

# MORPHOLOGY OF THE RETROMALLEOLAR GROOVE ON CADAVERIC FIBULAE UTILIZING GROSS INSPECTION AND COMPUTED TOMOGRAPHY

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### INTRODUCTION

The lateral malleolus is comprised of lateral, medial, and posterior surfaces. The lateral surface is convex and located subcutaneously. The medial surface presents a triangular articular facet with an inferior apex that articulates with the lateral face of the talus. Inferoposteriorly to the articular facet is the posterior bundle of the talofibular ligament that inserts on the digital fossa, the most prominent groove in the lateral malleolus. The posterior surface is limited laterally by the oblique crest and medially by the extension of the posterior border of the fibular shaft. This surface is hollowed by a depression: the retromalleolar groove. The groove is obliquely situated and is bounded superomedially by a tubercle, which is superior to the apex of the retromalleolar fossa. Inferolaterally, the groove is bounded by a longitudinal ridge along the distal part of the posterior border of the lateral malleolus down to its apex. The tubercle and the ridge have been named the retromalleolar tubercle and the retromalleolar ridge, respectively. The groove contributes to part of the floor of the superior peroneal tunnel. According to Athavale et al, the superior peroneal tunnel is made up of the following: superior peroneal retinaculum (roof), retromalleolar groove (osseous floor of tunnel), and the posterior intermuscular septum of the leg (non-osseous floor of tunnel). The tunnel is normally occupied by the tendons of the peroneus longus and brevis. In addition to the two peroneal tendons, several other structures can be observed within the tunnel such as peroneus quartus muscle, low lying fibers of the peroneus brevis muscle, and an accessory peroneal nerve (1).

It has been documented that the morphology of the retromalleolar groove plays a contributory role in peroneal tendon pathology, with flat and convex grooves showing the highest association (2). There is limited data that objectively quantifies the morphology of the retromalleolar groove. The

purpose of this study was to assess the incidence of the morphology of the retromalleolar groove, which we hypothesized would be predominately concave as it has been reported in previous studies (1,2) based on anatomical observation and computed tomography (CT) scans.

### MATERIALS AND METHODS

Twenty-three dry cadaveric fibulae from The Stanford-Meyer Osteopathology Collection in San Diego's Museum of Man were utilized for the present study. The fibulae used were already disarticulated from the tibia, which allowed proper analyses to be made both grossly and radiographically. The age and sex of the patients was not known. The bones were donated to science in India in the 1960s and were documented as having no pathology. Twelve of the fibulae obtained were bilateral fibulae from 6 people. The other 17 did not have a contralateral fibula.

#### Gross Inspection

Each fibula was individually placed on a velvet backdrop overlying a table to highlight the anatomical landmarks and was photographed with a 12.1 megapixel Sony camera. Multiple pictures were taken of each bone including the proximal and distal ends as well as the retromalleolar groove, retromalleolar tubercle, and digital fossa. The retromalleolar groove was found on the posterior aspect of the fibula and extended from the distal apex proximally to the retromalleolar tubercle. The digital fossa was medial to the retromalleolar groove. Each fibula was previously marked to indicate the specimen number, and the numbers were recorded with the photographs (Figures 6-8). The following were excluded from the study: fibulae with apparent gross pathology, poor bone quality/bone stock that were crumbling/porous, and articulated fibulae to tibias.

**Radiographic Inspection**

After the gross inspection of each fibula, the bones were imaged at University of California San Diego (UCSD) using CT scans. The bones were randomly assigned into 4 groups so that they could be placed on a plexiglass board on the scanner table. Groups 1-3 each had 6 bones and Group 4 had 5 bones, totaling 23 bones. A marker was placed on the right side of the plexiglass to indicate left from right on the CT scans to maintain orientation. The CT scans were then analyzed by 2 UCSD radiology fellows and the type of retromalleolar groove (concave, convex, or flat) was determined (Figures 1-3).

In fibulae with a concave groove, the width, depth, and length of the groove were also measured. Digital fossa

measurements (distance from tip, longitudinal extension, width, depth), length of fibulae, and width of fibulae were also performed. The fibulae that showed slightly concave retromalleolar grooves were categorized into the concave group (Figure 4). Bones were labeled as slightly concave when they demonstrated very shallow tunnels with depth less than 1 mm. In flat retromalleolar grooves, the depth was always zero, and in convex grooves the depth could not be obtained as it is not possible to obtain depth on a convex surface. The retromalleolar groove length was measured from the most inferior tip of the fibula to the peroneal tubercle. The two maximum cross sectional diameters of the inferior aspect of the fibula were measured at the level of the peroneal tubercle (Figure 5).

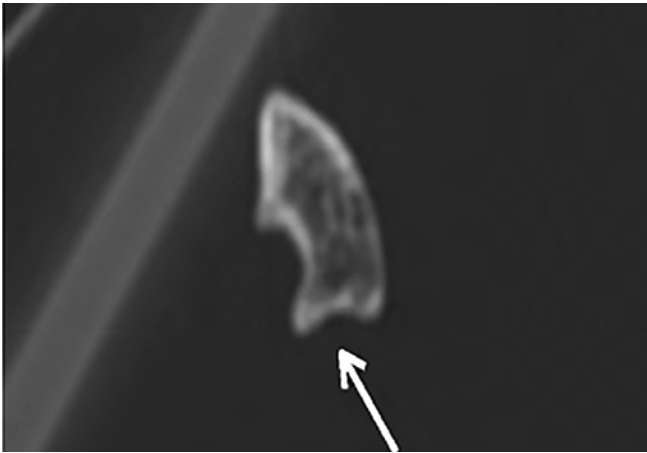


Figure 1. Concave retromalleolar groove.

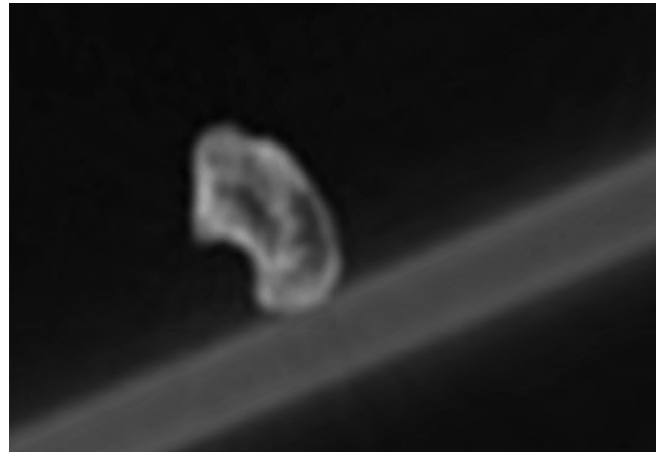


Figure 2. Convex retromalleolar groove.

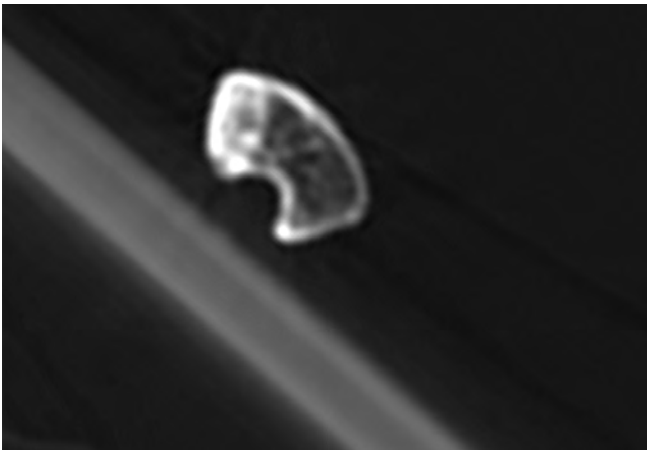


Figure 3. Flat retromalleolar groove.

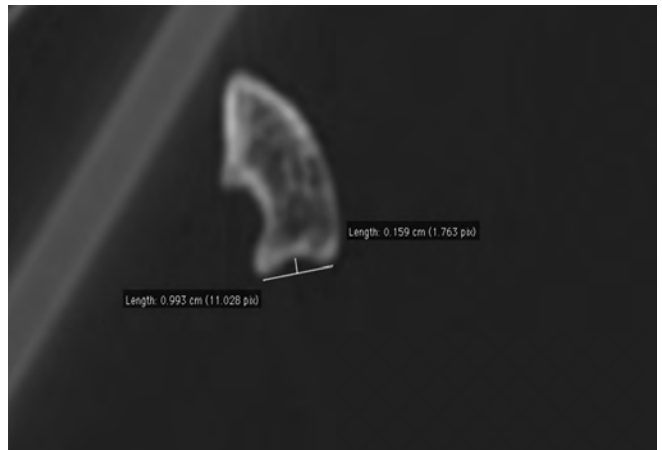


Figure 4. Fibulae that showed slightly concave retromalleolar grooves were categorized into the concave group.

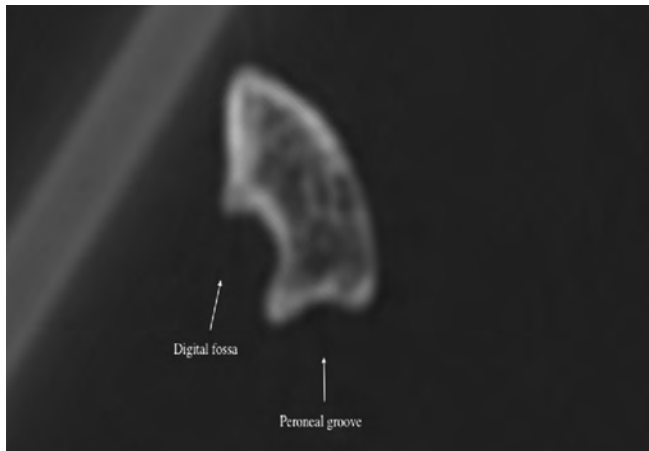


Figure 5. Measuring the groove length.

## RESULTS

The results of the gross and radiographic inspection are shown in Tables 1, 2, and 3. Table 1 shows the mean concave retromalleolar groove dimensions. Table 2 presents the mean digital fossa dimensions for the specimens, and Table 3 shows the fibula measurements. Figure 9 shows the distribution of the morphology of the retromalleolar groove.

## DISCUSSION

It has been documented in the literature that convex and flat fibular grooves are directly associated with peroneal tendon injury (2,3). Grooves are furrows or channels and by definition are concave, and in all locations where a tendon is related to a bone, a concave groove or a flattened area is present (1). The incidence of the morphology of the groove varies between studies (1,4,5). According to a study by Athavale et al, the majority of grooves were obliquely oriented, shallow, and concave with no mention of convex or flat grooves being observed (1). Ozbag et al reported the shape of the malleolar groove to be regularly concave in 68% of fibulae (5). Adachi et al examined magnetic resonance images of patients with peroneal tendon dislocation versus those without dislocation, and reported morphology of the groove to be 15.38% (12/78) convex, 5.13% (4/78) concave, and 29.49% (23/78) flat in the pathologic group (6). In the non-injured group, 14.10% (11/78) were convex, 7.69% (6/78) were concave, and 28.20% (22/78) were flat (6). There was no significant difference found between the retromalleolar groove morphology among the patients with peroneal tendon injury and those without (6).

Upon imaging the fibulae on CT scan in our study, it was evident that concave, convex, and flat grooves were all represented. The appearance of the retromalleolar groove was defined as convex when the depth could not be obtained as this is not possible on a convex surface; concave when the

Table 1

	Length(mm)	Width(mm)	Depth(mm)
Total Mean All Groups	14.538	8.087	1.071
Standard Deviation	1.886	1.398	0.333

Table 2

	Distance From Tip (mm)	Longitudinal Extension (mm)	Width (mm)	Depth (mm)
Total Mean All Groups	3.587	8.451	8.929	2.978
Standard Deviation	1.601	2.063	1.279	0.932

Table 3

	Fibula Length (cm)	Total Width Distal End 1 (cm)	Total Width Distal End 2 (cm)
Total Mean All Groups	36.549	2.426	1.787
Standard Deviation	3.010	0.229	0.144

depth was at least 1 mm and showed a depression or furrow; flat when the depth was zero and there was no concavity or convexity. Interestingly, the incidence of concave groove was only slightly superior to the incidence of a flat groove, 48% (11/23) and 43% (10/23) respectively, which does not support our hypothesis. The average length, width, and depth of the retromalleolar groove was 14.538 mm, 8.087 mm, and 1.071 mm, respectively. The standard deviation of the depth of the retromalleolar groove was 0.333, which shows an accurate depiction of depth between the fibulae in this study. The depth of the digital fossa also showed a low standard deviation of 0.932 indicating that the mean depth of the digital fossa of 2.978 mm was a consistent finding between the fibulae. Ozbag et al measured length, width, and depth of the malleolar groove and reported 19.7 mm, 9.2 mm, and 1 mm, respectively, which are similar to the values we found (5).



Figure 6. Retromalleolar tubercle, digital fossa, and retromalleolar groove.



Figure 8. Measuring device for gross inspection.

Although the sample size in this study was low with only 23 fibulae, it demonstrated that there is a large variability between morphology of the retromalleolar groove. This is consistent among the studies to date.



Figure 7. Fibula on cloth.

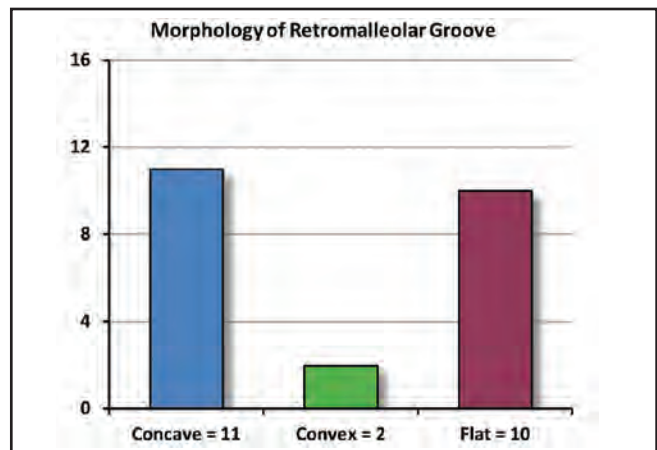


Figure 9. Morphology of retromalleolar groove: Eleven of 23 (48%) were concave or slightly concave, and 10 of 23 (43%) were flat. Only 2 of 23 (9%) of the fibulae demonstrated a convex groove.

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