14]. Maffulli et al. [15] reported that the Brostrom technique is a safe procedure to restore sporting activity, although poor scores were reported in 21–24%, with recurrent instability in 16% of cases. Difficulties with some common surgical techniques have been reported [16–18], together with complications, including limitation of movement at the subtalar joint and ankle instability [4]. It is, therefore extremely important to have a good understanding of the relationship of the LCL complex, especially the ATFL, with respect to specific bony landmarks.

There is a lack of precision in the exact bony attachments of the ATFL as well as differences regarding its variations, including the number of bands present [19]. Prior studies reported variation in the existence of one, two and three band forms of the ATFL [18–24]. ATFL originates from the anterior border of the fibular lateral malleolus [25]. However, distal insertion of the ATFL was variable between the talar neck [25] and the junction between the body and neck of the talus [26]. The ATFL length was reported in previous literature is ranging between 13 mm and 40 mm [11,18,21,27–30]. The width was reported in a number of studies which was reported to be ranging between 4 mm and 12.98 mm [18,21,22,28,30]. Dimmick et al. [4] and Hua et al. [10] used MRI to measure ATFL thickness which was reported to be 2.19 mm and 1.46 mm respectively.

A more detailed understanding of the anatomy of the ankle ligaments should enable better diagnosis and treatment of ankle sprains. There will also be an improved understanding of the mechanism(s) of injury, especially of the ATFL, as well as establishing effective treatment protocols, including reconstruction techniques [31]. Although the most common factors that may put an individual at higher risk of injury are controversial [32], prevention and rehabilitation of ankle sprains concerns many medical professionals. Preventive methods such as taping and ankle braces [33] and balance training [34,35] help prevent future ankle sprains, especially in cases of previous injury. These can be improved and developed by studying ATFL variations and ligament behaviour, especially during movements that put different parts of the ligament at a higher risk of injury.

The aim of this study was to investigate, in detail, the morphology of the ATFL with respect to surgical reconstruction by determining its exact proximal and distal bony attachments, the length of these attachments and changes in ligament length with respect to joint position. The latter will provide an understanding of the role of the ligament in providing stability in different joint positions. This study will assist in providing: (i) an improved diagnosis and surgical treatment of ATFL injuries; (ii) a better understanding of the mechanism(s) of injury; and (iii) more effective injury preventive protocols.

2. Materials and methods

Fifty feet (25 right, 25 left) were dissected from 25 European Caucasian formaldehyde embalmed cadavers (10 male, 15 female), with an average age of 83 years (range: 62–97 years). There was no indication of injury or surgical repair to the lateral collateral ligament complex of the ankle at the time of death.

Skin, fascia, muscles and tendons on the anterior and lateral aspects of the ankle were carefully removed to expose the anterior talofibular ligament. The tendons of extensor hallucis longus, extensor digitorum longus, tibialis anterior and fibularis tertius were sectioned to expose the ATFL. Care was taken to preserve as much of the ligament as possible; fat and fascia between individual bands of the ATFL was carefully removed to avoid damaging the individual fibres. However, some measurements were not taken

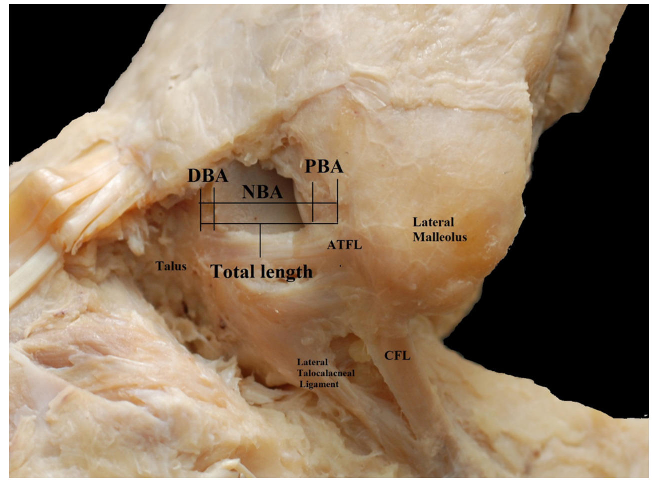

Fig. 1. ATFL length: no bony attachment (NBA), proximal bony attachment (PBA) and distal bony attachment (DBA).

in some specimens due to number of factors including ligament intactness and joint stiffness (movement limitation).

Variation in the number of bands and their orientation were recorded and photographs taken. Multiband ligaments were considered when separated sets of fibres had different distal insertions and/or directions, although some bands were not completely separate at the origin. When more than a single band was observed the superior band was taken as being the main component and referred to as the ATFL: additional bands were referred to as the inferior (IATFL) and middle (MATFL) bands when two and three bands were present.

Ligament length, width and thickness were measured using electronic digital Vernier callipers (Toolzone 150 mm; China), from the most proximal to the most distal attachment points with the ankle in neutral (foot at an angle of 90° to the leg): the ankle was secured in the neutral position passively while the length was measured; this was reliable as it was done by two other investigators with no significant difference. Ligament length was also measured with the ankle in maximum passive dorsiflexion, plantarflexion, inversion and eversion. It is acknowledged that the maximum range of each of these movement differed, consequently they were not standardised across specimens. All ligament length measurements were made to the ligament's longest fibres in each joint position. The free length, i.e. the non-bony attachment length (NBA) was also determined (Fig. 1) as the distance between the proximal and distal bony attachments. This reflects the length of the ligament that is subject to increasing tension during movement. The distal bony attachment (DBA) length was also determined, being taken as the distance between those fibres having a bony attachment distally and the last fibres at the distal point of insertion (Fig. 1). These measurements were only taken with the ankle in plantarflexion. The proximal bony attachment (PBA) was determined by subtracting the NBA and DBA from the total ligament length with the ankle plantarflexed (Fig. 1).

The width of each ATFL band was measured at three points: the mid-length of the ligament and at the proximal and distal attachments; the thickness of each band was measured at the mid-ligament length: the mid-ligament length was determined from the total length in plantarflexion.

The attachment of the ATFL to the lateral malleolus was determined, recorded and photographs taken. To enable a consistent description of the origin, a specific method was adopted in which the lateral malleolar tip was used as a bony reference point to identify the precise proximal insertion of the ATFL (Fig. 2). The distance and angle between the lateral malleolar tip and midpoint of the