Technical Note The Journal of Hand Surgery (Asian-Pacific Volume) 2022;27(6):1-4 • DOI: 10.1142/S2424835522710047

The Utility of the Interosseous Arterial System for Microvascular Interposition Grafting

Brahman SIVAKUMAR[*,†,‡], Tim WANG[*], Richard LAWSON[*], David J. GRAHAM[†,§,**,††]

[*]*Department of Hand and Peripheral Nerve Surgery, Royal North Shore Hospital, NSW, Australia*
[†]*Australian Research Collaboration on Hands (ARCH), 4/75 Railway St. Mudgeeraba, QLD, Australia*
[‡]*The University of Sydney, Department of Surgery, Faculty of Medicine, Camperdown, NSW, Australia.*
[§]*Department of Musculoskeletal Services, Gold Coast University Hospital, Southport, QLD, Australia*
[**]*Griffith University School of Medicine and Dentistry, Southport, QLD, Australia*
[††]*Department of Orthopaedic Surgery, Queensland Children's Hospital, South Brisbane QLD, Australia*

Interposition microvascular grafting may be required during digital replantation or revascularisation. Although traditionally performed using venous autograft, the use of arterial segments for microvascular grafting confers a number of benefits. Here, we discuss the harvesting of such a graft from the interosseous arterial system and its use in the clinical setting.

Level of Evidence: Level V (Therapeutic)

Keywords: *Posterior interosseous artery, PIA, Arterial graft, Microsurgery, Anastomosis*

Received: Mar. 16, 2022; Accepted: Aug. 07, 2022
Published online: MMM. DD, YYYY
Correspondence to: David J. Graham
Australian Research Collaboration on Hands (ARCH)
Suite 4/75 Railway St, Mudgeeraba
QLD 4213, Australia
Tel: +61-7-55980194, Fax: +617-55963537
E-mail: davegraham80@gmail.com

INTRODUCTION

Interposition microvascular grafting may be required during digital replantation or revascularisation. Although traditionally performed using venous autograft, the use of arterial segments for microvascular grafting confers a number of benefits, including comparable calibre and muscular composition to digital arteries, and potentially increased patency rates (when extrapolated from *in vitro* and large vessel clinical studies). We discuss the technique of harvesting an arterial graft from the interosseous system and its use in the clinical setting (Fig. 1).

TECHNIQUE

Following identification and preparation of both ends of the recipient vessel, a 5–10 cm longitudinal incision is performed over the dorsal wrist, centred on Lister tubercle. Full-thickness flaps are raised down to the extensor retinaculum, in order to protect branches of the superficial radial nerve which run within the subcutaneous adipose tissue. The extensor pollicis longus tendon is identified within the third dorsal compartment by flexing and extending the interphalangeal joint of the thumb, and a longitudinal incision is performed in the extensor retinaculum overlying the fourth dorsal compartment. The tendons of the extensor digitorum communis and extensor indicis proprius muscles are retracted ulnarward, and the lateral sub-branch of the fifth division of the posterior interosseous nerve (PIN) is found on the radial and deep aspect of this compartment.[1] Accompanying this nerve is a branch from the anastomosis between the anterior and posterior interosseous arteries, the fourth extensor compartment artery (4ECA). An appropriate segment of artery (or artery and nerve, if a vascularised nerve graft is also required) is harvested to facilitate tension-free anastomoses, prior to a layered closure at the donor site. Cadaveric dissection demonstrated the feasibility of using the interosseous arterial system as a donor for arterial grafting (Fig. 2).

We have used the interosseous arterial system for revascularisation with success. A 26-year-old miner presented with an Urbaniak II avulsion injury (a devascularised digit) to his right index finger after it was caught and crushed between heavy metal sheets. Exploration revealed division of both digital neurovascular bundles; the radial neurovascular bundle was found to have sustained an extensive zone of injury, with a 20 mm defect of both nerve and artery following debridement. Thirty-millimetre segments of the terminal branch of the PIN and the distal anastomosis of the AIA and PIA were harvested at the base of the fourth dorsal extensor

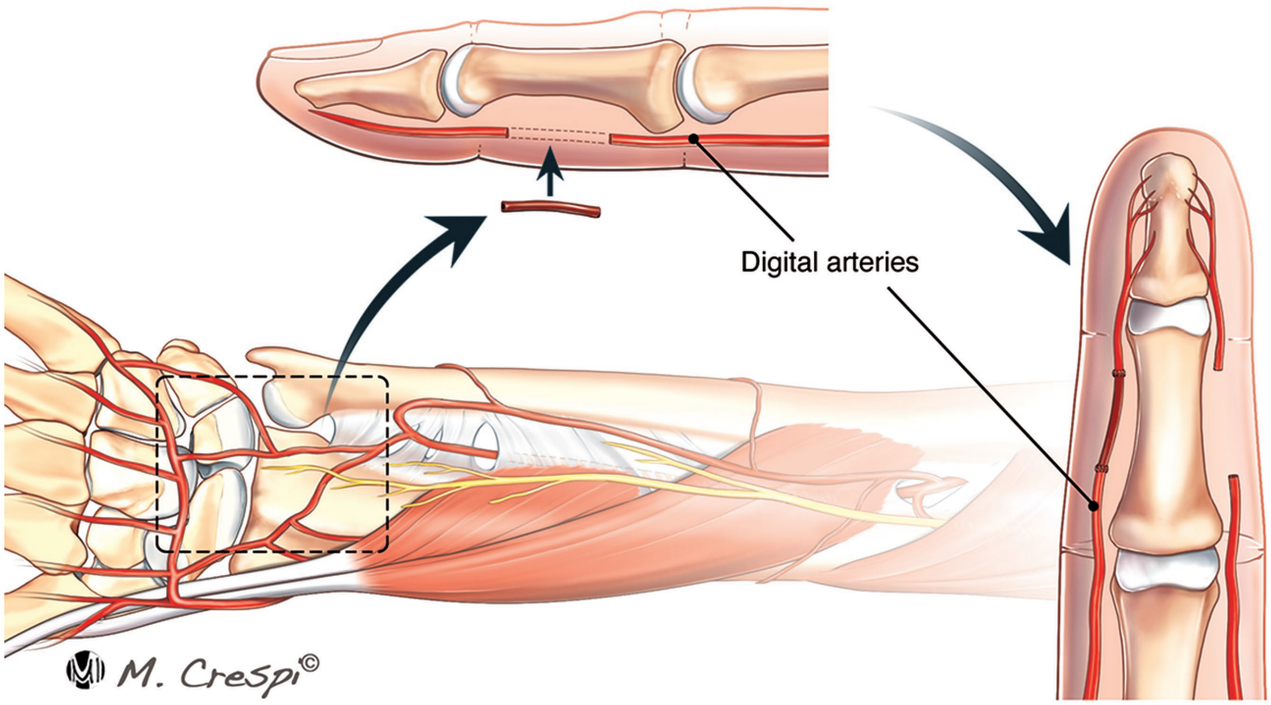

Fig. 1. Schematic representation of the interosseous arterial system, harvest and inset into the digital artery defect.

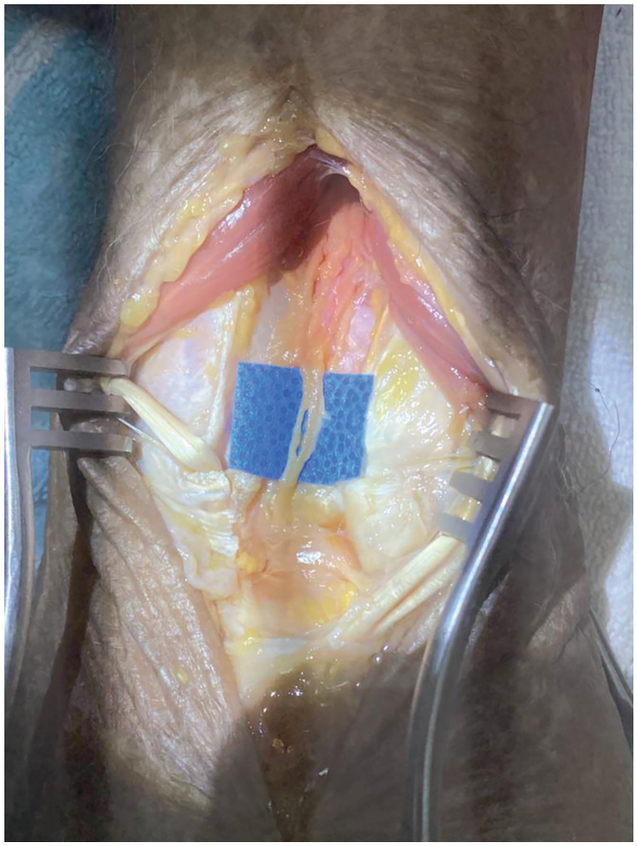

Fig. 2. Anatomical dissection of the interosseous arterial system.

Fig. 3. Clinical photo demonstrating a well-perfused digit post-grafting.

compartment, and were used to reconstitute the segmental defect. The grafts were of similar calibre, and the arterial graft was noted to be patent and flowing at the end of the operation, with the digit well-perfused (Fig. 3). No post-operative complications occurred, and the patient went on to full functional recovery.

DISCUSSION

Interposition microvascular grafting may be required during digital replantation or revascularisation to ensure adequate flow through minimally traumatised vessels. The integrity of the digital vessels is critical for successful microvascular anastomosis and procedural success. With crush or avulsion injuries in particular, the zone of endothelial damage is difficult to assess and often extends well beyond the apparent level of vessel injury.[2] Adequate debridement to healthy intima may lead to gaps in vessel continuity; excessive osseous shortening can compromise both function and aesthetics and is not recommended for defects >1 cm.[2]

Conventional sources of microvascular grafts include veins from the wrist or forearm, as well as the dorsum of the foot. The wrist and forearm veins are advantageous because of similar vessel calibre and the confinement of surgical morbidity to a single limb. However, longer segments of venous graft required for larger defects can prove troublesome. The necessary reversal of the vein graft can result in calibre discrepancies at the distal arteriovenous anastomosis, and is particularly evident following preferential venous dilation once flow is re-established. This calibre discrepancy can result in technical difficulties, turbulence and kinking, all of which can result in thrombosis and procedural failure.[3]

The use of arterial interpositional grafts has been shown to result in superior patency rates when compared to venous grafts, with preservation of volumetric flow in both *in vitro* studies and large vessel coronary artery bypass grafting.[3,4] The anterior and posterior interosseous arteries (AIA and PIA) are regional sources of arterial autograft in the setting of digital replantation or revascularisation. The use of the PIA in replantation has been documented once previously in the literature.[3] A recent cadaveric study of 34 arms found that the AIA and PIA were present in 98.5% and 92.9% of specimens, respectively.[5]

The AIA and PIA anastomose at the distal diaphysis of the radius, and yield numerous branches which course

towards the wrist.[6] We prefer the use of the 4ECA, which is of reasonable calibre (mean 0.38 mm; range 0.21–0.72 mm); has been found to be constant on cadaveric dissections; and affords the opportunity to harvest the terminal branch of the PIN if required.[6] The dimensions of the 4ECA render it suitable for grafting of the digital artery, which has been found to have an internal diameter ranging from 0.89 to 1.37 mm (measured by arteriogram) at the diaphysis of the proximal phalanx.[7] However, if this vessel is found to be absent, deficient or injured, alternate sources of autograft include the PIA itself (internal dimensions ranging between 1.50 and 1.59 mm) or its other branches.[6,7] PIA grafts of 8–10 cm length can be harvested; if the artery is of insufficient calibre or an additional arterial graft is required, an incision in the interosseous membrane affords excellent access to the AIA.

Theoretical advantages of interpositional grafting using the interosseous arteries include comparable calibre to the digital arteries, the muscular composition of the graft, minimal donor site morbidity in the same limb and potential sources of vascularised or non-vascularised nerve graft in the lateral or terminal branches of the PIN. Microvascular arterial grafting using the interosseous arterial system is a viable alternative to traditional vein grafting. Further *in-vitro* and clinical comparison would be beneficial.

DECLARATIONS

Conflict of Interest: The authors do NOT have any potential conflicts of interest with respect to this manuscript.

Funding: The authors received NO financial support for the preparation, research, authorship and/or publication of this manuscript.

Ethical Approval: NOT required.

Informed Consent: Informed consent from patient to publish their case report obtained. There is NO information (names, initials, hospital identification numbers or photographs) in the submitted manuscript that can be used to identify patients.

Acknowledgements: None.

REFERENCES

1. Elgafy H, Ebraheim NA, Yeasting RA. The anatomy of the posterior interosseous nerve as a graft. *J Hand Surg Am*. 2000;25(5):930–935. https://doi.org/10.1053/jhsu.2000.16359.
2. Lee ZH, Klifto CS, Milone MT, et al. Survival after digit replantation and revascularization is not affected by the use of interpositional grafts during arterial repair. *Plast Reconstr Surg*. 2019;143(3):551e–557e. https://doi.org/10.1097/PRS.0000000000005343.
3. Arnez ZM, Lister GD. The posterior interosseous arterial graft. *Plast Reconstr Surg*. 1994;94(1):202–206. https://doi.org/10.1097/00006534-199407000-00026.
4. Gaudino M, Benedetto U, Fremes S, et al. Radial-artery or saphenous-vein grafts in coronary-artery bypass surgery. *N Engl J Med*. 2018;378(22):2069–2077. https://doi.org/10.1056/NEJMoa1716026.
5. Al-Talalwah W, Getachew D, Soames R. The morphology of common interosseous artery and its clinical significance. *Sch J App Med Sci*. 2015;3(3B):1126–1131.
6. Sheetz KK, Bishop AT, Berger RA. The arterial blood supply of the distal radius and ulna and its potential use in vascularized pedicled bone grafts. *J Hand Surg Am*. 1995;20(6):902–914. https://doi.org/10.1016/S0363-5023(05)80136-4.
7. Leslie BM, Ruby LK, Madell SJ, Wittenstein F. Digital artery diameters: An anatomic and clinical study. *J Hand Surg Am*. 1987;12(5.1):740–743. https://doi.org/10.1016/s0363-5023(87)80060-6.