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## Safety of neurovascular structures in ankle arthroscopy: cadaveric study

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### Abstract

**Introduction:** Anterior and posterior portals used for ankle arthroscopy but anterior portals are safer, provide good access and visualisation of joint.

**Aims:** The anatomical structures nearby portals are vulnerable to injury during surgery. To study the anatomy of ankle joint using dissection method.

**Methods and material:** 20 cadaveric limbs were dissected and the distance of different portals to the nearby neurovascular structures was measured.

**Results:** The mean distance from anteromedial portal to the great saphenous vein and saphenous nerve was 5.28 mm, 9.12mm and that between the medial midline portal to the dorsalis pedis artery and deep peroneal nerve was 10.08 mm and 16.20mm. The mean distance from antero-central portal to the dorsalis pedis artery was 2.38mm, to superficial peroneal nerve was 7.09mm and deep peroneal nerve was 4.12mm. The mean distance from anterolateral portal to lateral branch of superficial peroneal nerve was 3.18mm. There was injury in one specimen.

**Conclusions:** This present study concluded that medial midline portal is comparatively safe for ankle arthroscopy. Antero-central portal has potential risk of injury to dorsalis pedis artery.

**Keywords:** Ankle arthroscopy, ankle anatomy, complications of ankle arthroscopy

### Introduction

The first arthroscopic inspection of ankle joint was done by Burman in 1931 [1].

Ankle joint related symptoms and complaints are very common these days and so arthroscopy of ankle joint has increased popularity in present time because it may be use to diagnose as well as treat ankle pathologies.

The anatomical structures at ankle joint shows wide variations in terms of course and distance hence they become more prone for injury during ankle arthroscopy through any of anterior arthroscopic portals [2, 3]. Reported complication rates for this procedure have ranged from 0% to 25% [4, 5, 6, 7, 8, 9]. Neurologic injuries, which ranged from 0.04% to 4.8% is commonest [10]. The surgeon must familiar to the neurovascular structures to avoid complications [6].

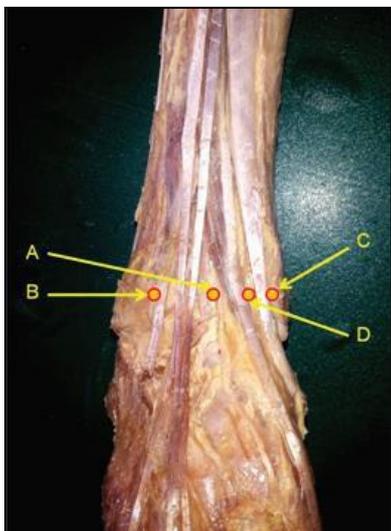
Arthroscopy of the ankle can be systematic and reproducible when the surgeon is familiar to the anatomy of ankle and accurate placement of the arthroscopic portals. [11, 12, 13, 14, 15]

### Material and methods

20 ankles were obtained from 12 cadavers and evaluated for study, those with damaged anatomy were discarded. Then limbs were dissected to study the neurovascular injury during ankle arthroscopy.

The bony and muscular landmarks such as both malleoli, extensor hallucis longus and tibialis anterior muscle were identified and marked.

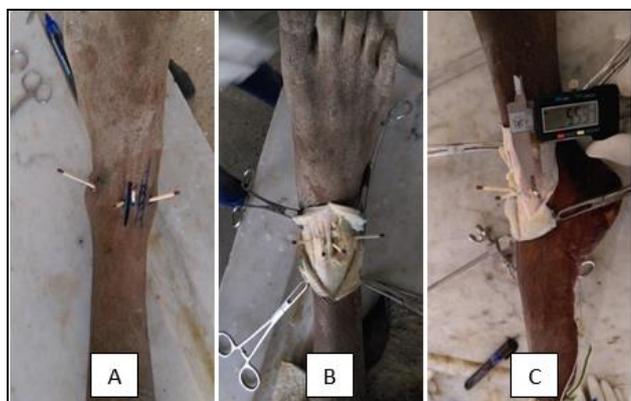
- A. Antero-central Portal
- B. Anterolateral Portal
- C. Anteromedial Portal
- D. Medial midline Portal



**Fig 1:** Anterior Portals of ankle arthroscopy

The muscle tendons were palpated first to determine the site of entry and the joint was distended with 20 ml saline by using syringe. Then portal was established at each site by giving a stab incision followed by blunt dissection with scissors down to the joint. A 4 mm arthroscope was inserted and portal established. Portal sites were marked with a marker (wooden stick).

The dissection of skin and subcutaneous fat was done and underlying fascia was separated for visualization of the neurovascular structures below. During the dissection, anatomy and the location of neurovascular structures (muscles, tendons and nerves) was preserved. Followed by dissection the neurovascular structures were identified and distance was measured from each portal. In a condition where there were two branches of one structure the distance from the portal to the nearest branch was recorded.



**Fig 2:** A. Portal site marked by wooden sticks B. Dissection at ankle joint, C. Measurement of distance

**Four portals were used**

- Anteromedial (medial to tibialis anterior tendon): From this portal we measured distance of saphenous nerve and saphenous vein.
- Medial Midline portal (between tibialis anterior tendon and extensor hallucis tendon): From this measured the distance of dorsalis pedis artery and superficial peroneal nerve.
- Anterocentral (just lateral to extensor hallucis longus): measured distance of Dorsalis pedis artery, Superficial peroneal nerve and deep peroneal nerve.
- Anterolateral: (lateral to the tendons of extensor

digitorum longus and peroneus tertius): measured distance of Lateral branch of superficial peroneal nerve.

All distances were measured with the help of digital vernier calliper.

**Observations & results**

In the present study we present the data obtained after dissection of 20 ankles.

The mean distance from anteromedial portal to the saphenous nerve and saphenous vein was 9.12mm (2.0- 14.0mm) and 5.28mm (1.6-11.3mm).

**Table 1:** Mean Distance From portals to neurovascular structures

Neurovascular Structure	Mean Distance (mm)	Tethering
<b>Anteromedial Portal</b>		
Long Saphenous Vein	5.28 (1.6-11.3)	0
Saphenous Nerve	9.12 (2.0-14.0)	0
<b>Medial Mid line portal</b>		
Dorsalis Pedis Artery	10.08 (4.0-14.4)	0
Superficial Peroneal Nerve	16.20 (7.0-24.3)	0
<b>Anterocentral Portal</b>		
Dorsalis Pedis Artery	2.38 (1.0-7.1)	0
Superficial Peroneal Nerve	7.09 (1.1-13.5)	0
Deep Peroneal Nerve	4.12 (1.9-8.3)	0
<b>Anterolateral Portal</b>		
Lateral Branch of Superficial Peroneal Nerve	3.18 (0-6.3)	1

The mean distance from medial midline portal to dorsalis pedis artery was 10.08mm (4.0-14.4mm) and superficial peroneal nerve was 16.20mm (7.0-24.3mm).

The Anterocentral portal was at a mean distance of 2.38mm (1.0-7.1mm) from dorsalis pedis artery, 7.09mm (1.1- 13.5) from superficial peroneal nerve and 4.12mm (1.9-8.3mm) from deep peroneal nerve.

The mean distance from anterolateral portal to lateral branch of superficial peroneal nerve was 3.18mm (0-6.3). In one specimen there was tethering of lateral branch of SPN.

**Discussion**

Ankle arthroscopy has become an important resource for the diagnosis and treatment of pathologies of this joint, but as with any procedure, it is subject to complications.

Ferkel described 9% complication rates in his study. 4 Out of these, 49% were neurological complications.

This study was aimed at studying the anatomy of the ankle region with respect to the anterior ankle arthroscopic portals.

**Anteromedial portal**

In this study the mean distance between from the anteromedial portal to the great saphenous vein and saphenous nerve was 5.28mm (1.6-11.3) and 9.12mm (2.0-14.0). Buckingham *et al.* [13] reported mean distance 5.7 mm from long saphenous vein and there was one laceration, saphenous nerve was at mean distance of 5.9 mm there was one case damage to the nerve.

Golano *et al.* [14] reported the mean safe distance between the portal and the great saphenous vein was 9mm (range 3-16mm) and for saphenous nerve was 7.4mm (range 0-17mm). Though these structures are relatively risk free, they reported 5 cases neurological complications during arthroscopy using the anteromedial portal. Woo *et al.* [16] conducted a study in chinese cadavers and found the mean distance was 10.2mm (range 1.1 to 20.2).

Bharambe *et al.* <sup>[17]</sup> reported mean distance from portal to great saphenous vein and saphenous nerve was 7.7 mm, range being 6.5 to 9.5 mm.

### Medial midline portal

In this study the dorsalis pedis artery was at mean distance of 10.08 mm (range 4.0-14.4 mm) and superficial nerve was at 16.20 (range 7.0-24.3mm) from medial midline portal. Buckingham *et al.* <sup>[13]</sup> found mean distance of 11 mm (range 5-15mm) from the dorsalis pedis artery.

Bharambe *et al.* <sup>[17]</sup> found mean distance for DPA and deep peroneal nerve was 1.7 (range being 1 to 2mm).

### Anterocentral portal

The mean distance from anterocentral portal to dorsalis pedis artery was 2.38mm (range 1.0-7.1mm), to superficial peroneal nerve was 7.09mm (range 1.1-13.5mm) and deep peroneal nerve was 4.12mm (range 1.9-8.3mm) in present study. Buckingham *et al.* <sup>[13]</sup> reported the mean distance to be 0.7 (range 0-5) for dorsalis pedis artery and 1.1 (range 0-5) for deep peroneal nerve. Dorsalis pedis artery was injured in one case, three cases superficial peroneal nerve lacerated and in one case deep peroneal nerve was tethered.

Golano *et al.* <sup>[14]</sup> discouraged the use of this portal due to high associated risk of injury to superficial peroneal nerve superficially and deep peroneal nerve and dorsalis pedis artery on the deeper plane. They also stated that any associated variations of the artery may also lead to vascular lesions.

Feiwell and Frey <sup>[15]</sup> found the average distance from anterocentral portal to the neurovascular bundle to be 3.3mm (range, 0-10mm). There was 4 cases was related to the neurovascular bundle injury. Bharambe *et al.* <sup>[17]</sup> found the average distance from portal to DPA and deep peroneal nerve was 1.4mm.

### Anterolateral portal

In the present study the mean distance between the anterolateral portal and superficial peroneal nerve was found to be 3.18 mm (range 00-6.3mm) and in one case nerve was tethered. Stetson and Ferkel <sup>[12]</sup> reported a mean distance of the portal from the superficial peroneal nerve branch to be 6.2 mm (range, 0-24mm). Buckingham *et al.* <sup>[13]</sup> reported a mean distance of 0.5 mm (range, 0-10 mm) and 2 cases of laceration to the nerve.

Woo *et al.* <sup>[16]</sup> found the mean distance from the portal to superficial peroneal nerve was 5.5mm (range, 0.4 to 14.4). They also stated that the anterolateral portal should be placed as close to the fibula as possible to avoid injury to the nerves.

Bharambe *et al.* <sup>[17]</sup> found the mean distance from superficial peroneal nerve to portal being 2.5mm. Martin oliva x *et al.* <sup>[18]</sup> found mean distance of 4.8mm from anterolateral portal.

### Conclusion

The study concluded that, medial midline portal is safest ankle portal for ankle arthroscopy since neurovascular structures are far away from the portal. While anteromedial portal has risk of injury to saphenous nerve and vein. Anterocentral has potential risk of dorsalis pedis artery injury, Anterolateral portal has a risk of SPN injury due to variability in course.

Ankle arthroscopy can be reproducible if surgeon has a knowledge of anatomy and neurovascular structures adjacent to portal.

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