

Received: 2023.04.03

Accepted: 2023.08.16

Available online: 2023.12.10

Published: 2024.01.10

Evaluating Arterialized Vein in Thumb Replantation using Indocyanine Green Angiography: A Case Report

Authors' Contribution:

Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABDEF 1 **Alfio Luca Costa**
BDEF 2 **Michele Rosario Colonna**
BDEF 1 **Vincenzo Vindigni**
BDEF 1 **Cesare Tiengo**
BDEF 1 **Giuseppe Sofò**
BDEF 1 **Federico Ricci**
BDEF 1 **Franco Bassetto**

1 Clinic of Plastic Surgery, Department of Neuroscience, Padua University Hospital, Padua, Italy

2 Department of Human Pathology and Diseases of the Adult, the Child and the Adolescent, University of Messina, Messina, Italy

Corresponding Author: Alfio Luca Costa, e-mail: alfiolucacosta.alc@gmail.com

Financial support: None declared

Conflict of interest: None declared

Patient: Male, 44-year-old
Final Diagnosis: Amputated thumb
Symptoms: Amputated thumb
Clinical Procedure: —
Specialty: Plastic Surgery • Surgery

Objective: Unusual clinical course

Background: The absence of valid vessels for the anastomosis constitutes a contraindication to replantation, but the need for arterial vessels in good condition has recently been questioned and some authors have proposed the arterialization of the veins with promising results. However, this method is not routine in replantation and it is unclear what conditions can establish venous congestion and loss of the replanted segment.

Case Report: We detail a case where indocyanine green aids in evaluating arterialization of a vein during thumb replantation in a 40-year-old smoker following a crush injury. Multiple attempts to anastomose the princeps pollicis and its collateral vessel failed due to a thrombus formation, leaving the finger non-perfused despite urokinase treatment. To confirm the absence of reperfusion, we administered 0.3 mg/kg of indocyanine green through an upper limb peripheral vein. Observing no reperfusion, we located a suitable radial dorsal vein and performed an arteriovenous anastomosis at the proximal phalanx level. Indocyanine Green Angiography (IGA) revealed a slightly delayed reperfusion but a effective venous outflow. We did not consider it necessary to perform additional venous anastomoses other than the single dorsal radial venous anastomosis.

Conclusions: This single case report shows the potential of indocyanine green as a valid aid to evaluate the perfusion of the replantation and also any early venous congestion, being able to modify the operative plan accordingly.

Keywords: Amputation, Traumatic • Indocyanine Green • Replantation • Thumb

Full-text PDF: <https://www.amjcaserep.com/abstract/index/idArt/940622>



1127



5

9



Publisher's note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher

Background

In the case of a digital amputation, the arterial vessels can be irreparably compromised in the amputated segment. Sometimes it is impossible to perform an arterial anastomosis even with the interposition of a long venous graft [1]. Although the absence of anastomosed vessels constitutes a contraindication in replantation, the need for arterial vessels in good condition has recently been questioned in recent literature, where some authors have proposed the arterialization of veins with promising results [2-3]. However, this method of rescuing the amputated segments is not routine, and it is not clear what conditions can establish venous congestion [3]. Indocyanine green angiography (IGA) is increasingly used as a monitoring technique for free flaps and mastectomy flaps, proving sensitive in detecting perfusion problems and venous congestion [4,5]. In this case report, we present the potential of indocyanine green in assessing a thumb replantation arterialization of a vein in a 40-year-old smoker patient following a crush trauma.

Case Report

A 42-year-old right-handed man who was a manual worker suffered an amputation at the level of the proximal phalanx of the right-hand thumb following a crushing injury involving an industrial combine harvester hood. The patient presented with a multifragmentary fracture of the proximal phalange. The stump was attached to the hand only by the flexor pollicis longus tendon.

The stump presented an interruption of the princeps pollicis artery at its bifurcation. After careful fencing of the margins, we performed fracture osteosynthesis using 2 K-wires and extensor tendon suture. We performed a vein anastomosis on the dorso-ulnar aspect of the thumb. We attempted the arterial anastomosis between the princeps pollicis artery and the radial collateral artery because the ulnar one was disrupted at several points along its entire length. Before the anastomosis completion, a 500-mg bolus of ASA i.v. and low-molecular-weight heparin was administered. Following the anastomosis, the finger did not reperfuse due to formation of a thrombus distal to the anastomosis. The selective intraluminal administration of urokinase did not achieve the desired clinical outcome, leaving a white, non-perfused finger.

We administered 0.3 mg/kg of indocyanine green in a peripheral vein of the upper limb to document the absence of reperfusion of the finger. Therefore, a radial dorsal vein of a caliber congruous to the princeps pollicis was identified, and arteriovenous anastomosis was performed at the proximal phalanx level. The finger showed signs of early reperfusion, turning pink in color, with bleeding after needle pricking (Figure 1).



Figure 1. Appearance of the finger immediately after the arteriovenous anastomosis, with pink color and positive refill test.



Figure 2. ICG angiography immediately after the arterial revascularization. The indocyanine green shows the arterial flow that from the artery princeps pollicis revascularizes the thumb through one of the dorsal veins. The apex of the thumb is more intensely perfused in its radial portion, probably because a radial dorsal vein was used for arteriovenous anastomosis.

The repeated IGA documented a slightly delayed reperfusion compared to the non-amputated fingers and persistence of indocyanine green longer than in the rest of the hand (Figure 2). However, within 5 min, a progressive reduction in the intensity of the green was found, which indicated a slower but effective venous drainage at the time of reperfusion. Based on the IGA examination, we did not consider it necessary to

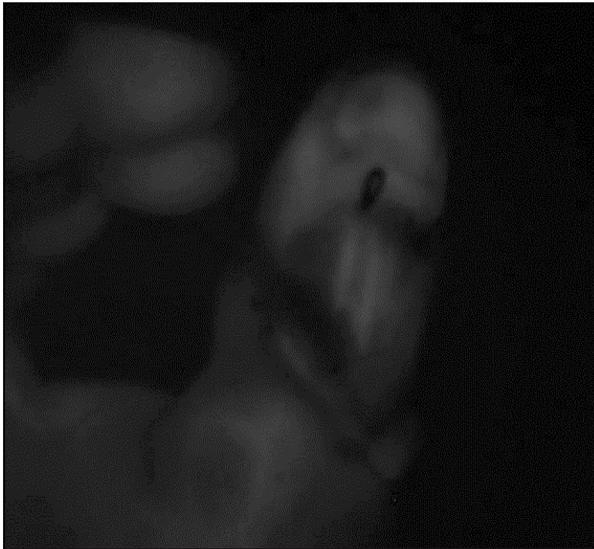


Figure 3. Angiographic picture 2 minutes after ICG injection.



Figure 4. Angiographic picture 5 minutes after ICG injection, showing slowed but effective venous drainage.

perform further venous anastomoses in addition to the single venous anastomosis on the dorso-ulnar aspect of the thumb (Figures 3, 4). The procedure was completed by suturing the digital nerves, along with the volar and dorsal skin.

In the early postoperative hours, we found a slight venous congestion, which was resolved on the first postoperative day. The wound healed without any complication in 2 weeks (Figure 5).

Discussion

In traumatic hand surgery, it is accepted practice to attempt even technically complex replantations in the case of thumb



Figure 5. Follow-up at 2 weeks after stitch removal, showing optimal wound healing.

injuries, even in conditions in which finger replantation is not favorable [1]. The loss of the thumb implies a hallux or second toe-free transplant to restore the opposition and grip function of the hand [6]. Although functionally satisfactory, these interventions involve a second surgery with the loss of a finger in a healthy area [6]. Another alternative to the sacrifice of a finger is a local flap, such as the posterior interosseous osteocutaneous flap, but with suboptimal results [7].

In thumb replantations where the distal arterial vessels are irreparably compromised, the possibility of using an arterialized vein for anastomosis can be considered to rescue the segment [2,3]. Experimental studies have demonstrated that veins, in contrast to arteries, are more prone to rupture than to stretching. As a result, in the event of a laceration trauma, it is plausible that veins may experience less severe damage compared to arteries [8]. If there are no available arteries but only veins, it is possible to use the arterialized veins similarly to the venous flaps [2,3].

The arterialization of a vein in finger replantation or degloving injuries is reported in less than 20 cases in the literature [3]. Still, the physiological mechanism underlying acute reperfusion and how this occurs is unclear, as are the conditions that can lead to venous congestion and loss of the replanted segment [2,3].

Indocyanine green fluorescence angiography (ICGA) uses a dye administered intravenously that emits diffuse fluorescence when exposed to light with wave frequencies close to infrared (NIR). The device is equipped with a camera that allows one to evaluate, in this way, the perfusion of tissue in real time and is an accepted tool for intraoperative evaluation of mastectomy flaps and free flaps [4,5].

In this context, the application of the ICGA has made it possible to have a dynamic picture in which the arterial flow of the replanted segment and venous congestion can be found intraoperatively, and it is possible to modify the surgical plan itself.

ICG angiography has recently been used for the study of arterialized venous flaps, proving reliable in the study of the vascular tree of the venous flaps and allowing modification of the operative plan to avoid venous congestion and flap necrosis [9]. Similarly, in our clinical case, the use of indocyanine green angiography guided the surgical choice toward an arteriovenous anastomosis rather than regularization of the stump.

Conclusions

Indocyanine green is a well-established tool for assessing arterial and venous blood flow and already has several fields of application in microsurgery. Here, reported a possible application

of indocyanine green as a valid tool to evaluate arterial inflow and venous outflow in an arterialized-vein replantation case.

Due to its low plasma half-life, indocyanine green angiography can be used several times during the same surgical procedure. In complex traumas, it can aid in evaluating the perfusion of replantation and in assessing any early venous congestion, which would require the identification of other veins for anastomosis or the early application of methods to counteract venous congestion (eg, removal of the nail plate, leeches).

This new application of IGA is very promising, but further studies are needed to define the real role of indocyanine green in complex limb trauma and replanting.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

References:

1. Sears ED, Chung KC. Replantation of finger avulsion injuries: A systematic review of survival and functional outcomes. *J Hand Surg Am.* 2011;36(4):686-94
2. Wang X, Zhang P, Zhou Y. Replantation of a circumferentially degloved ring finger by venous arterializations. *Indian J Orthop.* 2013;47:422-24
3. Fakin R, Gazzola R, Calcagni M, et al. Replantation by palmar arteriovenous anastomosis in complex finger amputations. *Chir Main.* 2015;34(5):240-44
4. Mazdeyasna S, Huang C, Paranzino AB, et al. Intraoperative optical and fluorescence imaging of blood flow distributions in mastectomy skin flaps for identifying ischemic tissues. *Plast Reconstr Surg.* 2022;150(2):282-87
5. Chattha A, Bucknor A, Chen AD, et al. Indocyanine green angiography use in breast reconstruction: A national analysis of outcomes and cost in 110,320 patients. *Plast Reconstr Surg.* 2018;141(4):825-32
6. Troisi L, Mazzocconi L, Mastroiacovo A, et al. Beauty and function: The use of trimmed great toe in thumb and finger reconstruction. *Plast Reconstr Surg Glob Open.* 2022;10(9):e4540
7. Costa AL, Colonna MR, Vindigni V, et al. Reverse posterior interosseous flap: Different approaches over the years – a systematic review. *J Plast Reconstr Aesthet Surg.* 2022;75(11):4023-41
8. Mitchell GM, Morrison WA, Papadopoulos A, O'Brien BM. A study of the extent and pathology of experimental avulsion injury in rabbit arteries and veins. *Br J Plast Surg.* 1985;38:278-87
9. Gornitsky J, Beauchemin G, Chollet A, et al. The use of indocyanine green angiography in arterialized-venous free flaps: Case report and insight into flap vascular physiology. *JPRAS Open.* 2022;32:116-21.