

Thinking Out of the Box: Use of the Radial Artery Distally to the Snuffbox as Recipient Vessel

Luigi Troisi, MD, PhD,
FEBOPRAS*†
Francesco Zanchetta, MD*
Macarena Vizcay, MD*†
Sara Stucchi, MD†
Antonio Baez, MD‡
Eugenio Pajardi, MD*†

Background: The use of the radial artery (RA) as a recipient vessel in the hand is mainly described in the snuffbox. However, we believe that employing the RA distally to the extensor pollicis longus (EPL) tendon may provide remarkable advantages.

Methods: We conducted a prospective study from June 2019 until December 2021, which included all patients who underwent reconstructive procedures with the RA distally to the snuffbox as the recipient vessel. We reviewed patients' medical records: demographics, type of trauma, defect characteristics, microsurgical procedure, reoperations, and short- and long-term complications.

Results: We found 23 patients eligible for this study; 22 patients required a reconstructive procedure due to a trauma and one for a congenital malformation. RA distal to snuffbox was always identified and judged reliable and apt as a recipient vessel. There were no issues with the anastomosis and no total flap failure in all cases. The morbidity in the recipient area was also minimal, with no mobility deficits, loss of sensation, or neuroma development.

Conclusions: The RA is the primary vessel in the dorsum of the distal upper limb; performing the anastomosis distally to the EPL tendon may offer various advantages, making the surgery safer and less invasive. (*Plast Reconstr Surg Glob Open* 2022;10:e4537; doi: 10.1097/GOX.0000000000004537; Published online 30 September 2022.)

INTRODUCTION

The hand plays an essential role in daily life and has crucial relevance in social life and the work field. In the event of severe trauma or malformations, the reconstructive surgeon often has to cope with complex defects, sometimes with a lack of one or more fingers.

In these situations, microsurgery may be the best solution, and it allows surgeons to cope with a vast and heterogeneous group of clinical conditions. Accordingly, to the defect, flaps harvested from different areas of the body may be employed.¹⁻¹⁴

*From the *Reconstructive Microsurgery Service, University Department of Hand Surgery & Rehabilitation, San Giuseppe Hospital, IRCCS MultiMedica Group Milan, Milan, Italy; †School of Specialization in Plastic, Reconstructive and Aesthetic Surgery, Milan University, Milan, Italy; and ‡General Surgery Service, Instituto Carlos Chagas, Rio de Janeiro, Brazil.*

Received for publication April 28, 2022; accepted July 27, 2022.

This paper has been presented as poster during the 76th Annual Meeting of the American Society for the Surgery of the Hand and at the 11th Congress of the World Society for Reconstructive Microsurgery, June 2022, Cancun, Mexico.

The present manuscript was exempt from IRB approval.

Copyright © 2022 The Authors. Published by Wolters Kluwer Health, Inc. on behalf of The American Society of Plastic Surgeons. This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

DOI: 10.1097/GOX.0000000000004537

As in all body surfaces, the viability of reliable recipient vessels is essential in reconstructive surgery. Different from the volar aspect of the hand, there is only one main vessel in the hand dorsum, namely the radial artery (RA). At the distal forearm, the RA runs between the flexor carpi radialis medially and the brachioradial laterally, but at the level of the carpus, the RA changes its direction, passing posterolaterally and supporting a rich dorsal arterial net.¹⁵ The RA enters in the snuffbox through the space between the radial carpal ligament and abductor pollicis longus and extensor pollicis brevis; it lies on the surface of the scaphoid and the trapezium. Then, the RA exits from the snuffbox, passing under the extensor pollicis longus (EPL) before entering in the spaces between the two heads of the first interosseous muscle. After the RA enters the space between the first dorsal interosseous muscle and the transverse head of the adductor pollicis muscle, it proceeds further to the ulnar side.¹⁶ Finally, the RA forms an anastomosis with the deep branch of the ulnar artery and constitutes the deep palmar arch.¹⁷

The harvesting of the RA as the recipient vessel is most described in the anatomical snuffbox.¹⁸ However, we believe that the use of the RA outside this anatomical

Disclosure: *The authors have no financial interest to declare in relation to the content of this article. All authors have completed the ICMJE uniform disclosure form.*

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

area and distal to the EPL tendon may have significant advantages.

In the present article, we described our experience in hand reconstructive procedures with the RA distally to the snuffbox as recipient vessel. (See Video 1 [online], which displays the anastomosis in the snuffbox.)

METHODS

We conducted a prospective study from June 2019 until December 2021, which included all patients who underwent reconstructive procedures with RA distally to the snuffbox as recipient vessel. We reviewed the patients' medical records: demographics, type of trauma, defect characteristics, microsurgical procedure, reoperations, and short- and long-term complications.

Summary statistics were calculated. Quantitative data were expressed as the mean \pm SD, and nominal data are expressed as a percentage. Analyses were performed using SPSS software version 26.0 (IBM, Armonk, N.Y.).

Surgical Technique

Surgical reconstructive procedures are usually performed under general anesthesia due to the time requested for the operation and the frequent presence of two different surgical fields.

The patient is positioned supine with the upper limb in the center of an arm table. Preoperatively, the position and course of the RA are marked with hand-held Doppler distal to the EPL tendon, in the first intermetacarpal space. Superficial veins in the same area are marked as well.

The incision marking is made with the hand in the same position as that held to block the tendons forming the snuffbox. With the hand fully pronated, the thumb is abducted by placing a folded gauze between the thumb and the index finger. This step allows straightening the tissue in the first intermetacarpal space. This straightening helps the individualization of the artery.

An explorative incision is performed with tourniquet without exsanguination and blunt dissection with scissors is performed. The branches of the superficial radial nerve and the superficial veins are identified and preserved in the subcutaneous tissue (Fig. 1).

More in-depth, the RA is identified distal to the EPL tendon and proximal to the point where it deepens in the space between the two bellies of the first dorsal interosseous muscle. At this point, the RA is isolated for a length sufficient to perform the anastomosis: the tourniquet is released allowing the evaluation of its pulsation. Before proceeding with the anastomosis, papaverine is sprinkled on the vessel, and wet gauze with warm water is left in place for at least 10–20 minutes. This way, the possible vasoconstriction that occurred during the isolation phase may have time to vanish.

After the site for the anastomosis is chosen, the distance from the recipient site is accurately measured. If the flap pedicle does not have a sufficient length, a vein graft is harvested to fill the gap.

Takeaways

Question: Is it safe to use the RA distally to the EPL tendon as the recipient vessel for microsurgery procedures in the hand?

Findings: In our article, we described our experience in hand reconstructive procedures with the RA distally to the snuffbox as recipient vessel. Our study shows that the RA distally to the snuffbox may be a reliable and safe recipient vessel for microsurgical procedures.

Meaning: Performing the anastomosis using the RA distally to the EPL tendon may offer various advantages, making the surgery safer and less invasive.

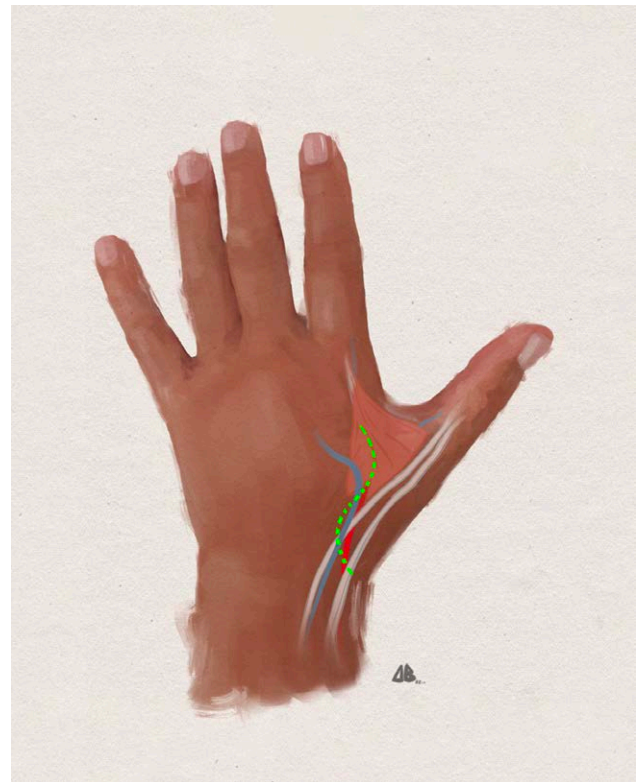


Fig. 1. Illustration of the incision.

Generally, an end-to-side anastomosis to the RA is preferred. We sometimes may identify a lateral branch of the RA distally to the snuffbox with a reliable pulsation and a good match with the artery of the pedicle of the flap; with these branches, an end-to-end anastomosis may be performed without problem.

When the use of a vein graft is required, an end-to-side anastomosis is performed between the RA and the vein graft; then, an end-to-end anastomosis is performed between the vein graft and the artery of the pedicle of the flap. Generally, the artery is accompanied by two veins. However, superficial veins are generally preferred as recipient veins for their larger caliber. The end-to-end anastomosis is generally performed for the vein (Fig. 2). A direct closure in the anastomosis site is generally possible



Fig. 2. Anastomosis in the snuffbox.

thanks to the relative laxity and redundancy of the skin in the area.

When the skin between the anastomosis site and the skin flap edges is incised, after the placement of the pedicle, the skin may be closed by direct suture. If there is too much tension and the risk of pedicle compression is too high, the pedicle should be left exposed and dressed with a greasy gauze to prevent its desiccation. In this case, the wound is left to heal by secondary intention.

Sometimes, the skin between the defect and the recipient site may be not incised and a subcutaneous tunnel can be created to allocate the pedicle. This is easier in the dorsum of the hand, where the skin is definitively looser.

Generally, after a microsurgery procedure, an immobilization is indicated for 2 weeks. When a fracture is present as well, this time may be prolonged if necessary.

RESULTS

A total of 23 patients were found to be eligible for this study. (See Table, Supplemental Digital Content 1, which shows data of the patients [ALT, anterolateral thigh; IP, interphalangeal; MP, metacarpoPhalangeal; MTP, metatarsophalangeal; P, phalanx; PIP, proximal interphalangeal; PUP, proximal ulnar artery perforator; RA: radial artery; TL, termino-lateral; SCIP, superficial circumflex iliac artery perforator; TT: termino-terminal; vg: vein graft]. <http://links.lww.com/PRSGO/C250>.) Of them, 22 were men and one was a woman; the average age of the patients was 37.8 (3–73) years. A microsurgery procedure for trauma of the hand was required for 22 patients; reconstruction with a free flap per 21 patients and a thumb revascularization for one patient. The remaining patient was a child with a thumb hypoplasia treated with a toe transfer.

In 20 cases, a free flap was necessary to treat a defect of one or more digits, including five cases where the thumb was reconstructed with a trimmed great toe flap. In one case, the defects were in the dorsum of the hand.

In 18 cases, the artery anastomoses were performed in an end-to-side fashion to the RA, whereas in five cases, an end-to-end anastomosis was chosen: in three cases to a branch of the RA and directly to the RA in the other two cases. The use of a vein graft was necessary in nine cases.

In all the cases, the RA distal to the snuff box was identified, and every time it was judged reliable and apt as the recipient vessel. Thanks to its diameter, constant patency and high flow, in no case was it necessary to change the preoperative plan. A superficial vein was easily identifiable close to the RA and suitable for vein anastomosis in all the patients. No revision surgery was necessary and no major complication was observed. The mean postoperative hospital stay was 5.5 (4–12) days and the mean follow-up was 17.6 (2–31) months.

One major complication was seen with partial flap necrosis with bone exposure which required phalanx shortening and flap remodeling. Also, one minor complication was seen with flap epidermolysis, which did not require surgical revision. No deficit of movement, loss of sensation, or neuroma were reported in the recipient area.

DISCUSSION

The RA is always present in the dorsal side of the hand according to several anatomical studies.^{15,16} Furthermore, if the RA is interrupted, the continued existence of the deep palmar branch provides excellent perfusion, particularly of the thumb. This is possible because the main vessel of the thumb, the first palmar metacarpal artery, originates from the RA after it enters the space between the two heads of the first interosseous muscle. If the RA is completely blocked, the ulnar artery—thanks to the deep palmar arch—can provide enough blood flow to the first palmar metacarpal artery, as well as to the thumb.¹⁹ In contrast, when the ulnar artery is damaged, the loss of the RA's contribution to the vascularization of the hand and thumb might create serious complications.¹⁹

As a regional reference center, we frequently deal with subacute wounds when the patients have been referred to our unit more than a week after the trauma. In these circumstances, we prefer to perform anastomoses outside the zone of injury to avoid the scar tissue and fibrosis surrounding the vessels in the area of the trauma.²⁰

The RA is our first option as a recipient vessel for defects in the dorsum of the distal forearm, wrist, and hand, as well as the first interdigital region. In addition, when the digital vessels on the radial side of the hand are not deemed as useful, the RA may be a viable option.

Regarding our experience, in 78.3% of the cases, when the RA was selected as a recipient vessel, an end-to-side anastomosis was preferred to completely preserve the vascularization of the hand, especially of the thumb. Conversely, in three of 23 cases, a collateral branch of the RA with a reliable pulsation and a good match with the artery of the flap pedicle was selected as recipient vessel; an end-to-end was performed, so that the main flow of the RA to the thumb and the hand was preserved. Finally, only in two cases, when a complete reconstruction of the thumb was required, we conducted an end-to-end anastomosis to the RA.

When the use of a vein graft was required, we generally made an end-to-side anastomosis between the RA and the vein graft; then, we performed an end-to-end anastomosis between the vein graft and the artery of the flap pedicle.

The use of the RA inside the snuffbox as recipient vessel for reconstructive surgery in the hand has been widely described¹⁸; nevertheless, its use distal to the EPL may have significant advantages. The main benefit is that the anastomoses are made in a more apt zone, with the vessels lying on the muscle bellies of the first interosseous muscle. Conversely, inside the snuffbox, the vessels tend to be in touch with rigid structure, such as the surface of the scaphoid and trapezium, increasing the risk of compression.²¹ Moreover, the presence of a strong tendon with a wide range of motion like the EPL may be dangerous in the days after surgery and, with our technique, this risk is avoided as the anastomoses are located outside and distally to the area of movement of the EPL tendon.²¹

In addition, in the snuffbox, the presence of the EPL tendon and the tendons of the first extensor compartment may be an obstacle. When the RA is divided in the snuffbox, it comes up superficial, so the anastomosis may be performed quite comfortably. Different from when an end-to-side anastomosis has to be performed in the snuffbox, the RA can not be mobilized so that the procedure has to be performed at the bottom of the snuffbox in a narrow space. This issue may be avoided by performing the anastomosis distally to the EPL tendon.²¹

Another advantage of isolating the RA distal to the snuffbox is the lower morbidity to the hand. Indeed, it avoids scars just above tendons like the extensor pollicis brevis and EPL, thus reducing the risk of adherence and stiffness to the thumb. Furthermore, the more distal the incision, the lesser the danger of injury to the major branch of the superficial radial nerve, thus reducing the likelihood of sensation loss and neuroma formation.^{22,23} Another advantage is the RA's relative distal position to the EPL, which may reduce the need for vein grafts, especially in the case of finger reconstruction.

The residual scar is generally inconspicuous because of the small size and good quality; this is largely enabled by the skin laxity in this area which allows direct wound closure without tension. For these reasons, the scar is usually well concealed.

CONCLUSIONS

The RA is the main vessel in the dorsum of the distal upper limb. Performing the anastomosis distally to the EPL tendon may offer various advantages, making the surgery safer and less invasive.

Luigi Troisi, MD, PhD, FEBOPRAS

Reconstructive Microsurgery Service

University Department of Hand Surgery & Rehabilitation

San Giuseppe Hospital IRCCS Multimedica Group

Via San Vittore 12

20123 Milan, Italy

E-mail: luigitroisi@gmail.com

REFERENCES

1. Tang JB, Elliot D, Adani R, et al. Repair and reconstruction of thumb and finger tip injuries: a global view. *Clin Plast Surg*. 2014;41:325–359.
2. Turner A, Ragowanssi R, Hanna J, et al. Microvascular soft tissue reconstruction of the digits. *J Plast Reconstr Aesthet Surg*. 2006;59:441–450.
3. Buncke HJ, Rose EH. Free toe-to-fingertip neurovascular flaps. *Plast Reconstr Surg*. 1979;63:607–612.
4. Morrison WA, O'Brien BM, MacLeod AM. Thumb reconstruction with a free neurovascular wrap-around flap from the big toe. *J Hand Surg Am*. 1980;5:575–583.
5. Wei FC, Chen HC, Chuang CC, et al. Reconstruction of the thumb with a trimmed-toe transfer technique. *Plast Reconstr Surg*. 1988;82:506–515.
6. Li X, Wang Y, You R. Application of different types of free foot flaps in hand surgery. *Microsurgery*. 1995;16:730–738.
7. Kim JT, Koo BS, Kim SK. The thin latissimus dorsi perforator-based free flap for resurfacing. *Plast Reconstr Surg*. 2001;107:374–382.
8. Koshima I, Urushibara K, Inagawa K, et al. Free medial plantar perforator flaps for the resurfacing of finger and foot defects. *Plast Reconstr Surg*. 2001;107:1753–1758.
9. Atzei A, Pignatti M, Udali G, et al. The distal lateral arm flap for resurfacing of extensive defects of the digits. *Microsurgery*. 2007;27:8–16.
10. Pan ZH, Jiang PP, Wang JL. Posterior interosseous free flap for finger re-surfacing. *J Plast Reconstr Aesthet Surg*. 2010;63:832–837.
11. Jeon BJ, Yang JW, Roh SY, et al. Microsurgical reconstruction of soft-tissue defects in digits. *Injury*. 2013;44:356–360.
12. Horta R, Silva P, Costa-Ferreira A, et al. Microsurgical soft-tissue hand reconstruction: an algorithm for selection of the best procedure. *J Hand Microsurg*. 2016;03:73–77.
13. Hung MH, Huang KF, Chiu HY, et al. Experience in reconstruction for small digital defects with free flaps. *Ann Plast Surg*. 2016;76(Suppl 1):S48–S54.
14. Troisi L, Zanchetta F, Berner JE, et al. Reconstruction of digital defects with the free proximal ulnar artery perforator flap. *Plast Reconstr Surg Glob Open*. 2022;10:e4054.
15. de Rezende MR, Mattar Júnior R, Cho AB, et al. Anatomic study of the dorsal arterial system of the hand. *Rev Hosp Clin Fac Med Sao Paulo*. 2004;59:71–76.
16. Gupta C, Ray B, Dsouza AS, et al. A morphological study of variations in the branching pattern and termination of the radial artery. *Singapore Med J*. 2012;53:208–211.

17. Jaschtschinski SN. Morphologie und topographie des arcus volaris sublimis uno profundus des Menschen. *Anatomische Hefte* 1896;7:161–188
18. Wei F, Mardini S. *Flaps and Reconstructive Surgery*. 2nd Edition. Philadelphia, PA: Elsevier; 2016
19. Miletin J, Sukop A, Baca V, et al. Arterial supply of the thumb: systemic review. *Clin Anat*. 2017;30:963–973.
20. Codina M, Lister G. Early microsurgical reconstruction of complex trauma of the extremities. *Plast Reconstr Surg*. 1986;78:285–292.
21. Khan IA, Varacallo M. *Anatomy, Shoulder and Upper Limb, Hand Extensor Pollicis Longus Muscle*. Treasure Island, FL: StatPearls; 2022.
22. Ali AM, El-Alfy B, Attia H. Is there a safe zone to avoid superficial radial nerve injury with Kirschner wire fixation in the treatment of distal radius? A cadaveric study. *J Clin Orthop Trauma*. 2014;5:240–244.
23. Samarakoon LB, Lakmal KC, Thillainathan S, et al. Anatomical relations of the superficial sensory branches of the radial nerve: a cadaveric study with clinical implications. *Patient Saf Surg*. 2011;5:28.