Journal of Plastic, Reconstructive & Aesthetic Surgery (2015) 68, 17—25

JPRAS
An International Journal of Surgical Reconstruction
www.JPRASurg.com

Anatomical basis of a proximal fasciocutaneous extension of the distal-based posterior interosseous flap that allows exclusion of the proximal posterior interosseous artery

Chao Sun [a], Yu-long Wang [b], Zi-hai Ding [b,e], Peng Liu [b], Xiang-zheng Qin [c], Hong-liang Lee [d], An-min Jin [a,*,e]

[a] *Department of Orthopaedics, Zhu Jiang Hospital, Southern Medical University, Guangzhou, Guangdong Province 510282, PR China*
[b] *Anatomical Institute of Minimally Invasive Surgery, Southern Medical University, Guangzhou, Guangdong Province 510515, PR China*
[c] *Department of Anatomy, Yanbian University Medical College, Yanbian 133002, PR China*
[d] *Department of Orthopedics, General Hospital of Chinese PLA, Beijing 100853, PR China*

Received 22 September 2013; accepted 15 September 2014

KEYWORDS
Posterior interosseous artery;
Chain-link perforator flaps;
Anatomy;
Forearm;
Hand

Summary *Objective:* The objective of this study was to provide anatomical information for the repair of small tissue defects in the hand with posterior interosseous artery chain-link perforator flaps, a proximal fasciocutaneous extension of the distal-based posterior interosseous flap, which allows the exclusion of the proximal posterior interosseous artery.
Methods: Fourteen posterior interosseous artery chain-link perforator flaps taken from human cadavers were studied by the following three methods: latex perfusion for microanatomy analysis, denture material and vinyl chloride mixed packing for cast analysis, and latex perfusion for the production of clearance specimens. Statistical analysis was performed on cutaneous perforators coming from the intermuscular septum of the extensor carpi ulnaris and the extensor digitorum communis. A cluster analysis was conducted to determine the overall distribution of perforators.
Results: There are two main clusters of perforators at a relative distance of 21% and 48% along the ulnar head-to-lateral epicondyle interval. On average, the posterior interosseous artery extends six cutaneous perforators through the intermuscular septum of the extensor carpi ulnaris and the extensor digitorum communis. Of these six arteries, two are clinically significant

* Corresponding author.
E-mail address: jinanmin2008@163.com (A.-m. Jin).
[e] An-Min Jin and Zi-hai Ding contributed equally to the manuscript.

http://dx.doi.org/10.1016/j.bjps.2014.09.042

perforators (0.5 mm or more in diameter) and are located 6 ± 2 cm proximal to the head of the ulna and 10 ± 1 cm distal to the lateral epicondyle of the humerus. Their mean diameters are 0.5 ± 0.1 and 0.6 ± 0.1 mm, with pedicle lengths of 16.8 ± 5.1 and 21.2 ± 12.3 mm, respectively. At the two main clusters of perforator-intensive sites, the vessel chains formed by adjacent perforators are parallel to the intermuscular septum of the extensor carpi ulnaris and the extensor digitorum communis.

Conclusions: This study demonstrates that the posterior interosseous artery has two main clusters of perforators in the middle and distal one-fifth of the forearm, which can be used for repairing hand defects with posterior interosseous artery chain-link perforator flaps.

Since Lu et al.,[1] Penteado et al.,[2] and Zan-colli and Angrigiani[3] independently described the original technique, the reverse posterior interosseous artery (PIA) flap has been largely applied to covering skin defects over the distal forearm, wrist, and hand due to its advantages, including versatility, good texture, large area, simple operation, ease of survival, and no need for sacrificing the main vessels.[4–19] The disadvantages of this technique include unreliable vascular anatomy as a result of damage to the small vessels or anatomical variations[3,5,15,20] and tedious pedicle dissection.[13] Additionally, because the PIA is proximally accompanied by the posterior interosseous nerve (PIN) in the form of neurovascular bundles, the hazard of cutting the PIN branches increases during pedicle dissection.[8,19,20] Sporadic reports have demonstrated that PIA[21–23] or PIA perforator[24,25] free flaps are clinically useful. However, technical difficulties have limited their widespread use. In recent years, the authors found complete vessel chains between adjacent cutaneous perforators of stem blood vessels in an anatomic study.[26] Hypothetically, flaps with cutaneous perforators of the PIA pedicle, linking vessels to the feeding artery, could be an alternative approach to the traditional reverse PIA flap for the repair of small-scale tissue defects and could avoid the disadvantages mentioned above. Although several anatomical studies of PIA flaps have been published previously,[4,20,27,28] the locations of the perforator clusters along the ulnar head-to-lateral epicondyle interval axis have not been defined. Therefore, the present study systematically studied the cutaneous perforators of the PIA using modern anatomical microscopy techniques, such as vascular perfusion, molding, and specimen clearance to provide anatomical information for clinical practice. To facilitate the identification of the cutaneous vascular chain of the PIA in clinical practice, the authors targeted the cutaneous perforators extending from the intermuscular septum of the extensor carpi ulnaris and the extensor digitorum communis, which contains an abundance of cutaneous perforators.

Materials and methods

Fourteen fresh upper-extremity specimens from men without vascular disease and a history of surgery or trauma were provided by the Invasive Surgical Anatomy Department of the Southern Medical University. The instruments used in the analysis included a surgical microscope (M520 F40; Leica Microsystems, Wetzlar, Germany), micro-instruments, general surgical instruments, a vernier calliper (digital callipers, Har-bin Measuring & Cutting Tool Group Co., Ltd., Harbin, People's Republic of China), and a digital camera (Canon 50D; Canon, Inc., Tokyo, Japan). The 14 upper extremities were amputated at the elbow and studied using the following methods: latex perfusion microdissection (10 specimens), specimen molding (two specimens), and latex perfusion for making clearance specimens (two specimens).

Microscopic dissection after latex perfusion

The brachial artery was cannulated and perfused with red latex under manual pressure until incisions within the pulp of the fingers stained red. The arm was stored in a refrigerator at 0 °C. Dissection was postponed until 24 h after preparation, and an incision was made on the ulnar and dorsal side of the forearm. The skin over the deep fascia was reflected to the radialis margin of the extensor carpi ulnaris to reveal the intermuscular septum between the extensor carpi ulnaris and the extensor digiti minimi. The fat tissue was removed carefully from the superficial fascia under a surgical microscope (16×) to observe the linking vessels. The intermuscular septum was cut to expose the PIA. Subsequently, the course of the PIA was observed, and the parameters of the septocutaneous perforators were recorded, including their location, distance from the center of the ulnar head for distal perforators, distance from the lateral epicondyle for proximal perforators, external diameter, number, cluster patterns, and pedicle length. These parameters were measured at the level of the septocutaneous perforators through the deep fascia, with the exception of pedicle length, which was measured from the point of the cutaneous branches through the deep fascia to the first branch point that traveled to the superficial fascia. The diameter of the septocutaneous perforator (artery only) was measured using calipers under the surgical microscope without stretching the cutaneous perforators. The location and diameter of the anastomosis of the dorsal branch of the anterior interosseous artery (AIA) and the PIA were also measured (Figures 1–4).

Cast specimens

The brachial artery was filled with 10 ml ethyl acetate to expand the small blood vessels, and two cast specimens were made by filling the brachial artery with denture