

A Clinical Case Report of Polydactyly and Multi-plane Finger Amputation

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1. Abstract:

1.1. Objective:

To investigate the time period for clinical management of multi-plane and multi-segmental finger amputations, and the particularity of the reconstruction time for the distal segment vein without venous anastomosis in multi-segmental finger amputations.

1.2. Methods:

We retrospectively analyzed the clinical data of a patient with cutting polydactyly and multi-plane finger amputation who was admitted to our hospital on January 13, 2022.

1.3. Results:

Four fingers and nine segments of severed fingers were replanted, and seven segments survived. According to Tamai's scoring criteria, the index finger was excellent, and the middle, ring, and little fingers were good.

1.4. Conclusions:

Under good wound debridement and protection, the time period for multi-plane repair of severed fingers can be extended. In the case of multi-plane finger amputation, the reconstruction time for the distal segment vein without venous anastomosis may be longer than that of single distal

segment finger amputation by more than 9 days.

Type of Study and Level of Evidence:

Individual Case-Control Study Therapeutic Decision Analysis, 3b

2. Keywords:

Nerve injury Multi-plane amputation of finger body nerve regeneration Multi-finger amputation

3. Statement:

This article has been approved by the relevant ethics body review board and each patient's informed consent and any necessary HIPAA consents have been obtained. (Fig.5)


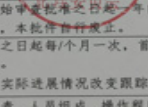
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Figure 5: Ethical license document.

4. Introduction:

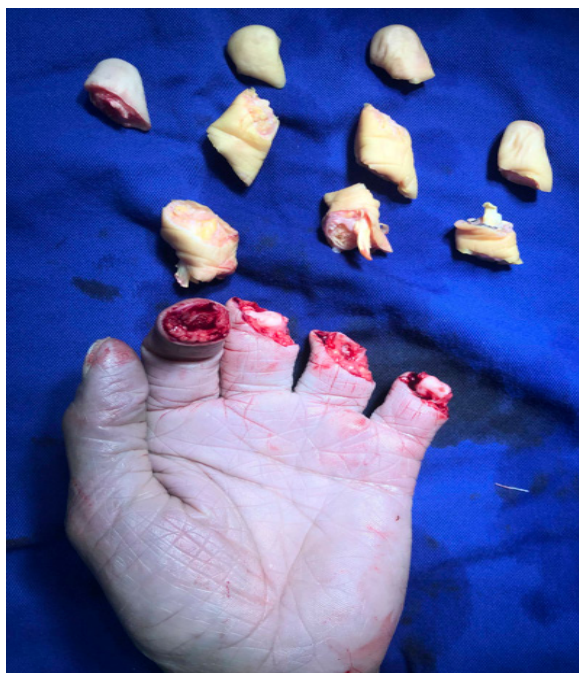
Many reports have been published on multi-plane amputation of fingers[1]. However, simultaneous amputation of multiple fingers on the same palm poses higher requirements for clinical diagnosis, treatment, and curative effect. Replantation of multiple fingers and multiple segments is difficult and technically demanding, and is rare in clinical practice[2]. Most of these replantations are performed by a team of surgeons[2]. However, team surgery requires a high level of personnel resources. In primary hospitals or

when multiple emergency operations must be carried out simultaneously, such patients are often forced to undergo amputation or transfer to another hospital[10]. On January 13, 2022, our department replanted 4 severed fingers and 9 segments of a 54-year-old patient, and 7 segments survived, achieving satisfactory results. Due to the limited resources at the time, the entire procedure was completed by an experienced doctor and his assistants in 12 hours. To explore the clinical response window period of multi-finger and multi-plane amputation in elderly patients and the particularity of the time of distal venous reconstruction without venous anastomosis in multi-segment amputation, we report the following to provide the basis for further prospective research:

5. Clinical data:

Description of the case: A 54-year-old man was admitted to the hospital with a machine-cutting injury to his left hand. His fingers 2-5 were completely amputated in 9 segments. The amputations had been exposed to the elements for 2 hours. After admission, the patient underwent a series of tests, including an X-ray, blood work, and an electrocardiogram. The results of these tests were normal, so the patient was scheduled for surgery. The amputated levels of the 2-5 fingers of the left hand were as follows: 1. Distal segment of the index finger, 2. Proximal interphalangeal joint (PIP) of the middle and ring fingers, 3. Middle and distal segments of the middle and ring fingers, 4. Proximal interphalangeal joint and distal interphalangeal joint (DIP) of the little finger. The amputations were horizontal and oblique.(Fig.1)

Figure 1: Preoperative appearance



5.1. Treatment:

After admission, the patient underwent surgery to replant the amputated fingers and segments. The surgery was performed under brachial plexus

anesthesia.

5.2. Surgical procedures:

After receiving brachial plexus block anesthesia, the affected limb was washed and the wound was rinsed. The severed fingers were cleared and the wound was debrided from outside to inside under a microscope. As much healthy soft tissue, blood vessels, nerve bundles, and other important parts were retained as possible. Iatrogenic injury was avoided. The blood vessels and nerves were marked. The soft tissue breaks on both sides and the length of the fracture ends were evaluated. The phalanges and joints were shortened and fused. After debridement, the wound was washed with hydrogen peroxide, povidone (iodine-containing disinfectant), and a large amount of normal saline. First, the fracture end was repaired using Kirschner wires for internal fixation. Joint fusion was performed to repair the superficial flexor tendon. The DIP joints of fingers 2-5 and PIP joints of fingers 3-5 were fused and fixed with 2 Kirschner wires, respectively. The digital artery on the dominant side was anastomosed. The digital nerve and extensor tendon were repaired and sutured. The dorsal digital vein was anastomosed. One artery was anastomosed in each segment, and one vein was anastomosed in each segment. Except for the volar vein at the end of the finger body of the 2-4 fingers, the other segments were anastomosed with the dorsal middle main vein. (Fig.2)

Figure 2: Immediate postoperative appearance.



5.3. Postoperative management:

After the operation, the patient was kept in bed rest for 1 week. The room temperature was maintained at 24-26°C. Anticoagulant, antispasmodic, anti-infection, and volume expansion drugs were used. The patient's condition was closely observed, and blood volume was replenished as needed. Psychological counseling was also provided. The blood circulation

of the replanted fingers was closely observed, and any vascular crisis was reported to the doctor immediately. An obvious arterial crisis occurred once in the middle and ring fingers. A local injection of papaverine was given, and the blood supply was restored after massaging the proximal end of the wound. A venous crisis occurred at the end of the middle and ring fingers on the second day after the operation. Bleeding was performed through a small incision at the end of the finger. The bleeding stopped on the 9th and 18th days, respectively. This resulted in partial necrosis of the fingertip and partial skin tissue necrosis of the proximal severed finger of the little finger. The other fingers survived. The necrotic part at the end of the middle and ring fingers was trimmed. The Kirschner wire was removed 10 weeks after the operation. Rehabilitation exercises were then performed.(Fig.3)

Figure 3: Two months after the operation.



5.4. Results:

The operation lasted 12 hours and the blood circulation was good. After replantation, venous crisis occurred at the end of the middle and ring fingers, resulting in partial necrosis of the finger body and partial skin tissue necrosis of the proximal severed finger of the little finger. These injuries were completely healed after conservative treatment. The patient's ability to grasp and pinch was partially recovered 3 months after the operation, and the pain was recovered 6 months after the operation. The appearance of the hand was good, and the patient was able to participate in manual labor without disrupting daily life. At the last follow-up, the patient was satisfied with the appearance, function, and sensation of the replanted fingers. According to the Tamai functional scoring criteria for replantation of severed fingers[4], the curative effect was excellent in the index finger and good in the middle, ring, and little fingers. (Fig.4)

Figure 4: Six months after the operation, flexion and extension can be achieved.

6. Discussion

The clinical response window period of replantation of multiple fingers and planes is longer than that in theory. Replantation of multiple fingers and planes is a delicate and complex surgical operation with great difficulty. The window period of finger replantation is usually 6-8 hours[11]. Therefore, fast and efficient surgical treatment is particularly important. Most hospitals adopt the surgical mode of multi-team doctors working in groups[2]. However, grouping operation has a high requirement on hospital personnel reserve. For primary hospitals with a limited number of doctors or emergencies where multiple emergency operations need to be carried out simultaneously, such patients are often unable to receive effective treatment. They are forced to undergo amputation or transfer to another hospital for treatment [10]. In this case, the hospital received multiple emergency operations simultaneously. An experienced physician and his assistants completed the replantation operation. The total time was 12 hours. According to the replantation order of "proximal end first, distal end later," the assistants completed debridement, bone fixation, and other tasks with low technical requirements. This suggests that the clinical response window for replicating multiple severed fingers and planes may be extended to 10-12 hours under normal circumstances. In cases where group work is not enough, it can be completed by a single experienced team of doctors and assistants. Reconstructing the distal vein without venous anastomosis in multi-plane digital amputation may take longer than in single distal digital amputation. This is because the anatomical position of the severed finger veins is not constant, the number of veins is small, and the lumen is small. Therefore, how to solve the venous reflux problem during distal segment replantation is an important factor affecting the postoperative survival of the finger body[6].

Among the existing replantation methods of the distal severed finger, the physiological venous drainage method is mainly anastomosed with the ventral finger or dorsal vein[5]. Under the guidance of this method, as long

as the palmar or dorsal vein is available for anastomosis, it is the preferred method for venous drainage of the distal replanted vein[9]. Due to the characteristics of the vascular distribution of the distal segment vein, when the distal segment severed finger body has no supply of finger pulp and dorsal vein for anastomosis, bloodletting therapy is a more commonly used clinical treatment method[8]. The corresponding reconstruction time of the distal segment vein is generally 3-5 days[12]. However, in this case, a venous crisis occurred at the end of the middle and ring fingers on the second day after the operation, and bleeding was performed through a small incision at the end of the finger. The bleeding stopped on the 9th and 18th days, respectively, resulting in partial necrosis of the fingertip. This suggests that the reconstruction of the distal vein without venous anastomosis in multi-plane finger amputation is different from the general single distal finger amputation. It is difficult to reconstruct the venous drainage within at least 9 days after operation through exsanguination. When the wound crusted or bleeding coagulated, the interval of blood withdrawal can be reduced, or the blood withdrawal can be restarted. Branches should be preserved as much as possible during wound cleaning. Thorough debridement is essential for ensuring the survival of the replanted finger[2]. However, excessive debridement can easily make the digital artery a passing artery, which can prevent the middle segment of the severed finger from receiving sufficient nutrition from the artery and cause black necrosis[4]. In this case, the skin of the proximal severed tissue of the little finger once appeared black and necrotic. After a comprehensive analysis, it was believed that the severed finger was short, and the digital artery entered the tissue with few branches, insufficient to nourish the finger. This suggests that even if some small vascular tissue suture increases the operation's difficulty and the operation time, it should be retained as much as possible when conditions permit.

Adequate preoperative and postoperative communication is the cornerstone of successful rehabilitation. Middle-aged and elderly patients are less likely to comply with treatment. Injured patients are often manual workers with low general education, and communication is relatively complicated. This can make it difficult to get them to cooperate with treatment. In this case, the patient was an older man, and his ability to control his emotions and understand instructions was reduced. As a result, a vascular crisis could quickly occur when he experienced pain or tension. This suggests that we should pay special attention to preoperative and postoperative nursing cooperation. This can be done by nursing the patient's position and pain, providing psychological counseling after trauma, and guiding the patient to have a favorable treatment and recovery mentality. In addition, close observation of the blood circulation of the replanted finger, detection of vascular crisis, and timely notification of doctors to deal with it[7] can effectively increase the survival rate of replantation. After decades of development, the indications for the replantation of severed fingers have also significantly changed. The technology of replantation of severed fingers is developing in the direction of more complex operation, and higher requirements are put forward for the aesthetics and function of the finger after the operation. There have also been many innovations and breakthroughs in treating multiple fingers and multiple plane amputation with complex injury and difficult replantation[13]. This report provides

a new case study on the clinical response window period of multi-finger multi-plane amputation replantation and the time of distal venous reconstruction without venous anastomosis, which is conducive to further exploring the particularity of multi-plane amputation and has extremely high clinical research value.

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