Variations of the Origin of the Arcuate Artery

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Background: The purpose of this study was to investigate the origin of the arcuate artery.

Methods: This cadaveric study was performed on 20 feet from ten cadavers of both sexes (age range, 61–94 years).

Results: The results indicate that the arcuate artery originated from the dorsalis pedis artery in 13 of 20 specimens (65%) and from the lateral tarsal artery in 6 of 20 (30%), and a variation in origination was noted in 1 of 20 specimens (5%).

Conclusions: This cadaveric study demonstrates that the arcuate artery can originate from the dorsalis pedis artery, the lateral tarsal artery, and one other variant. The dorsal arterial network of the lower extremity is important to consider during the overall clinical and surgical assessment of a patient. (J Am Podiatr Med Assoc 103(3): 181-184, 2013)

The blood supply to the forefoot largely depends on the dorsalis pedis artery and its branches. The anterior tibial artery forms the dorsalis pedis artery at the level of the ankle joint and lies inferior to the extensor retinaculum and the extensor hallucis brevis muscle.[1,2] The lateral tarsal artery arises at the cuneonavicular joint from the dorsalis pedis artery.[3] Distally at the first tarsometatarsal joint, the dorsalis pedis artery branches laterally to form the arcuate artery.[2] The arcuate artery, the deep plantar branch, and the first dorsal metatarsal branch are all branches from the dorsalis pedis.[3] The dorsalis pedis pulse, which is normally palpated between the extensor digitorum longus and extensor hallucis longus muscles,[1,4,5] may not be palpable when variations in the arterial anatomy are present. The arcuate artery branching off the dorsalis pedis artery is commonly noted in many anatomy textbooks and atlases, but studies have shown that the arcuate artery is not always present or that it is a continuation of the lateral tarsal artery.[3] In these cases, the dorsal metatarsal arteries are supplied by the dorsalis pedis directly, the lateral tarsal artery, or the perforating branches from the plantar arch, depending on the anatomical variations. Although the arcuate artery was previously thought to be the major blood supply to the forefoot, the lateral tarsal artery has also been found to be significantly responsible for the blood supply to the dorsum of the foot. Studies have found that the lateral tarsal artery supplies the second through fourth dorsal metatarsal arteries in 18% to 33% of cases.[3] The prevalence of the arcuate artery has been found to range from 10% to 67%.[6] This wide range is due to the lack of a unified definition of the arcuate artery. Some authors define the arcuate artery as one that originates at the cuneonavicular or tarsometatarsal joint.[7] Other authors define the arcuate artery based on the number of dorsal metatarsal arteries it supplies.[2] Determining the prevalence of the arcuate artery highly depends on an accurate definition as to the origin of the arcuate artery. The purpose of this study is to investigate the origin of the arcuate artery and the implications it has on the podiatric medical physical examination when variations in its anatomy exist.

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Materials and Methods

This cadaveric study was performed on 20 feet from ten cadavers (six men and four women) ranging in age from 61 to 94 years. Blunt dissection with a hemostat was used to assess the anterior tibial artery as it formed the dorsalis pedis. The arcuate artery was noted to originate from either the dorsalis pedis artery or the lateral tarsal artery. The extensor digitorum longus and extensor digitorum brevis were reflected to allow better visualization. The arterial network was sketched and photographed with a Panasonic SDR-H60 camera (Panasonic Corp, Osaka, Japan).

Results

The results indicate that the arcuate artery in 13 of 20 specimens (65%) branched from the dorsalis pedis artery. The dorsalis pedis artery terminated with the first dorsal metatarsal branch and the deep plantar branch (Fig. 1). The arcuate artery continued laterally and supplied the second through fourth intermetatarsal spaces.

In 6 of 20 specimens (30%), the arcuate artery originated from the lateral tarsal artery (Fig. 2A). The lateral tarsal artery branched from the dorsalis pedis artery. As the lateral tarsal artery coursed distally, it gave rise to the arcuate artery. The arcuate artery supplied the second through fourth intermetatarsal spaces. The deep plantar branch and the first dorsal metatarsal artery branched from the dorsalis pedis. There was no anastomosis between the dorsalis pedis artery and the arcuate artery (Fig. 2B). The extensor digitorum brevis and extensor digitorum longus tendons were cut to make this observation.

In 1 of 20 specimens (5%), another variation in the vasculature was noted (Fig. 3A). The dorsalis pedis artery formed the deep plantar branch and the first dorsal metatarsal artery. It was noted in this specimen that the dorsalis pedis artery further branched to supply the second intermetatarsal space. The arcuate artery was not observed to originate off the dorsalis pedis artery. The artery supplying the third and fourth intermetatarsal spaces branched from the lateral tarsal artery. The lateral tarsal artery originated as a branch of the dorsalis pedis artery (Fig. 3B).

Discussion

This cadaveric study was an extremely efficient tool for evaluating the variations of the forefoot vascular supply and its significance in surgery. Even with a small sample size, similar results were obtained compared with previous research studies. Previous studies have observed that the arcuate artery arose at either the tarsometatarsal or cuneonavicular area. In this study, the arcuate artery arose from either the dorsalis pedis artery or the lateral tarsal artery, or a completely different variant was evident. The dorsalis pedis artery was the major contributor to the formation of the arcuate artery (65%). In the study by Huber,[7] the arcuate artery arose from the dorsalis pedis artery in 54% of the sample. The arcuate artery then coursed laterally to give rise to separate branches to the second through fourth dorsal intermetatarsal spaces. An anastomosis with the lateral tarsal artery was observed in some cases. A similar study noted that the arcuate artery originated directly from the dorsalis pedis artery and branched laterally, providing vasculature to the second, third, and fourth metatarsals in 90% of the cadaveric feet studied.[2] In 30% of the lower extremities analyzed, the lateral tarsal artery branched off the dorsalis pedis artery, traversing distal to lateral. The lateral tarsal artery continued medially as the arcuate artery. No anastomosis

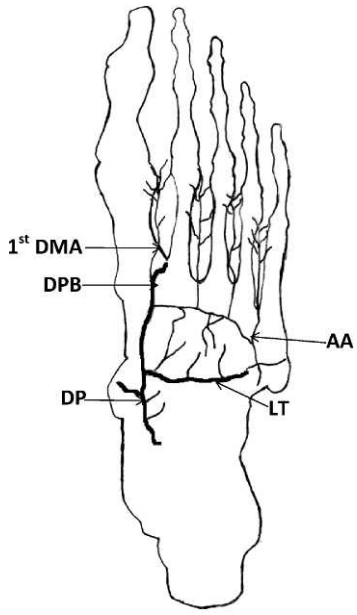

Figure 1. Schematic representation of the most commonly observed vascular supply in the forefoot. The arcuate artery (AA) branches off the dorsalis pedis artery (DP) and gives rise to the second, third, and fourth dorsal metatarsal arteries (DMAs). Anastomosis is observed with the lateral tarsal artery (LT). DPB indicates deep plantar branch. (Figure sketched by Luis Rodriguez.)

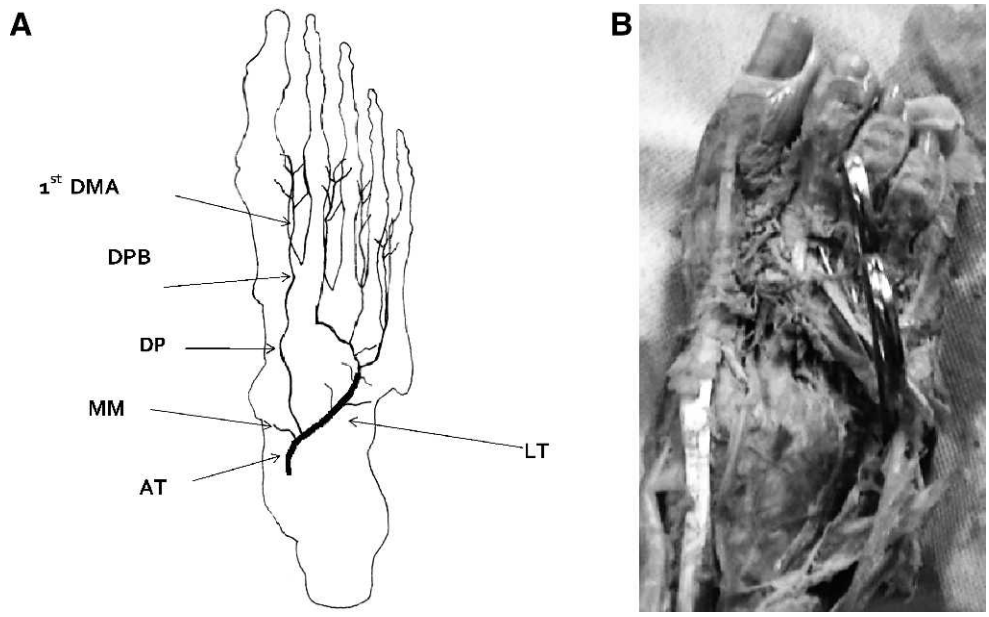

Figure 2. Schematic (A) and photographic (B) representations of the arcuate artery arising from the lateral tarsal artery (LT) and giving rise to the second, third, and fourth dorsal metatarsal arteries (DMAs). No anastomoses are apparent between the arcuate artery and the dorsalis pedis artery (DP). AT indicates anterior tibial; DPB, deep plantar branch; MM, medial malleolar. (Part A sketched by Luis Rodriguez.)

between the dorsalis pedis artery and the second dorsal metatarsal artery was observed. In this study, it was considered that the lateral tarsal artery formed the arcuate artery. Distally, the dorsal pedis artery bifurcated into the first dorsal metatarsal branch and the deep plantar branch but did not contribute to the formation of the arcuate artery.

Of the 20 cadaveric feet studied, only one

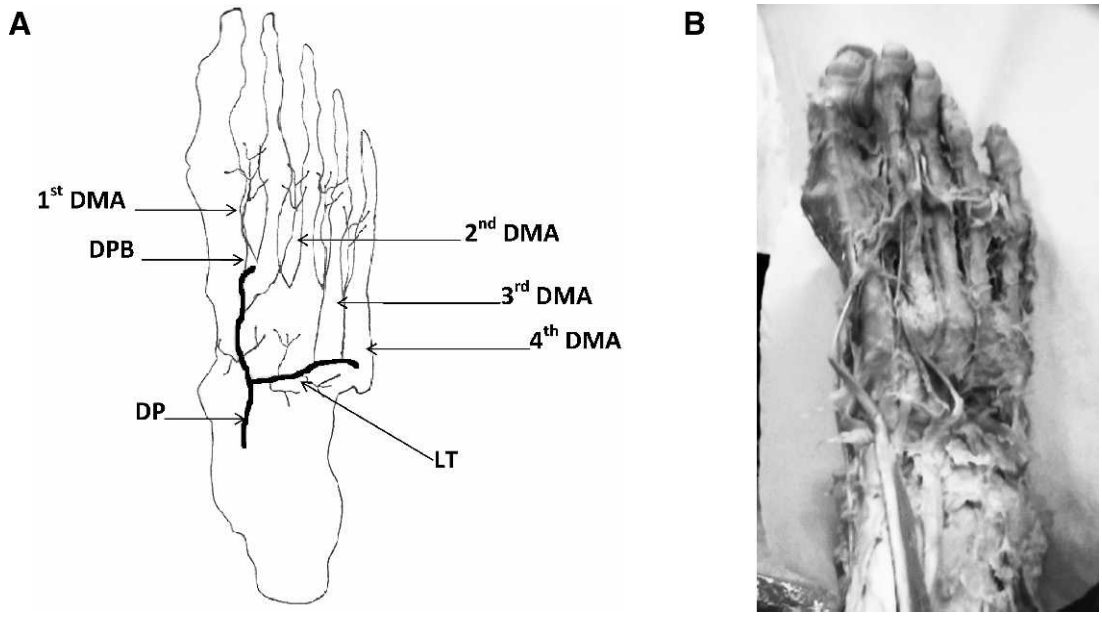

Figure 3. Schematic (A) and photographic (B) representations of the variation. The arcuate artery is absent. Branching off the dorsalis pedis artery (DP) are the first and second dorsal metatarsal arteries (DMAs). The third and fourth DMAs are branching off the lateral tarsal artery (LT). DPB indicates deep plantar branch. (Part A sketched by Luis Rodriguez.)

specimen (5%) was classified as a variant. The arcuate artery was absent and the dorsalis pedis artery continued distally, trifurcating into the first and second dorsal metatarsal arteries and the deep plantar branch. The third and fourth intermetatarsal spaces were supplied by the third and fourth dorsal metatarsal artery branches off the lateral tarsal artery. The published literature has found similar variants in as many as 16.7% of cases, which can be attributed to the larger sample size.[3] The variant observed in the present study is comparable with the variant found by Huber[7] and by Kelikian and Sarrafin[8] (in Figures 7–9, group B of the variations of the arterial pattern on the dorsum of the foot). However, in the present study, the arcuate artery was absent and the first and second dorsal metatarsal arteries branch off the dorsalis pedis artery. No anastomosis between the second and third dorsal metatarsal arteries was seen. According to Huber,[7] the arcuate artery is present but supplies only the second dorsal intermetatarsal space.

The anatomical variation of the arcuate artery is important during the preoperative evaluation of a podiatric medical patient. A basic clinical evaluation may be altered owing to anatomical variation, such as a Doppler study or any other noninvasive vascular study. These arteries are important when faced with the issue of nonhealing wounds and amputation of the digits. Yamada et al[2] found the arcuate artery to be absent in 33% of 30 limbs studied. The study by Huber[7] found the presence of the arcuate artery in 54% of limbs studied. During a digital amputation, complications may arise at the surgical area should there be a variation in the arcuate artery. According to Sage,[9] a converging semielliptic incision is made around the base of the toe with an apex dorsal and plantar incision. This incision is important because it helps protect the vasculature, as opposed to the racquet incision, which may compromise the adjacent digital blood supply.[10] The ideal ray amputation of the lateral four toes should sever only the two digital arteries to either side of the toe that is to be removed. Severing the intermetatarsal artery may result in necrosis secondary to loss of the adjacent digital branch.[10]

Universally, the dorsalis pedis artery and its branches are largely responsible for the blood supply to the dorsum of the foot. Knowledge of the anatomical variations in forefoot vasculature is crucial in the use of dorsal flaps after transmetatarsal amputations.[11,12] The use of Doppler or palpation of the pedal pulses alone to assess peripheral vascular disease may lead to misdiagnosed pathology.[7,13]

Conclusions

As our profession continues to advance in the area of limb salvage, knowledge of variations in the vasculature will be of extreme importance in choosing the best procedure and providing the best care for our patients.

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