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# Descriptive Study on Distalmost Perforating Peroneal Artery Emphasizing Its Role in Flap Surgeries

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## SUMMARY

**Aims.** Peroneal flap with vascular pedicles is considered as a good substitute for limb reconstructions or any other soft tissue defects because of the number of perforating branches given from the PA. Purpose of this study is to evaluate the branching and communicating pattern of distal most perforating peroneal artery (PP).

**Methods**. Dissected lower limbs of 48 cadavers were studied for the course and communications of PP.

**Results**. The study encountered usual as well as variant communications of PP. In about 12% of the study sample PP continued as DPA and in about 6% of the cases it was communicated with DPA dorsal to the talar head region. The most frequent finding in the present study is PP piercing the interosseous membrane between tibia and fibula at about 6 to 6.5cm proximal to the tip of lateral malleolus. In one of the specimens it was piercing the LM at the base of LM.

**Conclusions**. The results of present study imply a cautious dissection to locate an appropriate vascular pedicle for the flap surgery as there are small communications of PP with ATA as well as DPA and PP can also take variant course. Because failure to do so may lead to accidental and serious vascular injuries.

## KEY WORDS

*Perforating branch of peroneal artery; ankle; trauma; vascular injury; dorsalis pedis artery; emergency medicine; flap surgery; reconstructive surgery*

## HIGHLIGHTS

1. Peroneal flap with vascular pedicles is considered as a good substitute for limb reconstructions or any other soft tissue defects because of the number of perforating branches given from the PA;
2. our study was focused upon distal-most perforating branch of peroneal artery and we recorded the most common distance of it piercing the interosseous membrane from the tip of LM as about 6 to 6.5 cm;
3. another observation was presence of communicating branches between PP & DPA dorsal to the head of talus making it vulnerable to sprain injuries.

## INTRODUCTION

Profound knowledge of vascular anatomy of the concerned region adds to the success rate of any surgeries, especially flap surgeries. Purpose of our study was to discover and discuss the branching & communicating pattern of distal most perforating peroneal artery (PP) emphasizing its surgical significance. Peroneal (PA) and dorsalis pedis artery (DPA) are the chosen vessels for limb salvage because of their acceptable patency (1). Peroneal flap with vascular pedicles is considered as a good substitute for limb reconstructions or any other soft tissue defects because of the number of perforating branches given from the PA (2). Way back, in 1984, Yoshimura et al. introduced PA perforator flap for soft tissue defects (3). In comparison to

anterolateral thigh flap, the PA perforator flap reduces bleeding and preserves muscle function enhancing the mobility of the flap (4). Moreover, blood vessels in distal leg and foot are of surgical importance since ankle arthroscopy is gaining popularity in recent years, to address the pathologies in and around the ankle region (5). Distal most perforating branch of peroneal artery (PP) is one among such vessels which is vulnerable to injury due to its course and communications. Any surgical procedure in the anterolateral part of ankle has the possibility of encountering PP. It has been reported that usually PP pierces the interosseous membrane (IM) between tibia & fibula approximately 5 cm above the lateral malleolus (LM) to pass downwards on the anterolateral side of the ankle region to supply it (6). This traditional course of PP along with its anastomosis with lateral tarsal artery as well as anterior lateral malleolar arteries predisposes it to sprain injuries, particularly inversion sprain injuries (7). Apart from these usual communications if there are additional as well as variant communications or if it shows any deviant course it will be an easy target for vascular injuries.

## MATERIALS AND METHODS

Appropriate design, review and interpretation of the results are fundamental for the usefulness of any study and it should follow standard ethical guidelines8. The present study structure meets the ethical standard of MLTJ. The study was conducted on 48 embalmed cadaveric lower limbs that was dissected by undergraduates over the period of five years. Extensor compartment of the leg and dorsum of the foot was examined for the course of anterior tibial artery (ATA) and DPA. In the lower part of this compartment peroneus tertius is pushed medially to observe the course of PP (distal most distal perforating branch of PA) that pierces the IM between tibia and fibula. The distance between the tip of LM and the point where the PP pierced the IM was measured using a millimetre scale.

## RESULTS

The most frequent finding in the present study is PP, a branch of PA, piercing the IM between tibia and fibula at about 6 to 6.5 cm proximal to the tip of LM. In one of the specimens it was piercing the IM at the base of LM. In four limbs ATA showed gradual thinning as it passed distally and subsequently, PP continued as DPA. In two limbs PP divided into medial and lateral divisions where the medial division continued as DPA. Additionally, in three limbs PP was communicated with the DPA over the talar head region. In one specimen PP was absent, instead a branch of ATA replaced it, which descended over the LM to ramify below it.

### Perforating Peroneal artery communicating with the ATA through lateral malleolar artery:

this was the most common type of PP observed among the 48 legs studied (**figure 1a**), it was observed in 36 lower limbs (75%). Here PP pierced the IM at the distance of 6 cm from the tip of LM. Then immediately below it received a communication from ATA, descended anterior to the tibiofibular syndesmosis and terminated by ramifying below the LM;
in two legs (4.1%) PP pierced the IM at the distance of 8.5 cm from the tip of LM (**figure 1b**). After descending for a short distance, it received a communication from ATA at the distance of about 7 cm from the tip of LM. However, its further course and termination were similar to the type described above.

### Perforating Peroneal artery continuing as DPA:

in two specimens (4.1%), a thick PP pierced the IM at 8cm proximal to the tip of LM. After a short distance, at about 6.5cm proximal to LM, it divided into lateral and medial divisions (**figure 2**). The lateral division managed the position and course of usual PP and the medial division continued as the DPA as ATA disappeared in the lower part of leg. In four legs (8.4%) PP pierced the IM at about 6-6.5 cm from the tip of LM and coursed medially to continue as DPA directly, between the LM and medial malleolus. Over the LM it furnished some small twigs to supply the area (**figure 3**). In these legs ATA was short and could not reach the foot.

### Perforating Peroneal artery communication with the DPA:

in two legs (4.2%) PP pierced the IM 6cm proximal to the tip of LM and descended anterior to the tibiofibular syndesmosis to terminate below the LM. Along its course, at the level of head of talus, it was connected to the DPA by a moderately thick communicating branch (**figure 4**); in one specimen (2.1%) PP pierced the IM 6.2 cm proximal to the tip of LM and descended anterior to the tibiofibular syndesmosis to terminate below the LM. At the level of ankle joint it was connected to the DPA by two communicating branches (**figure 5**).

### Perforating Peroneal artery replaced by a branch of ATA:

in another specimen (2.1%) the place of PP was replaced by a branch of ATA instead of the branch from PA from about 7.5 cm proximal to the tip of LM. It descended on the lateral aspect of the LM and terminated below providing small branches (**figure 6**).

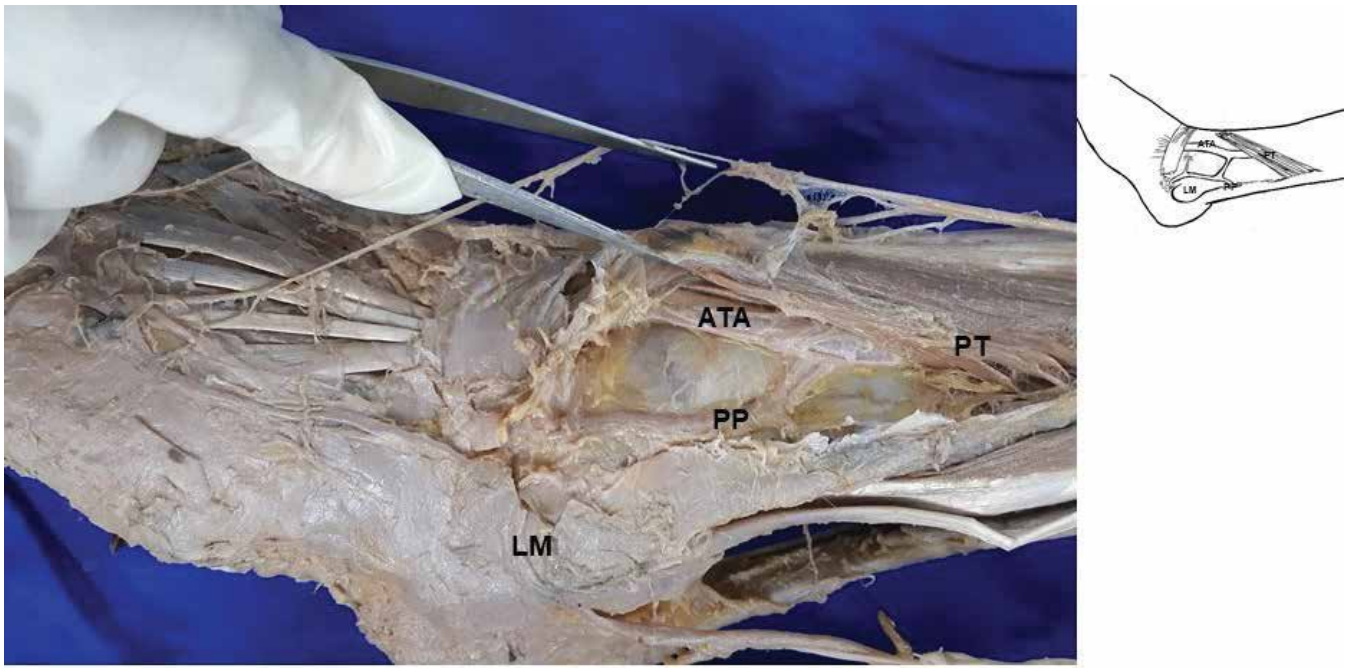


**Figure 1a.** Dissected left leg showing PP piercing the IM at 6cm from the tip of LM.
IM-interosseous membrane; ATA-anterior tibial artery; PT-peroneus tertius; LM-lateral malleolus; PP-perforating peroneal artery.

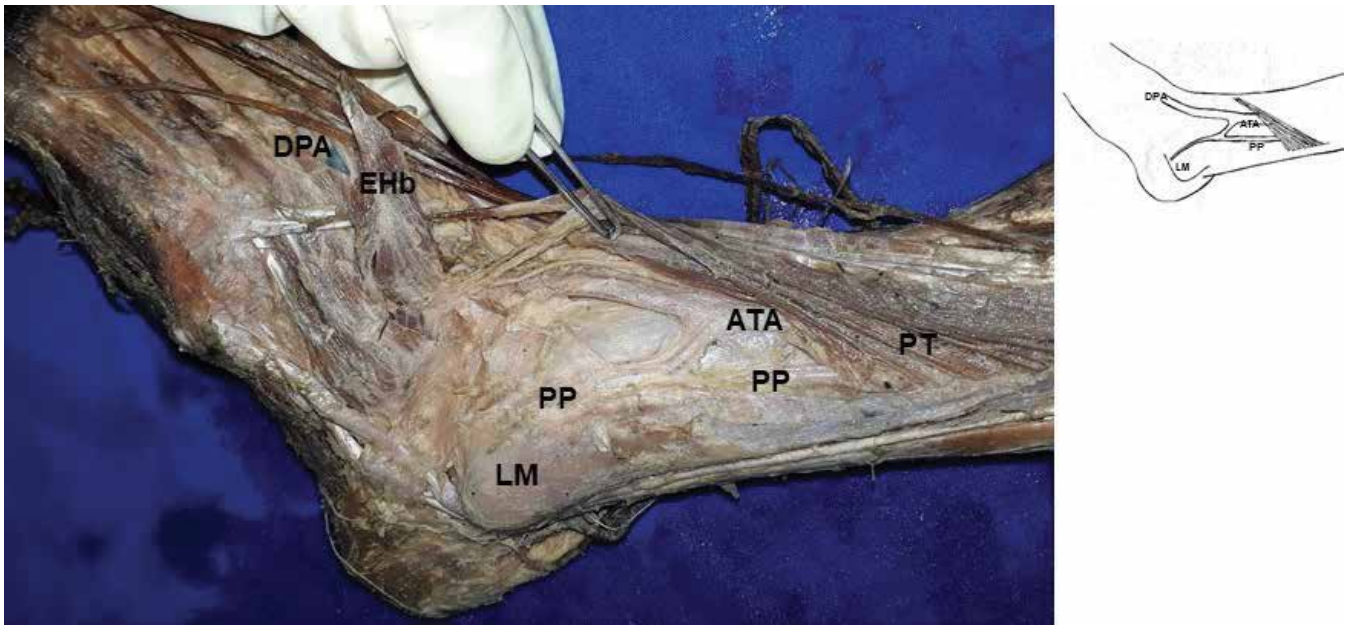


**Figure 1b.** Dissected left leg showing PP piercing the IM at 8.5cm proximal to the tip of LM. ATA-anterior tibial artery; DPA-dorsalis pedis artery; EHb-extensor halluces brevis; PT-peroneus tertius; LM-lateral malleolus; PP-perforating peroneal artery.

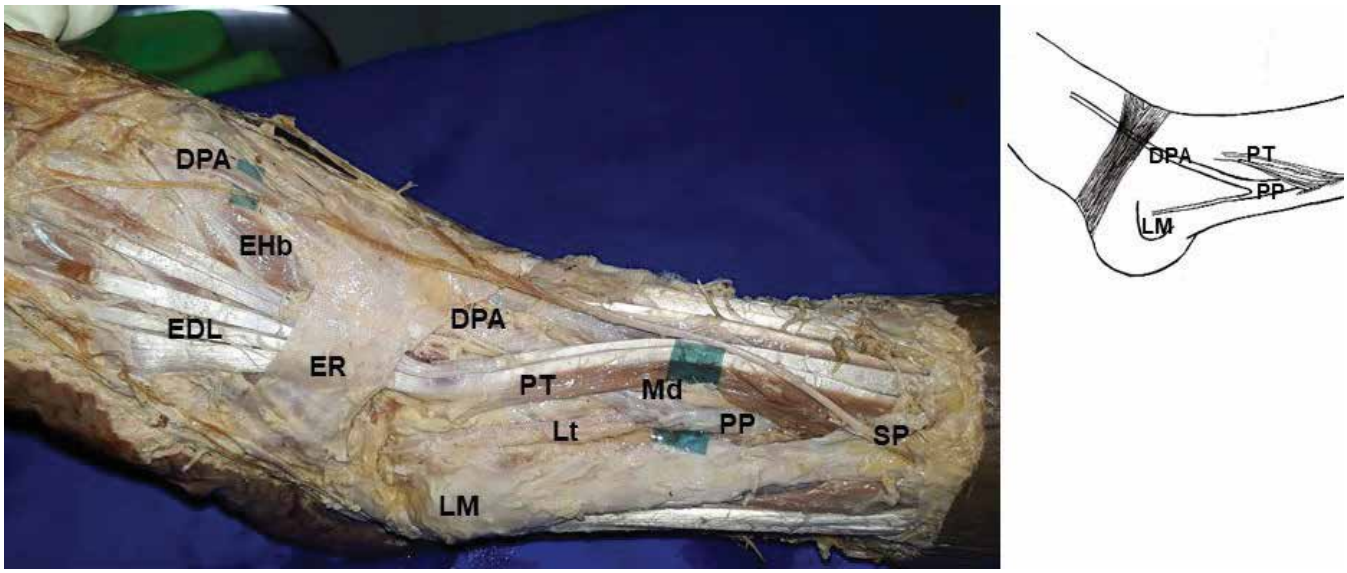


**Figure 2.** Dissected left limb showing PP dividing into lateral (Lt) and medial (Md) divisions. DPA-dorsalis pedis artery, SP-superficial peroneal nerve; ED-extensor digitorum longus; EHb-extensor hallucis brevis; PT-peroneus tertius; ER-extensor retinaculum; LM-lateral malleolus; PP-perforating peroneal artery.

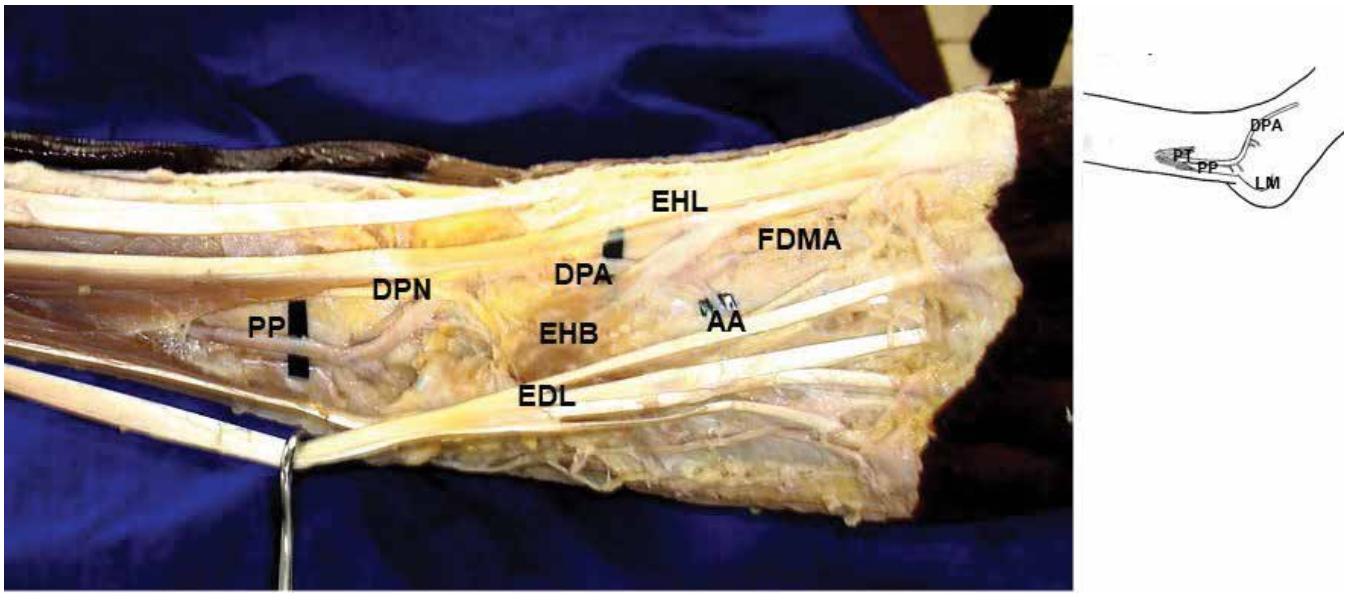


**Figure 3.** Dissected right leg showing PP continuing as DPA. PP- perforating branch of peroneal artery; DPA-dorsalis pedis artery; DPN-deep peroneal nerve; EHL- extensor hallucis longus; EDL- extensor digitorum longus; EHB- extensor hallucis brevis; FDMA- first dorsal metatarsal artery; AA- arcuate artery.

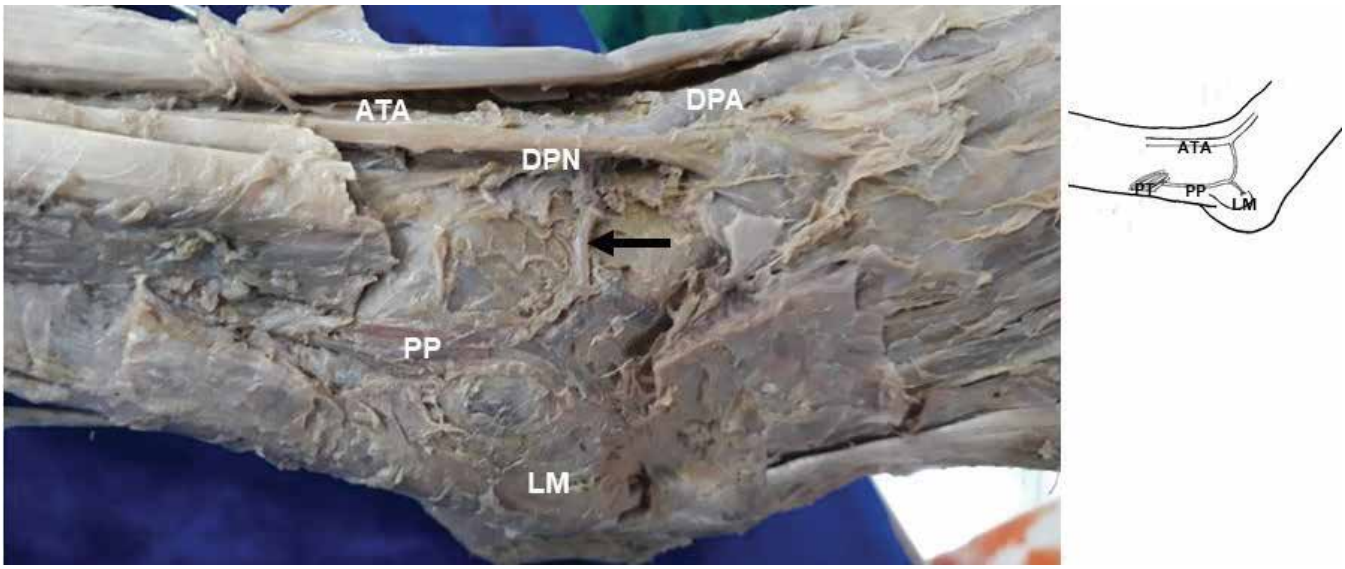


**Figure 4.** Dissected right limb showing single communication between PP and DPA. ATA-anterior tibial artery; DPN-deep peroneal nerve; DPA-dorsalis pedis artery; LM-lateral malleolus; PP-perforating peroneal artery; Black arrow – single communication between PP & DPA.

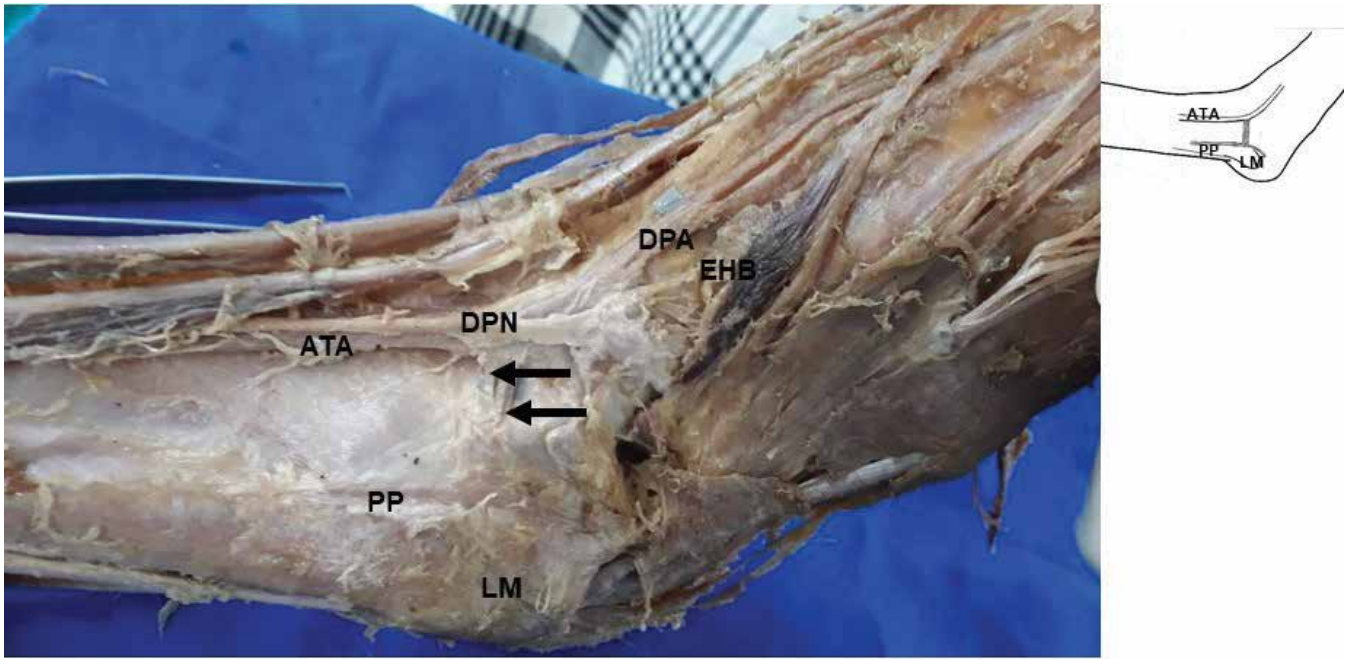


**Figure 5.** Dissected right limb showing double communication between PP and DPA (black arrows). DPA-dorsalis pedis artery; LM-lateral malleolus; PP-perforating peroneal artery; DPN-deep peroneal nerve; ATA-anterior tibial artery; EHB-extensor hallucis brevis.

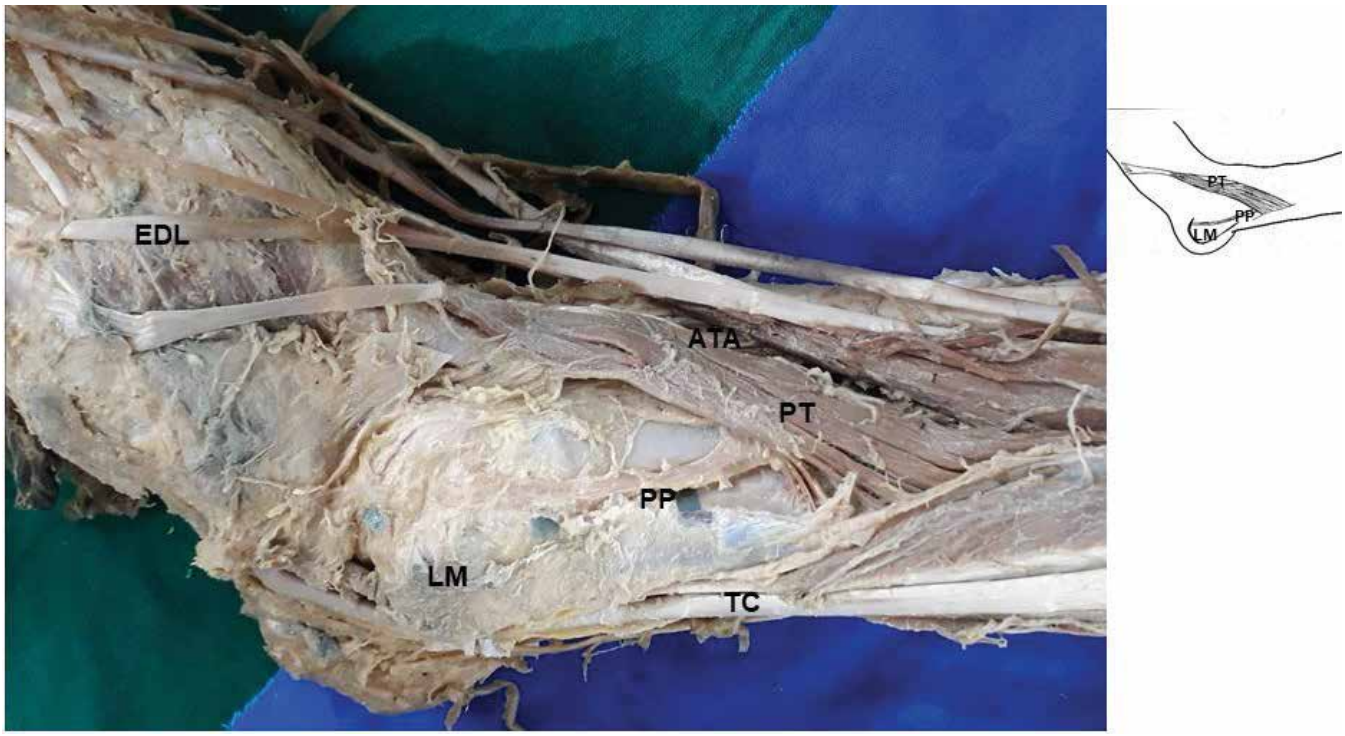


**Figure 6.** Dissected left limb showing the lateral aspect of leg and foot showing an artery from ATA taking the course distal perforating branch of PA. LM-lateral malleolus; PP-perforating peroneal artery; ATA-anterior tibial artery; PT-peroneus tertius; TC-tendocalcaneus; EDL-extensor digitorum longus.

## DISCUSSION

Reviewing the vascular anatomy in and around the foot and ankle helps to avoid and minimise complications during ankle arthroscopy or flap surgeries. A thorough knowledge of the vasculature of foot and ankle is said to be advantageous prior to the operative procedure (8). Perforator centred peroneal flaps are used for repair and restoration of bony as well as soft tissue defects (3,9). Tos et al., (2011) recommend perforator flap reconstructive surgeries to revamp areas of the body where local reconstruction procedures are not practicable (10). They encourage perforator based on propeller flaps in areas where there is minor loss of tissues since it results in less complications and functional restrictions, postoperatively, leading to a good aesthetic outcome. A perforator flap receives vascularity through a perforating branch of PA and corresponds to an area of skin supplied by it. The advantage of this flap is avoiding injury to the main artery that gives the perforator (11). Cheng et al, recommend perforator peroneal flap because they opine that it is a reliable procedure that provides lesser postoperative morbidity (12). It also yields satisfactory aesthetic results without sacrificing major blood vessels. Septocutaneous perforators anastomose with each other forming a microvascular suprafascial axis that stretches from the head of fibula to the tip of LM (11). Schaverein et al, after studying 30 specimens identified that the perforators from PA are not in clusters as reported by some studies, but they are distributed at different levels (13). Among the perforator flaps, the distal flap involves PP as a source vessel above the lateral malleolus (14). Williams et al. have stated that PP pierces the IM approximately 5 cm above the LM (6). However, in the present study PP pierced the IM at about 6-6.5 cm from the tip of LM in majority of the lower limbs. Moreover, in two specimens, It pierced IM at the distance of 8.5 cm from the tip of LM and then it communicated with ATA at about 7 cm from the LM (**figure 1a**) and in another specimen it pierced the IM at the base of LM. Masquelet et al, recommend supramalleolar perforator flap for reconstructions at the distal leg and foot (15). In their systematic review on perforator flap, Tajsic and his coworkers explained that in distally based perforator flap i.e supramalleolar flap, reconstruction failure rate is lowest compared to other perforator flaps or saphenous flaps (16).

Parikh et al, recommend anatomical knowledge about the communications and branching pattern of PP around the ankle, prior to any operative procedures in this region, because it is the main artery that gives branches over the ankle other than DPA (17). Vascular injuries at the ankle may involve ATA (18), PP19 or DPA (20). As quoted by Feliciano and his co-authors when a vascular injury is handled appropriately and in time, percentage of success rate will be high (21). When the PP continues as dorsalis pedis artery instead of ATA it courses more medially and comes into proximity with the head of talus. Thus, it makes the artery more susceptible to damage if the surgeon is unaware of this possible variation in the course of the artery. Additionally, when the PP continues as DPA its pulse may not be felt in its usual/classical position leading to misinterpretations (6). There are several reports of PP continuing as DPA in the literature (22,23,6). In a study series of Vijayalakshmi et al, DPA was observed to be the continuation of PP in 8% cases (24). Among the variations observed in the present study, the percentage of PP continuing as DPA is higher (12%) than other variations observed, as shown in **figures 2, 3**. Mowlavi et al., recommend taking dorsal-most prominent part of navicular bone as a landmark to palpate DPA and they palpated the same in 78% of the limbs they studied (25). Literature survey by the same authors found previous studies reporting impalpable DPA in 3.1 to 13.8% of healthy individuals.

Usually, PP anastomoses with the anterior lateral malleolar artery of ATA proximal to the ankle joint. However, in 75% of cases of our study (**figures 1a, 1b**) PP communicated with the ATA immediately after it pierced the IM. Moreover, the present study also witnessed communication between PP and DPA dorsal to the talar head (**figures 4,5**), making it predisposed to injury following ankle sprain.

## CONCLUSIONS

In the present study we encountered usual as well as variant communications of PP. In about 12% of the study sample PP continued as DPA and in about 6% of the cases it was communicated with DPA dorsal to the talar head region. This is an attempt to facilitate flap surgeries or other operative procedures by providing reference guide to minimize the risk of postoperative complications, because the variant vessel may get sacrificed accidentally at the cost of vascularity of the dorsum of foot.

## CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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