Case Study

A Case Study of Radial Artery Absence

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Summary: A very rare case of radial artery absence in the right side with diminished development of the posterior tibial arteries on both sides of the lower legs found in a 63 years old female Japanese cadaver was described. These abnormal findings of the arteries seem to have been related systematically with the development of the arteries in the upper and lower extremities in the embryonic period. A similar case of radial artery absence has been previously reported by Charles in 1894.

In the right upper extremity of a 63 years old female subject, which was dissected at Sapporo Medical College in 1982, the radial artery was found to be absent. Furthermore, it was also found that in the lower extremity of the same subject, the posterior tibial arteries were also recognized to be incompletely developed and/or diminished on both sides.

Such an anomalous condition of the arteries as presented in this paper seems to represent not only a rare case but also one which is related to the formation of the arterial system in the extremities at the embryonic period.

Herein, the abnormal findings of the arteries will be described and discussed from the view points of embryological and bibliographical items.

Material and Observations

The brachial artery took the normal

course and gave off the inferior ulnar collateral artery normally in the right upper extremity. As shown in Fig. 1 and 2, at about 1.5cm below the bend of the elbow and near the upper limit of the pronator teres, it branched off a slender artery, about 2mm in diameter, which appeared to be the remnant of the original radial artery and which then divided itself into several small muscle branches piercing the brachioradialis and extensor carpi radialis longus. The artery corresponding to the radial recurrent artery could not be seen.

The common interosseous artery arose from the ulnar artery immediately below the ulnar head of the pronator teres, and then the median artery, a short and slender branch, started from the ulnar artery about 4mm downwards from the separating point of the common interosseous artery. The ulnar artery, passed downward to the wrist, was normal in its course and finally gave off the branch to the superficial palmar arch.

The common interosseous artery with a diameter of 2.5 mm divided into the anterior and posterior interosseous arteries. The anterior interosseous artery, about 2 mm in diameter, passed downwards on the palmar side of the interosseous membrane and as it continued down to the wrist, it sent some branches to the muscles of the deep flexor group. When the anterior interosseous artery reached the lower end of the anterior border of the radius beneath the pronator quadratus, it then changed its course suddenly by passing round the lateral border of carpus and ascending to the back of the hand (Fig. 3).

This artery now took the original course of the radial artery after the abrupt turn around the lateral capus, i.e., it passed under the tendons of the muscles of the thumb and went to the space between the first and second metacarpal bones and descended into the palm of the hand. Finally it formed the deep palmar arch.

The median artery, a slender vessel after branching from the ulnar artery ran downwards for a short distance. The distal portion of the median artery was cut off during the course of student's dissecting practice. The median, ulnar and radial nerves showed no abnormality in their course and distributions, and muscles of the forearm were also within normal range of their morphology.

In the lower extremity on both sides, as shown in Fig. 5, the posterior tibial arteries showed weak and/or incomplete development. In particular, the artery on the left side was very slender in its diameter and gave off a few muscle branches to the flexor digitorum longus as it descended on the fascial layer of the muscle, and it finally faded away in the muscle at the point of about 14 cm below the separating point between the posterior tibial artery and the peroneal artery. On the contrary, the

peroneal artery developed strongly and continued down to the plantar arteries. The nerves and muscles in the lower extremity showed no abnormality in their shape and distributions as well as in the upper extremity.

Discussion

1) Embryological items

There are few studies concerned with the developmental anatomy of the arterial system of the upper extremity in human embryo. According to Arey (1954), it is the subclavian-axillary artery that becomes the sole arterial stem of the arm in the human embryo of 5 mm, and rearrangements of the arterial system of the forearm with continuous differentiation are complete before the end of the second month (Fig. 4).

As shown in Fig. 4, the interosseous artery in the forearm appears at first, and the median artery soon branches and annexes the vessels of the hand, the digital arteries. Soon after this, the ulnar artery arises from the branchial artery and is continued into the hand to anastomose the arteries of the digits. Finally, the radial artery appears in the forearm with changing its height of origin, i.e., at first the radial artery arises at a higher level than the ulnar, but later it establishes a connection with the main trunk at or near the site of origin of the ulnar artery and the upper portion of its original stem disappears to a large extent (Gray, 1973).

In this context, it should be noted that the radial artery is late in its formation and appearance than the ulnar artery in the forearm.

On the arterial system of the lower extremity, according to Senior (1919) who carried out a detailed study on the complex development of the arterial anatomy using the eight human embryonic materials

from 6 mm to 22 mm, the axis artery or the primary arterial trunk of the lower extremity arises as a branch of the dorsal root of the umbilical artery. Following this, many embryonic arteries such as the ramus communicans superior and the ramus perforans cruris appear at the early stage of 14 mm, and give the distinction among the ischial, the profunda popliteal and the interosseous arteries, all of which were included in the axial artery at the earlier stage of the embryo. Special attention should be paid that the origin of the peroneal artery in adults can be partially traced to the interosseous artery, a basic segment of the axial artery of the embryo.

On the other hand, the posterior tibial artery in adults is the product of the union between the superficial posterior tibial artery (SPT) and the superficial posterior peroneal artery (SPP) in the proximal portion (Senior, 1919). These embryonic arteries such as the SPT and SPP arise from the profunda popliteal artery at the stage of 14 mm embryo. It means that, in spite of a short segment which is found on the region of the interosseous membrane, the peroneal artery remains the older embryonic segment than that of the posterior tibial artery in adults.

From the fact that the radial artery and the posterior tibial artery appear in more delayed stage than the ulnar artery and a part of the peroneal artery, the coexistence of the absence of the radial artery in the forearm and the incomplete development of the posterior tibial artery in the crura may be thought as a result of systematic disturbance for the development of the arterial system in the upper and lower extremities at any embryonic moment. However, of course, there are many problems that remain unsolved in the systematic and comparative study of the development and arrangement between the arterial system of the forearm

and the crus in the embryonic period.

2) Bibliographical items

As to the anatomical variation of the radial artery, a number of studies have been done so far by many researchers, e.g., excellent studies by Müller (1903) and Adachi (1928). However, almost all of them have dealt with the relationship of the superficial brachial artery or the origin of the artery, i.e., sometimes the origin of the radial artery is higher than usual; it then branches more often from the axillary or the upper part of the brachial artery than from the lower part of the latter (Gray, 1973). It seems to be a very rare case that the radial artery is absent in the forearm as described in this paper.

Previously, a case of radial artery absence in the right forearm was reported by Charles (1894) quoted in Hollinshead (1958). According to Charles, the anterior interosseous artery occupied the original place of the radial artery compensately, and the median artery after branching from the common interosseous artery pierced and afterwards accompanied the median nerve under the annular ligament (retinaculum flexorum) to the hand. The anterior interosseous artery, almost as large as the ulnar, continued downwards nearly to the lower end of the radius, then it turned abruptly outwards and obliquely downwards under the tendons of the flexors of the fingers and thumb, and finally it pursued the normal course of the radial artery.

Both the case of Charles's and our own closely resemble each other in the point of the radial artery being absent in the forearm and compensated by the anterior interosseous artery in the region of carpus and hand.

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PLATES

Explanation of figures

Plate I

- Fig. 1. Flexor aspect of the superficial layer of the right forearm. ba, brachial artery; cia, common interosseous artery; pia, posterior interosseous artery; aia, anterior interosseous artery; mn, median nerve; fplm, flexor pollicis longus muscle; pqm, pronator quadratus muscle; fdpm, flexor digitorum profundus muscle; ua, ulnar artery; un, ulnar nerve.

Plate II

Fig. 2. Flexor aspect of the deep layer of the right forearm showing the absence of the radial artery. ba, brachial artery; cia, common interosseous artery; pia, posterior interosseous artery; aia, anterior interosseous artery; mn, median nerve; ua, ulnar artery; un, ulnar nerve.

Plate III

Fig. 3. Lateral aspect of the right hand. *srn*, superficial radial nerve; *aia*, anterior interosseous artery.

Fig. 4. Schematic stages in the development of the arteries of the human arm (redrawn from Fig. 333 in Arey (1961) and slightly modified by the author, T.S.). *b*, brachial artery; *i*, interosseous artery; *m*, median artery; *u*, ulnar artery; *r*, radial artery; *d*, digital arteries.

Plate IV

Fig. 5. Posterior view of the lower extremities in which the weakness of the posterior tibial artery (pta) on both sides is shown. poa, politeral artery; ata, anterior tibial artery; pta, posterior tibial artery; fhlm, flexor hallucis longus muscle; pa, peroneal artery; tn, tibial nerve; mpa, medial plantar artery; lpa, lateral plantar artery.