A NOTE ON THE FORMATION OF THE PLANTAR ARTERIAL ARCH OF THE HUMAN FOOT

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TWO FIGURES

INTRODUCTION

There has been a tendency to accept without question many anatomical descriptions which have found their way into standard textbooks of anatomy. Such descriptions, even though they may be faulty, are often passed on from textbook to textbook.

Early textbooks of anatomy (Bell, 1812, and Cruveilhier, 1844) as well as modern texts (Gray, Cunningham, Piersol, and Morris) have uniformly described the plantar arterial arch as being formed by the lateral plantar artery. Observations made in the course of routine laboratory and special dissections, however, have indicated to the author that the mode of formation of the plantar arch as described in many textbooks may not conform to the conditions existing in most of the cases, and that the deep plantar branch of the dorsalis pedis artery plays the major part in the formation of this arch.

MATERIAL AND METHODS

The observations described in the following study were made on 361 feet dissected by the medical students of Tulane University during the years 1926–1927, by the students in Wake Forest College School of Medicine, 1928–1938, and also include 150 feet dissected and studied by the author at Jefferson Medical College in April, 1939. In numerous instances dissection followed the use of special injections into the
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1943. A note on the formation of the plantar arterial arch of the human foot.


Anatomy — circulatory system

Compliments

Herbert M. Vann
arteries. The size of the lateral plantar artery at the base of the fifth metatarsal bone was noted, as was also the size of the deep plantar branch of the dorsalis pedis on reaching the sole of the foot at the proximal end of the first interosseous space. The arterial arch between these two points was closely observed, note being made as to whether or not there was a diminution in size from medial to lateral limits of the arch or vice versa, and also the manner of origin of distributing branches from the arch. These observations were recorded on mimeograph drawings of the foot.

The following figures are pen drawings of the dissected foot, plantar surface.

Fig. 1 The deep plantar branch of the dorsalis pedis artery is represented here crossing from the medial to the lateral side of the foot and playing the major part in the formation of the plantar arterial arch as was found in 80.887% of the cases.

Fig. 2 The course of the lateral plantar artery and its anastomosis with the deep plantar branch of the dorsalis pedis artery at the level of the first interosseous space as it was found to occur in only 15.235% of the cases.

**OBSERVATIONS**

*First series: 211 feet (sex and race not recorded)*

In 86.7% of the feet examined in this series, the point of smallest diameter in the arteries forming the arch was found to be located near the base of the fifth metatarsal bone (fig. 1).
The medial portion of the arch was, therefore, larger than the lateral, and the deep plantar artery appeared to diminish in size as it crossed the foot to the base of the fifth metatarsal bone. The plantar metatarsal arteries, in general, were observed to arise from the deep plantar portion of the arch and pass forward to the toes. The departure of these arteries from the arch was marked by a slight angle corresponding to the direction of blood current, i.e., lateraward.

In 10.4% of the feet the arch was formed primarily by the lateral plantar artery (fig. 2). Likewise, the plantar metatarsal arteries were found to be given off from the lateral plantar portion of the arch in line with the blood current, i.e., medialward.

The point of smallest diameter in the remaining 2.8% of the cases was doubtful, and therefore they are not considered in this paper.

Second series: 150 feet (sex and race recorded)

This series includes 89 white and 61 negro feet; 135 male, 15 female; 77 right, and 73 left. The dorsalis pedis artery played the major part in the formation of the plantar arch in somewhat varying percentages, as shown in the following tables:

<table>
<thead>
<tr>
<th>Sex (150)</th>
<th>Race (150)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Male</strong></td>
<td><strong>Female</strong></td>
</tr>
<tr>
<td>Dorsalis pedis</td>
<td>102</td>
</tr>
<tr>
<td>Lateral plantar</td>
<td>26</td>
</tr>
<tr>
<td>Doubtful</td>
<td>7</td>
</tr>
<tr>
<td><strong>Right and left (150)</strong></td>
<td><strong>Negro males, right (32) left (28)</strong></td>
</tr>
<tr>
<td><strong>Right</strong></td>
<td><strong>Left</strong></td>
</tr>
<tr>
<td>Dorsalis pedis</td>
<td>58</td>
</tr>
<tr>
<td>Lateral plantar</td>
<td>16</td>
</tr>
<tr>
<td>Doubtful</td>
<td>3</td>
</tr>
<tr>
<td>Dorsalis pedis</td>
<td>57</td>
</tr>
<tr>
<td>Lateral plantar</td>
<td>27</td>
</tr>
<tr>
<td>Doubtful</td>
<td>5</td>
</tr>
</tbody>
</table>
An analysis of the above figures brings out the fact that this artery predominated in the male sex, the negro race, and in the right foot. In comparing the two series, we note a percentage of 86.73 in the first series (211 feet), against 72.67 in the second series (150 feet). Combining the two series, our findings are as follows:

<table>
<thead>
<tr>
<th>Series compared</th>
<th>1ST SERIES (211)</th>
<th>2ND SERIES (150)</th>
<th>%</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsalis pedis</td>
<td>183</td>
<td>109</td>
<td>86.73</td>
<td>72.67</td>
</tr>
<tr>
<td>Lateral plantar</td>
<td>22</td>
<td>33</td>
<td>10.42</td>
<td>22.00</td>
</tr>
<tr>
<td>Doubtful</td>
<td>6</td>
<td>8</td>
<td>2.85</td>
<td>5.33</td>
</tr>
</tbody>
</table>

**DISCUSSION**

The plantar arterial arch has been described without exception in anatomical textbooks since as early as 1812 as being formed primarily from the lateral plantar artery (Bell, 1812; Cruveilhier, 1844; Gray, '36; Cunningham, '31; Morris, '25; and Piersol, '23). The lateral plantar artery has usually been described as passing lateralward and forward to the base of the fifth metatarsal, then medially to the level of the first interosseus space, where it is said to anastamose with the deep plantar branch of the dorsalis pedis artery, forming the plantar arch. If such were the case one would expect to find the point of smallest diameter in the arch to be located between the first and second metatarsal bones (fig. 2). This condition, however, has been found by the author to apply to only a small percentage of the feet examined in the course of this investigation.

The formation of the plantar arch by the deep plantar artery has been mentioned as a variation from the normal by both Quain (1892) and Cunningham ('31). Cunningham states (page 971): "Occasionally the anterior tibial artery and its dorsalis pedis continuation are larger than normal, and the terminal part of the dorsalis pedis takes the place, more or less completely, of the lateral plantar artery."
It is of interest to note in this connection that Morris ('25) represents by diagram the plantar arch as being formed mainly by the deep plantar branch of the dorsalis pedis artery (fig. 524; after Henle, '01) rather than by the lateral plantar branch of the posterior tibial; however, this figure does not correspond with text description of the arch.

Considerable evidence supporting the importance of the dorsalis pedis artery in the formation of the plantar arch is found in the extensive work of Corsey ('13). Corsey concluded after his dissection of the feet of fifty infant cadavers that previous anatomical descriptions were applicable to only about one third of the cases examined. He found that in over half of the cases the plantar arch was formed almost entirely by the deep plantar artery while in many of the remaining cases at least a part of the interosseous arteries were derived from this artery. A somewhat larger percentage of cases was recorded by Adachi ('28), who, reporting on 125 Japanese feet, found that the plantar arch was formed by the deep plantar branch of the dorsalis pedis in 72% of his cases. Lanz and Wachsmuth derive the arch from this source in 43% of German cadavers.

Not only do the findings of the present study corroborate those of Corsey and Adachi, but the number of cases (80.887%) in which the plantar arch was formed by the deep plantar artery actually exceeds that reported by Corsey and by Adachi.

Further support of this view may be found in a consideration of the arterial circulation of the hand. Frequent comparisons have been made between the plantar arch of the foot and the deep volar arch of the hand, the major portion of which is formed by the radial artery. The radial artery on the dorsum of the hand is comparable to the dorsalis pedis on the back of the foot, particularly since each is continuous through the first interosseous space between the two heads of the first interosseus muscle to pass to the palmar and plantar surfaces respectively. The radial artery then passes from the upper end of the first interosseous space transversely across the palm to the base of the fifth metacarpal bone, where it
anastomoses with the deep volar branch of the ulnar artery, completing the deep volar arch. It is the author's belief that in the same manner the deep plantar branch of the dorsalis pedis forms the major part of its corresponding arch.

Cruveilhier (1844, page 573) stated this comparison in a more definite manner as follows: "... the dorsal artery of the foot corresponds to the carpal portion of the radial; and the plantar arch, which is continuous with the dorsal artery of the foot, represents the deep palmar arch, which is the continuation of the radial in the hand."

In the light of such comparisons and the large number of cases in which the deep plantar artery forms the plantar arch it appears that such a condition is more than an occasional occurrence. Further investigation, which is now in progress should aid in establishing the role of the deep plantar artery in the formation of the plantar arterial arch.

SUMMARY AND CONCLUSIONS

1. In a majority of the cases (80.887%) the plantar arch was found to be formed by the deep plantar branch of the dorsalis pedis artery.
2. In 15.235% the arterial arch was formed by the lateral plantar artery.
3. There was some indication that the direction of the blood current influences the manner of origin of the plantar metatarsal arteries.

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