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Perforator anatomy of the radial forearm free flap versus the ulnar forearm free flap for head and neck reconstruction

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Abstract. The aim of this study was to investigate the vascular anatomy of the distal forearm in order to optimize the choice between the radial forearm free flap and the ulnar forearm free flap and to select the best site to harvest the flap. The radial and ulnar arteries of seven fresh cadavers were injected with epoxy resin (Araldite) and the perforating arteries were dissected. The number of clinically relevant perforators from the radial and ulnar arteries was not significantly different in the distal forearm. Most perforators were located in the proximal half of the distal one third, making this part probably the safest location for flap harvest. Close to the wrist, i.e. most distally, there were more perforators on the ulnar side than on the radial side. The ulnar artery stained 77% of the skin surface area of the forearm, showing the ulnar forearm free flap to be more suitable than the radial forearm free flap for the restoration of large defects.

Key words: ulnar artery; radial artery; vascular anatomy; cadaver; free forearm flap; head and neck reconstruction.

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Forearm free flaps are used for the restoration of soft tissue defects in the head and neck area. Many characteristics, such as the pliability, thinness, and length of the vascular pedicle, make these flaps ideal for the restoration of these defects.[1–3] While the radial forearm free flap (RFFF) is the most used free flap, its use has disadvantages, including wound-healing problems, aesthetic deformity of the donor site, and altered sensation in the distribution area of the radial nerve.[4–7] Many of these disadvantages can be avoided by using an ulnar forearm free flap (UFFF).[6,8] The donor site shows fewer wound-healing problems, and sensation in the distribution area of the ulnar nerve is usually not affected. In addition, the ulnar aspect of the forearm is less conspicuous and less hairy than the radial aspect.

Both forearm flaps are technically easy to harvest, with 95% success rates.[1–3,6] However, the UFFF is not often used as compared to the RFFF.

There is some controversy about which artery provides the main blood supply to the hand.[9] That said, the UFFF is increasingly being recognized as an interesting alternative to the RFFF.[8,10]

Knowledge of the vascular pattern is essential for the inclusion of perforators and therefore for flap success, as well as knowledge of the perforator anatomy in order to optimize the choice between the RFFF and the UFFF and to select the best site from which to harvest the forearm flap. The aim of this study was to map the perforators that arise directly from the radial and ulnar arteries and to investigate their vascular territories. Focus was placed on the distal third of the forearm, because the location of the skin island near the wrist affords the maximum length of the vascular pedicle and allows microvascular anastomosis in the neck for the restoration of most defects in the head and neck area.

Materials and methods

Seven fresh unembalmed cadaver arms without a history of trauma or surgery were used. There were five left arms and two right arms. The skin overlying the pisiform bone and medial epicondyle of the humerus was marked with a surgical skin marker pen. To compensate for discrepancies in arm length, the forearm was divided into three segments along the line between the pisiform bone and medial epicondyle: a proximal segment, a middle segment, and a distal segment. The distal segment was further divided into a proximal part (a) and a distal part (b).

Injection technique

The brachial artery and the bifurcation of the ulnar and radial arteries were identified. The ulnar and radial arteries were cannulated and flushed with water and liquid soap until the backflow appeared clear. An isovolumetric mixture containing acetone (8%) and a two-part epoxy resin (Araldite DBF (75%) with hardener HY 956 (17%)) was then injected simultaneously into both arteries with an electrical air pump at a constant injection pressure of 150 mmHg. Different colour pigments were added to the mixture and used for each artery. Injection was continued until staining of the skin of the fingers became visible. The mixture was allowed to harden for 24 h.

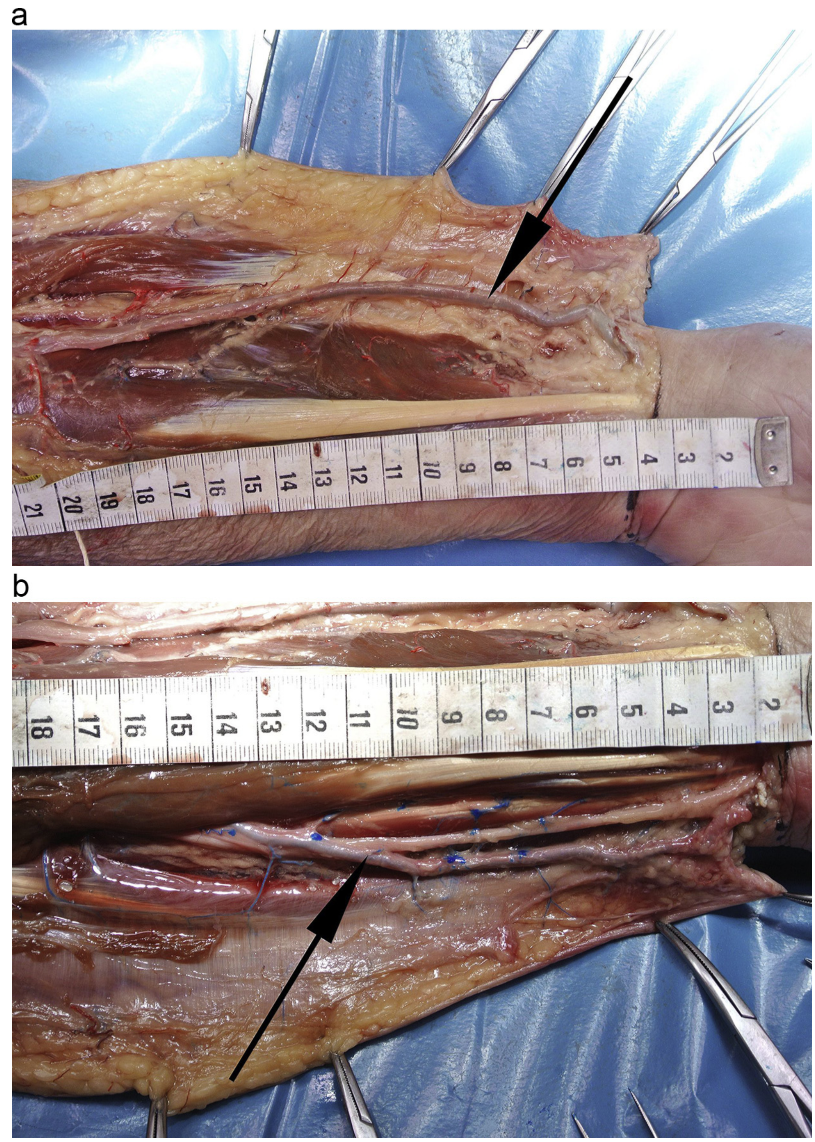

Fig. 1. Perforators of the radial and ulnar artery. (a) Radial artery with perforators to the skin (arrow). (b) Ulnar artery with perforators to the skin (arrow).

Mapping of the arteries, venae comitantes, and perforators

An incision was made on the volar aspect of the forearm in the wrist crease. A second skin incision was made from the wrist to the elbow crease midway between the ulnar and radial arteries. Medial and lateral skin flaps were raised. The radial and ulnar arteries and their venae comitantes were traced to the bifurcation at the brachial artery. All septocutaneous perforators that supplied the skin were identified and preserved (Fig. 1).

The length of the ulnar and radial arteries was measured from the bifurcation to the wrist, and the diameters of the arteries and the venae comitantes were measured at the level of the bifurcation and at the level of the wrist. The number and location of the perforators were recorded. Perforators with a diameter $\geq$0.5 mm were considered relevant for a forearm flap.

Mapping of the vascular territories

In four cases, the fasciocutaneous forearm flaps were dissected in the full circumference of the forearm, dehydrated with ethanol, and soaked in methylbenzoate overnight, to make the skin and fatty tissue transparent. The vascular territories of the arteries were mapped by measuring the surface area of stained skin.

Statistical analysis

The paired *t*-test and the Wilcoxon signed ranked test were used to analyse differences between the radial and ulnar arteries. All analyses were performed with IBM SPSS Statistics version 20.0 software (IBM Corp., Armonk, NY, USA).

Results

Diameter and length of the vessels

The mean distance from the pisiform bone to the medial epicondyle was 28.44 cm (standard deviation 2.231 cm). The diameters and lengths of the vessels of the seven cadaver forearms are listed in Table 1. The diameter of the radial artery