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CASE REPORT

A rare case of finger ischemia following bypass procedure with autologous vein graft for thumb revascularization: a case report and brief review of the literature

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Abstract

This case report aims to point out the importance of having in mind anatomical variation in the blood supply to the hand even in emergency settings. A 39-year-old patient presented at our emergency department with a wound on the distal anterolateral third of the left forearm with skin loss, degloving injury of the thumb starting from the 1st metacarpal, exposure of the proximal two thirds of the 1st metacarpal bone, and both radial and ulnar digital arteries of the thumb damaged. A 10-cm-long vein graft was anastomosed in termino-later fashion between the dorsal branch of the radial artery and the uninjured distal part of the ulnar collateral digital artery of the thumb, successfully re-establishing its blood supply. Starting from the 1st postoperative day, the thumb was warm and pink while the other fingers were pale and capillary filling was absent. An urgent arteriography of the left upper extremity demonstrated the presence of normal radial artery, hypoplastic ulnar artery, dominant median artery, and absence of vascularization of the 2nd, 3rd, 4th, and 5th fingers. By the end of 2nd week, the patient underwent amputation of the four fingers at the distal metacarpal level. Anatomical anomalies of hand arterial blood supply are not uncommon, even though rarely reported in literature. Therefore, an instrumental study should be performed before attempting any arterial intervention even in emergency settings. Nevertheless, further studies should be performed to identify ready-to-use tools to make surgeons aware of any anatomic variations in order to avoid such complications.

Level of Evidence: Level V, therapeutic study.

Keywords Hand surgery · Microsurgery · Thumb replantation · Surgical complication · Ultrasound

Introduction

Considering the contribution of each digit to the overall hand function, the thumb has the major part, accounting for 40% of total [1, 2]. The human hand can carry out unique tasks such as pinching, grasping, and circumduction thanks to the anatomy of the thumb [1, 2]. Loss of the thumb as a result of trauma causes a significant functional loss and a massive decrease in the individual life quality. Therefore, thumb replantation should be attempted in all cases, whenever possible [2–4].

Revascularization of the thumb is the primary step during the replantation process. While sharp- and guillotine-type injuries enable a relatively easier and successful anastomosis of vessels, severe avulsion and crush injuries are more challenging for surgeons [1–4]. In these types of injuries, a long arterial segment is often involved, which makes direct suturing usually unfeasible. Among the different surgical strategies available, bypassing the segmental arterial defect with an autologous vein graft is one of the best options. [4, 5] However, anatomical variations of the arterial supply of the hand are not uncommon; which may lead to unexpected complications following this type of surgical approach [6]. Nevertheless, the acute ischemia of hand after replantation of the thumb with a vein graft is a very rare complication, and to the best of our knowledge, no cases of acute ischemia of all the four fingers have been described in literature yet. [7]

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Case report

A 39-year-old patient was brought to the emergency ward at our Institution after trauma to the left hand caused by a roller machine. After initial management of the patient and stabilization of vital parameters, physical examination revealed a wound on the distal anterolateral third of left forearm with skin loss, degloving injury of the first left finger extending until the 1st metacarpal level, and exposure of the proximal two thirds of the 1st metacarpal bone. Flexor and extensor tendons of the thumb were intact. Superficial wounds were also present on the radial aspect of the distal phalanx of the 2nd finger and tip of the 4th finger. The distal phalanx of the 3rd finger was also exposed. The distal part of the 1st metacarpal and the shaft of proximal phalanx of the 2nd finger were also fractured (Fig. 1).

Approximately 4 h after the trauma, the patient was brought into the operating room. Under brachial plexus anesthesia, the fractures were reduced and fixed with K-wires. Microscopic evaluation demonstrated the complete lesions of both radial and ulnar digital arteries of the left thumb. A 10-cm-long vein graft was harvested from the anterior aspect of the left forearm and it was anastomosed in termino-lateral fashion between the dorsal branch of radial artery and the uninjured distal part of the ulnar collateral digital artery of the thumb (termino-terminal anastomosis), re-establishing the blood supply to the thumb (Fig. 2). The skin defect on the anterolateral aspect of the forearm was covered using a skin graft taken from the ipsilateral arm, and the wounds on the 2nd and 4th fingers were sutured. A Kutler flap was performed to cover the exposed distal phalanx of the 3rd finger. Immediately after surgery, a cast with the thumb included was applied.

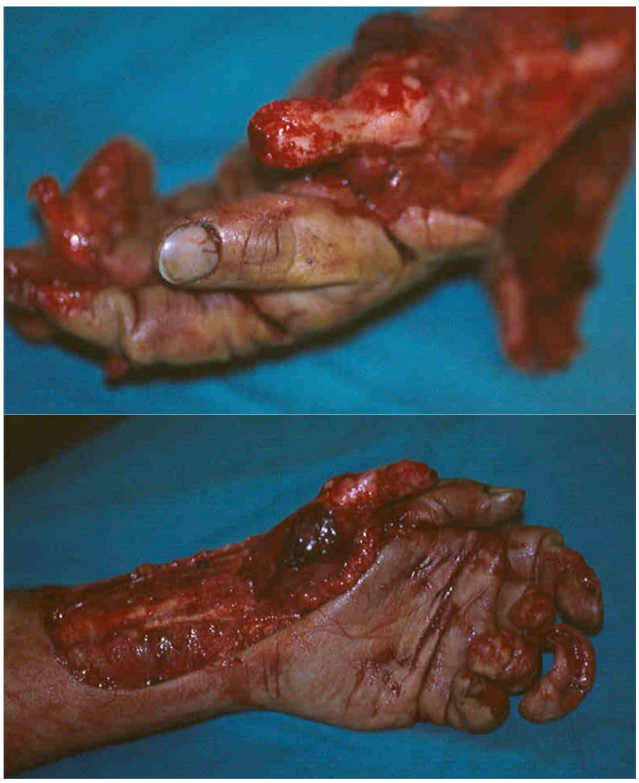

Fig. 1 Hand appearance at the Emergency Department

In the 1st postoperative day (POD), the thumb was warm and pink. However, the other fingers were pale and capillary filling was absent. An urgent arteriography of the left upper extremity was performed showing the brachial artery trifurcating at the level of the elbow giving a normal radial artery, a hypoplastic ulnar artery, and a dominant median artery, which was likely to be the main branch and the main blood supply of the palmar arch that was providing blood flow only to the proximal part of palm and the hypothenar region. Vascularization of the 2nd, 3rd, 4th, and 5th fingers was absent, potentially as a consequence of blood steal from the vein graft, which appeared to be patent and the thumb was fully vascularized. Therefore, no anastomosis revision was performed, having in mind the risk of jeopardizing the thumb vascularization and with no assurance to restore that of the other fingers (Figs. 3 and 4).

Anticoagulant therapy was continued and hand was kept warm all the time. Thumb vascularization was normal. However, no improvement was observed in the other fingers. On the 7th POD, necrosis reaching the proximal phalanges was evident (Fig. 5). At the end of the 2nd week, necrosis of the 2nd, 3rd, 4th, and 5th fingers was well established and the patient underwent amputation of the four fingers at the distal metacarpal level. After wound healing, the patient was provided with hand prosthesis.

Discussion

Venous grafting has been a useful technique with low complication rate for thumb replantation, especially for avulsion type injuries [8, 9]. In our case, the success of a well-performed thumb replantation was overshadowed by the unexpected ischemia of all other fingers. It is known that the arterial supply of the fingers derives mainly from superficial palmar arch (SPA) [6, 10]. Numerous studies have been performed to demonstrate the anatomical

Fig. 2 Ten-cm-long vein graft used for the anastomosis between dorsal branch of radial artery and collateral ulnar digital artery

variations of the SPA [6, 10–12]. It has been shown that the contribution from radial artery frequently varies while that of the ulnar artery remains relatively unchanged [6]. In very rare cases, the ulnar artery may be absent, and replaced by the median artery [6, 13]. In our case, the reason of this major complication was the absence of ulnar artery while having the radial artery only as responsible for the blood supply to the fingers.

To the best of our knowledge, no such cases have been described in literature in which the radial artery only guaranteed blood supply to the fingers. Furthermore, this type of complication has never been reported following an end-

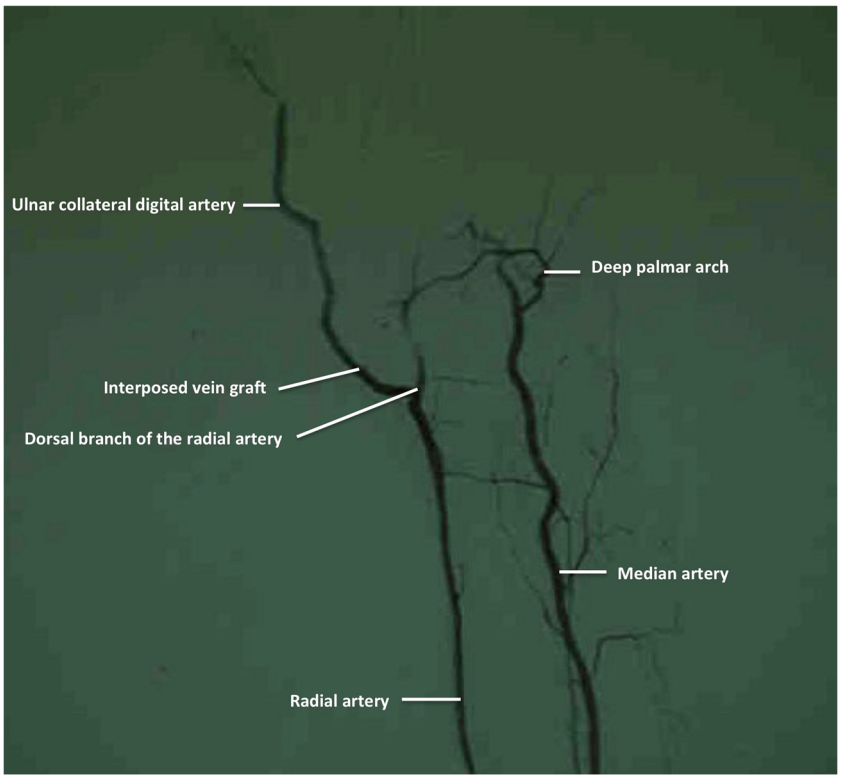

Fig. 3 Arteriography performed on the 1st postoperative day showed normal brachial artery trifurcating at the level of the elbow into three branches: radial, ulnar, and median arteries. The main one was the median artery that provided most of the blood supply to the palmar arcade. Ulnar artery appeared to be hypoplastic, while the radial artery was normal in caliber with good function of the anastomosis, patent vein graft, and thumb fully vascularized. However, vascularization of the 2nd, 3rd, 4th and 5th fingers was completely absent

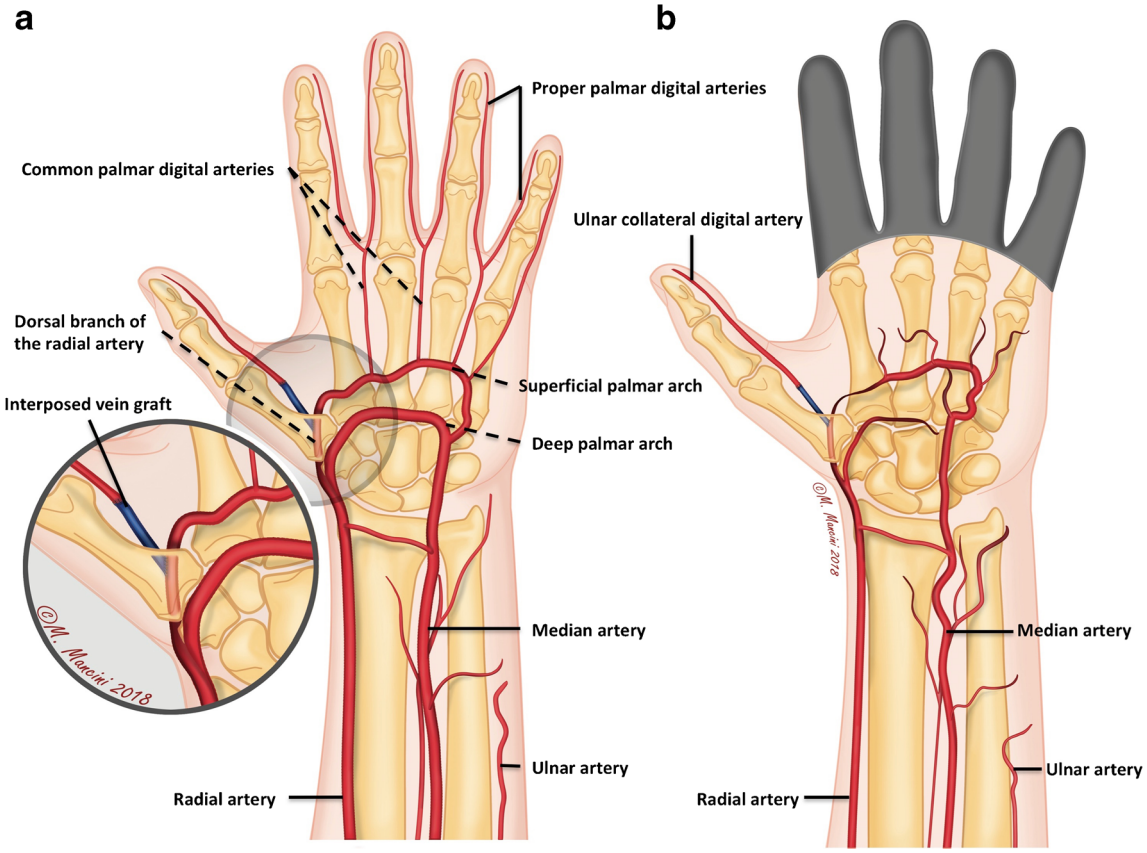

Fig. 4 Illustrations describing the vascular anatomy of the patients postoperatively (**a**) and as seen with the arteriography performed on the 1st postoperative day (**b**)

to-side anastomosis using venous graft between the dorsal branch of the radial artery and the distal part of the ulnar collateral artery of the thumb.

Furthermore, only few papers in literature reported hand ischemia after radial artery harvesting procedure [7, 14–16]. In one patient, ulnar artery was absent and replaced by a large interosseous artery. Harvesting the radial artery for a coronary artery bypass followed by low perfusion related to dysrhythmia caused hand ischemia [16]. In two patients, hand ischemia followed radial forearm flap harvesting. The angiography performed at that time demonstrated incomplete SPA, which failed to supply thumb and index fingers; whereas in the other case, ulnar artery strictures were reported as a consequence of the smoking habit of the patient [7, 15].

The present case might suggest searching preoperatively for abnormal arterial patterns of the hand even in

Fig. 5 Necrosis of last four fingers on the 7th postoperative day

emergency settings. Even though Allen's test is a widely used method to assess hand collateral circulation before any arterial intervention, it is impossible to be performed in a massively injured hand [2, 17]. Arteriography would be the gold standard since it could document the exact vascularization of the hand. However, it is associated with further delay to replantation [10].

Doppler ultrasound (US) would give valuable information about the vascular pattern of the hand. Yan et al. investigated 638 patients in order to detect any anatomical variation of radial and ulnar artery by means of Doppler US [18]. They reported an overall anatomical abnormality rate of 15.4%, which was significantly greater in the right forearm (8.9% versus 6.5%). Furthermore, it was reported that either the radial artery or the ulnar one was hypoplasic in 2.3% of the cases, with the ulnar artery being slightly more affected (1.3% versus 1%). The same findings were reported by Hurzjan et al. [19]. Nevertheless, Vessilev et al. observed a much higher incidence of anatomical abnormalities (11.9%) [20]. However, in our case, we do not know if Doppler US would have been capable to identify that the median artery was not contributing to the SPA.

In conclusion, anatomical anomalies of hand arterial blood supply are not uncommon; therefore, an instrumental study should be performed before attempting any arterial intervention. Nevertheless, among imaging studies at our disposal (e.g., Doppler US, angiography, photoplethysmography, or oximetric techniques), angiography only can reliably describe the arterial pattern of the hand. In emergency settings, available options may be unsatisfactory, and further studies should be performed to identify ready-to-use tools to make surgeons aware of any anatomic variations in order to avoid such complications.

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Compliance with ethical standards

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Conflict of interest Norman Della Rosa, Nicolò Bertozzi, Giulia Colzani, and Roberto Adani declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Furthermore for this type of study formal consent is not required.

Informed consent Informed consent was obtained from all individual participants included in the study.

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