

### **Anatomical Study of Evaluation of Safety of Various Portals Used in Ankle Arthroscopy**

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#### **Abstract**

Ankle arthroscopy is gaining popularity and its uses are being explored by various surgeons all over the world. Various portals are used for ankle arthroscopy. This study aims at finding the relevant surgical anatomy and safety of important structures around these portals. The distance of various portals to the adjacent anatomical structures was measured in 16 cadaveric limbs and 4 amputated limbs. In the study great saphenous vein, saphenous nerve and tibialis anterior tendon were at mean distance of 5.28 mm, 9.12mm and 4.39mm respectively from anteromedial portal. The mean distance from medial midlineportal to the dorsalis pedis artery, deep peroneal nerve, tibialis anterior tendon and extensor hallucis longus tendon was 10.08 mm, 16.20mm, 2.41mm and 2.62mm respectively. Extensor hallucis tendon was injured in two specimens during portal placement. The anterocentral portal was placed at mean distance of 2.38mm from the dorsalis pedis artery, 7.09mm from superficial peroneal nerve and

4.12mm from deep peroneal nerve. Distance between anterolateral portal and lateral branch of superficial peroneal nerve was 3.18mm. There was tethering in one specimen. This study confirmed that anteromedial portal is comparatively safe for ankle arthroscopy while there is high chances of tendon tethering in medial midline portal. Dorsalis pedis artery can be injured during anterocentral portal placement.

**Keywords:** Ankle arthroscopy, Complications in ankle arthroscopy, Portals for ankle arthroscopy

#### **Introduction**

Arthroscopy is the inspection of the synovial joint by means of a scope. In 1931 Burman attempted the arthroscopy of ankle joint in cadavers. He concluded that the ankle joint was unsuitable for arthroscopy, due to its narrow intra-articular access<sup>1</sup>. Recently arthroscopy of smaller joints has gained popularity. Ankle joint related symptoms and complaints are commonly encountered by Orthopaedicians. To

diagnose and treat these pathologies, arthroscopy is a common, less invasive and valuable procedure.

Anatomical variations of the structures are commonly seen in terms of distances and course around the ankle joint<sup>2</sup>. These anatomical structures (neurovascular and tendinous) may be injured during ankle arthroscopy through any portal<sup>3</sup>. Reported complication rates for ankle arthroscopy procedure have ranged from 0% to 25%<sup>4,5,6,7</sup>. Neurologic injuries, which ranged from 0.04% to 4.8% accounted for the majority of the important complications in the series studies<sup>8</sup>. Knowledge of the neurovascular structures is essential to avoid complications.

Arthroscopy of the ankle can be systematic and reproducible only when the surgeon is familiar to the intra-articular and extra-articular anatomy of ankle and when attention is given to accurate placement of the arthroscopic portals<sup>9,10,11</sup>. In this study anterior portals used for the arthroscopy of ankle were studied on cadavers and amputated limbs to compare the risk of injury to neurovascular structures and tendons.

### Material and Methods

20 ankle specimens were dissected, 16 ankles from 8 cadavers and four ankles from amputated limbs were studied. The surface landmarks such as malleoli (medial and lateral), extensor hallucis longus (EHL) and tibialis anterior muscle were identified and marked. The marked tendons were palpated to determine the site of entry and 20 ml of saline were injected into the joint to distend by using an 18-gauge needle. At each site, a portal was made using a 5 mm longitudinal skin incision and dissection was done by scissor deep to the joint. A 4 mm arthroscope was then inserted and replaced with a marker (a short matchstick) so that the track would be easily identified.

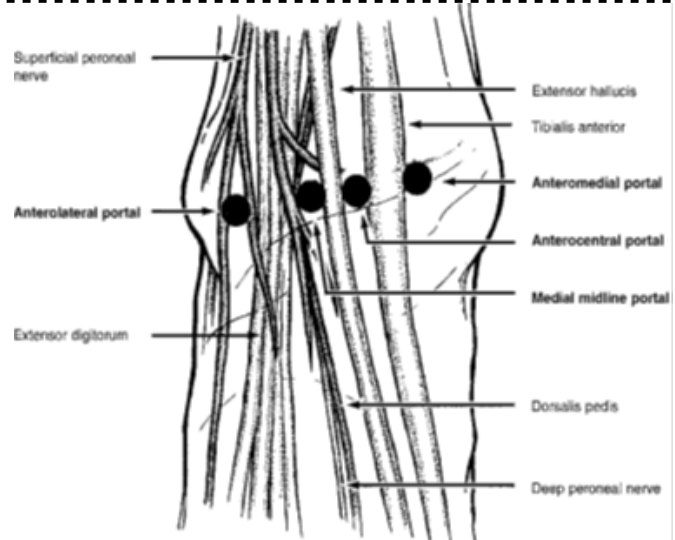


Figure 1: Anterior Portals of Ankle Arthroscopy



Figure 2: A. Injecting saline in the joint, B. Arthroscope introduced in the joint, C. Wooden markers over Portal Site, D. Neurovascular structures after dissection, E. Measurement from portal to anatomical structure  
Then skin and subcutaneous fat was dissected from underlying fascia for visualization of the muscle tendons, nerves and vessels around the joint. Throughout the dissection care was taken to preserve the dissected structures. After dissection, we identified the anatomical structures adjacent to the portal. Then we measured the distance of various structures from the portal. If some anatomical structure had two or more branches, the distance of the portal from the nearest branch was documented. All measurements were taken using digital Vernier caliper.

Four portals were used while the limb was in supine:

- Anteromedial (medial to tibialis anterior tendon): mean distance of saphenous nerve, saphenous vein and tibialis anterior tendon were measured.
- Medial Midline portal (between tibialis anterior tendon and EHL tendon): mean distance of dorsalis pedis artery (DPA), superficial peroneal nerve and tibialis anterior tendon and EHL tendon were measured.
- Anterocentral (lateral to EHL): measured mean distance of Dorsalis pedis artery, superficial peroneal nerve and deep peroneal nerve.
- Anterolateral: (lateral to the tendons of extensor digitorum longus and peroneus tertius): mean distance from portal to Lateral branch of superficial peroneal nerve (SPN) was measure.

### Observations & Results

The following data is obtained after dissection of 20 ankle specimens.

- The mean distance from anteromedial portal to the saphenous nerve, saphenous vein and tibialis anterior was 9.12mm, 5.28mm and 4.39mm respectively.
- The mean distance from medial midline portal to dorsalis pedis artery was 10.08mm, superficial peroneal nerve was 16.20mm, tibialis anterior tendon was 2.41mm and EHL tendon was 2.62mm. There were two specimens in which EHL tendon was injured during portal placement.
- Anterocentral portal was at a mean distance of 2.38mm from dorsalis pedis artery, 7.09mm from superficial peroneal nerve and 4.12mm from deep peroneal nerve.
- The Anterolateral portal was at a mean distance of 3.18mm from lateral branch of superficial peroneal nerve and in one specimen lateral branch of SPN lacerated.

Table 1: Proximity of anatomical structures from portal

Anatomical Structure	Distance (in mm)	Laceration
<b>Anteromedial Portal</b>		
Long Saphenous Vein	5.28 (1.6-11.3)	0
Saphenous Nerve	9.12 (2.0-14.0)	0
Tibialis Anterior Tendon	4.39 (1.0-10.1)	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
Tibialis Anterior Tendon	2.41 (0.6-8.4)	0
EHL Tendon	2.62 (0-5.9)	2
<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

### Discussion

The present study was geared toward studying the extra-articular anatomy of the ankle region with reference to the anterior ankle arthroscopic portals and the distances were measured between each of the respective portals and the commonly injured neurovascular and tendinous structures around them.

#### Anteromedial Portal

In our study the mean distance between the anteromedial portal and the great saphenous vein, saphenous nerve and tibialis anterior tendon was 5.28mm, 9.12mm and 4.39mm respectively. Stetson and Ferkel<sup>12</sup> stated that the anteromedial portal was made first as it is easy to establish and away from any major neurological structures. Buckingham et al<sup>13</sup> found mean distance 5.7mm of this portal from long saphenous vein and there was one laceration while 5.9 mm was mean distance from saphenous nerve and there was one case of damage to the nerve. Golanó et al<sup>14</sup> 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, there are reports of a case of lesion of the great saphenous

vein and 5 cases neurological complications during arthroscopy using the anteromedial portal. Woo et al<sup>15</sup> reported this distance to be around 10.2mm (range 1.1 to 20.2) in a study carried out in Chinese cadavers. Bharambe et al<sup>16</sup> reported that average distance from this portal to great saphenous vein and nerve was 7.7 mm with the range being 6.5 to 9.5 mm.

#### **Medial Midline Portal**

In our study the mean distance from medial midline portal to dorsalis pedis artery was 10.08 mm (range 4.0-14.4 mm), to superficial nerve was 16.20 (range 7.0-24.3mm), to tibialis anterior tendon was 2.41mm (range 0.6-8.4mm) and to EHL tendon was 2.62 (range 0.0-5.9mm). Buckingham et al<sup>13</sup> found that this portal was at a mean distance of 11 mm (range 5-15mm) from the dorsalis pedis artery. Bharambe et al<sup>16</sup> found mean distance to DPA and deep peroneal nerve was 1.7 (range being 1 to 2mm).Golanó et al<sup>14</sup> stated that the intra-articular view obtained by this portal is similar to that obtained by anterocentral portal but with lower chances of lesion to vital structures.

#### **Anterocentral Portal**

In this study the average distance between portal and dorsalis pedis artery was 2.38mm (range 1.0-7.1mm), between portal and superficial peroneal nerve was 7.09mm (range 1.1-13.5mm) and between portal and deep peroneal nerve was 4.12mm (range 1.9-8.3mm). The average distances of this portal to dorsalis pedis artery and deep peroneal nerve were found to be 0.7 (range 0-5) and 1.1 (range 0-5) in a study done by Buckingham et al<sup>13</sup> in 1997. There were 3 cases of superficial nerve laceration and 1 case of deep peroneal nerve laceration in their study. Golanó et al<sup>14</sup> discouraged this portal because of the risk of injury to superficial peroneal nerve superficially and deep peroneal nerve and dorsalis pedis artery on the deeper

plane. They stated that any variations of the arterial anatomy may also lead to vascular lacerations. Bharambe et al<sup>16</sup> found the average distance of 1.7mm from portal to deep peroneal nerve and dorsalis pedis artery. Feiwell and Frey<sup>17</sup> found the average distance of this portal from the neurovascular bundle to be 3.3mm (range, 0-10mm). In 1 case the arthroscope penetrated and in 4 cases was associated with the neurovascular bundle. Anterolateral Portal In the present study the average distance between the anterolateral portal and superficial peroneal nerve was found to be 3.18 mm (range 0.0-6.3mm) and in one case nerve was tethered. Stetson and Ferkel<sup>12</sup> stated that this portal is created just lateral to the peroneus tertius tendon at the joint level. They reported this distance to be 6.2 mm (range, 0-24mm). Buckingham et al<sup>13</sup> reported an average distance of 0.5 mm (range, 0-10 mm). They also reported 2 cases of laceration to the nerve. Woo et al<sup>15</sup> found the average distance between the portal and superficial peroneal nerve to be 5.5mm (range, 0.4 to 14.4). They stated that the anterolateral portal should be placed as near the fibula as possible to avoid injury to the nerves.

#### **Conclusion**

To conclude among anterior ankle arthroscopic portals, Anteromedial portal is safest ankle portal, medial midline portal though safe has risk of EHL tendon injury. Anterocentral has potential risk of dorsalis pedis artery injury, Anterolateral portal features a risk of SPN injury because of variability in course. Knowledge of anatomy and structures in danger with regard to arthroscopic portals can help in minimizing complications of ankle arthroscopy.

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