

Progressive fingertip necrosis after nail avulsion injury in a patient with ulnar artery hypoplasia

A case report

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Abstract

Rationale: Slowly progressive hand ischemia is mostly associated with medical illness such as vasculitis, and in patients with smoking history, Buerger disease is often considered first. However, despite the very low incidence of vascular anatomical anomalies, they can lead to hand ischemia. And if there is no consideration for them, proper treatment cannot be selected.

Patient concerns: A 42-year-old male smoker presented with a slowly progressing 5th fingertip necrosis following blunt trauma.

Diagnoses: Angiography revealed congenital hypoplasia of ulnar artery, and excluded Buerger disease or hypothenar hammer syndrome.

Interventions and outcomes: We reconstructed the necrotic fingertip using a 2nd toe pulp free flap to reflect the patient's need.

Lessons: In this case report, the authors emphasize that the possibility of anatomical anomaly should be considered as a cause of the ischemia. Vascular imaging should be undertaken to investigate the cause of ischemia of the hand.

Keywords: fingertip necrosis, toe pulp free flap, ulnar artery hypoplasia

1. Introduction

When a patient comes to the outpatient clinic with a fingertip necrosis, the physicians have to identify the cause first. It is very important to distinguish the causes of hand ischemia because the treatment must be different depending on the cause. If the finger became necrotic fast, we have to consider acute causes such as trauma and thrombosis. And if the finger necrosis progressed slowly, chronic causes such as vasculitis have to be considered.^[1] However, in most cases, the possibility of an anomaly of the forearm vessels has to be considered. Thus, it is easy to start treatment without any vascular imaging. Although the incidence is rare, anatomic vascular anomaly sometimes causes worsening of ischemia due to various causes. Therefore, urgent vascular imaging studies should be conducted.

Several anomalous vascular patterns of the forearm and hand have been reported. However, ulnar artery hypoplasia without accompanying radial or ulnar deficiency is rare, and not clinically evident until radial arterial flow is impaired. The authors report

about a patient, whose tip of the 5th finger underwent progressive ischemic necrosis after a traumatic nail avulsion injury, and who was found to have an ulnar artery hypoplasia.

2. Case presentation

A 42-year-old male smoker with no previous medical illnesses was hit by a rotating gear on the nail of his left small finger. The nail avulsed. He dressed the finger with ointment and a bandage. The fingernail grew after 2 weeks, but the fingertip progressively turned black in color. He was treated in a local clinic with wound dressing and antibiotics. Six weeks after injury the patient was referred to our department. The distal phalanx of the 4th and 5th fingers showed mild atrophy and color change, and the 5th finger's nailbed and distal pulp were necrotic at the time of admission. There were no external wounds or signs of infection (Fig. 1A–C). He denied any pain or cyanosis before the accident.

A handheld Doppler examination revealed muffled sound distal to the proximal interphalangeal joint. The patient was treated with prostaglandin E1 and systematic heparinization to increase the blood flow until complete demarcation of the necrosis. The authors recommended revisional amputation for treatment first. However, the authors finally planned to perform a free 2nd-toe pulp flap because the patient strongly wanted to maintain the original length of the finger. Surprisingly, an arteriography of the left arm performed for the preparation of the operation showed a hypoplastic ulnar artery with atresia at the distal forearm. Filling of the deep palmar arch occurred only through the radial artery without any contribution from the atretic ulnar artery. The 4th and 5th digital arteries originating from the hypoplastic deep palmar arch showed poor distal blood flow (Fig. 2).

After debridement of the necrotic distal phalangeal bone tip and approximately one third of the pulp and nailbed the free 2nd-toe pulp flap was performed to cover the defect. The arterial pedicle was thrombosed up to the middle phalanx. During pedicle preparation, weak but pulsatile arterial blood flow was

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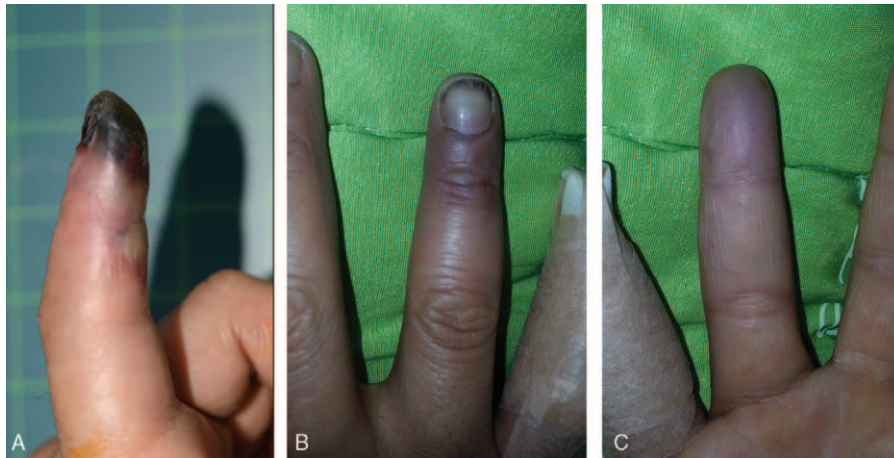


Figure 1. (A) Necrotic tip of the left small finger, and (B, C) cyanotic color change of the left ring finger on initial presentation.



Figure 2. Arteriography of the left distal ulnar artery: deep palmar arch filled only through the radial artery without any contribution from the atretic ulnar artery; hypoplastic palmar arches on the ulnar side; the 4th and 5th digital arteries originating from the hypoplastic deep palmar arch with poor distal blood flow.

confirmed proximal to the thrombosis. The fibular half of the left 2nd toe pulp with its arterial pedicle, accompanying nerve and superficial vein, was harvested. After anastomosis of the vessels good recovery of blood flow in the flap was observed, but then arterial spasm occurred. The latter did not subside after warm saline irrigation and papaverine irrigation but at the end of the operation the spasm disappeared. The donor site was closed well primarily.

The flap was pale for 2 days, and the blood flow appeared to be poor. However, after further 2 days, the spasm resolved completely. Six months after the operation, the reconstructed finger was in good condition, except for a mild hook-nail deformity. We observed unrestricted range of motion of all joints of the 5th finger (Fig. 3A and B).

3. Discussion

There exist many causes for ischemic hand conditions. Acute causes include arterial injury, emboli, or acquired arteriovenous fistula due to trauma including iatrogenic injury such as injection injury. Chronic ischemia can be caused by vasospastic diseases (such as Raynaud disease and secondary Raynaud syndrome),

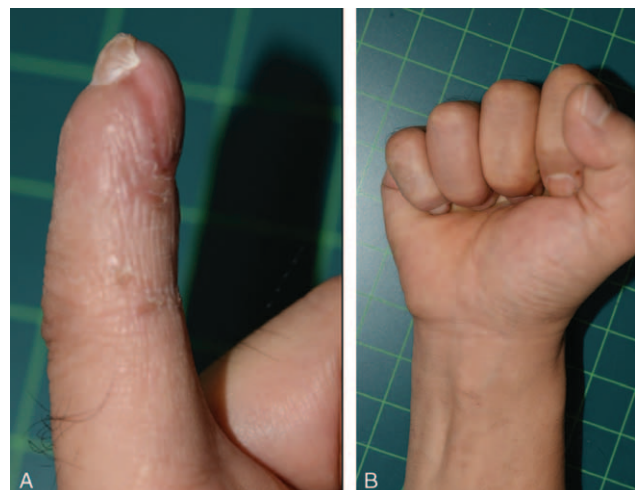


Figure 3. (A) Reconstructed small fingertip with a free toe-pulp flap and (B) the range of motion 6 months after operation.

arterial thrombosis, aneurysm, and connective tissue diseases (such as Buerger disease, systemic sclerosis, systemic lupus erythematosus, and Wegener granulomatosis).^[1]

In this case, the patient presented with a slow progression of hand ischemia after blunt trauma. Because the patient was a young male and long-term smoker, the authors initially suspected Buerger disease. The diagnostic criteria for Buerger disease are smoking history, onset before 50 years of age, arterial lesions below the knee, upper limb involvement or migratory phlebitis, and absence of atherosclerotic risk factors other than smoking.^[2] Although the patient was a relatively young smoker without any other disease, he did not fit the diagnostic criteria, such as presence of lesions of the lower extremities and there was no history of phlebitis or Raynaud phenomenon.

Because the patient was a manual worker, hypothenar hammer syndrome was considered as the 2nd differential diagnosis. Hypothenar hammer syndrome occurs when the ulnar artery is damaged by occlusion in the hook of the hamate by repetitive trauma.^[3] It was suspicious in that the patient's symptoms involved the ulnar 2 fingers and poor inflow of ulnar artery in Allen test. However, the authors could exclude hypothenar hammer syndrome because the patient denied the history of repetitive trauma to the hypothenar area.

Because the history and physical examination of the patient were not able to differentiate these diseases, we performed angiography for vascular evaluation. And surprisingly, an ulnar artery hypoplasia was identified in which the ulnar artery was not visible from the patient's forearm to the hand.

The arterial supply to the upper arm and hand is a continuation of the axillary artery to the brachial artery, and the brachial artery bifurcates into the radial and ulnar arteries in the forearm. The superficial branch of ulnar artery becomes the major contributor to the superficial palmar arch. The radial artery enters the hand dorsally, then anastomoses with the deep palmar branch of the ulnar artery, forming the deep palmar arch. Therefore, radial artery is the main contributor of the thumb and the lateral side of the index finger, and ulnar artery is the main contributor of the rest of the digits and the medial side of the index finger.^[4]

Several reports have described vascular anomalies of the forearm. Among the forearm artery anomalies, the superficial ulnar artery is well-known because this anomaly can be encountered during a forearm fasciocutaneous flap harvest.^[5] In a cadaver study, this abnormality was found in 9.38% of upper limbs.^[6] A hypoplastic ulnar artery, however, is rarely reported in English literature. McCormack et al reported one case of an attenuated ulnar artery out of 750 extremities studied, and Funk et al reported one case of bilateral ulnar artery hypoplasia out of 52 forearm flaps.^[7,8] Murphy et al^[9] also reported 2 cases of bilateral ulnar artery atresia in patients with radial artery pseudoaneurysm. In an anatomical study of forearm arteries with ultrasonography in 638 patients, ulnar artery hypoplasia was found in 16 (1.3%).^[10]

In this case, because of a hypoplastic ulnar artery, the 4th and 5th digital arteries originating from the hypoplastic deep palmar arch showed impaired perfusion. The authors believed that 3 major factors contributed to the necrosis of the fingertip: ulnar artery hypoplasia, chronic smoking, and trauma. Because of the dual supply of the hand coming from the radial and ulnar arterial systems, a congenital vascular anomaly in either of the 2 arteries will not bring about critical ischemia under normal conditions. But the poor arterial supplies of distal fingers can cause fingertip necrosis only by minor trauma. According to literature, smoking can cause endothelial dysfunction,^[11] increase platelet activation,

and trigger a coagulation cascade, which may result in thrombosis.^[12] Finally, blunt trauma to the affected fingertip, which already had decreased blood supply due to the anatomical anomaly and damage from smoking, may have triggered in necrosis of the fingertip.

In an isolated fingertip necrosis, different treatment strategies which follow the conventional reconstructive ladder are usually considered first. Healing by secondary intention with semi-occlusive dressing is performed first. Revisional amputation to achieve primary closure at distal interphalangeal joint level is considered as the next option. One step further on the reconstructive ladder, full thickness skin graft can be done. Local flap coverage such as various V-Y flaps can be chosen after full thickness skin grafting can be performed. Next, regional flaps such as thenar or cross-finger flaps can also be considered.^[13] Not only because of the factors that contributed to the necrosis but also the difficulty and risk of the surgical procedure itself, performing a free 2nd toe pulp flap seemed to be inappropriate as 1st-line treatment.

However, a free 2nd toe pulp flap provides functional advantages that cannot be achieved in other surgical options. It preserves length of the original finger, could provide enough soft tissue padding to the fingertip, while achieving protective sensation with an average of 7 mm for 2-point discrimination.^[14] On the contrary, other options mentioned above can result in severe hook nail deformity and inadequate soft tissue padding, which can lead to chronic pain. Therefore, the authors performed a free flap reconstruction which follows the newly established concept of reconstructive elevator.^[15]

Although the authors had discussed other options for treatment, the patient wanted to maintain the whole length of his finger, strongly promising to quit smoking. This concept of preservation of body integrity originated from Confucianism, which has traditionally dominated the Far East Asian cultures. This trend can be observed in a systematic review of digital replantation surgery, wherein large numbers of replantation surgery cases were reported in East Asia including South Korea, Japan, and China.^[14,16] Therefore, the authors decided to perform a free flap reconstruction accepting the patient's request, with informed consent.

Free flap reconstruction in a patient with vascular anomaly is not an easy option because of the high failure rate. However, it could be a feasible option for surgeons considering treatment of patients with strong will and demand, and patients under some influence of Eastern culture that strongly prefers preservation of body morphology. However, there must be sufficient surgeon experience. Such surgical plan should always come after a thorough explanation to the patient about its risk and possibility of intraoperative change of plan.

Anatomical variations of the ulnar artery can be easily overlooked as causes of chronic fingertip ischemia due to the rare incidence (approximately 1%) compared to radial artery anomalies. However, such variations should not be neglected. For the proper management of slowly progressing fingertip ischemia of unclear origin, vascular anatomical variations should be ruled out in the early stages by vascular imaging studies.

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