A comparative study of lateral and palmar venous anastomosis in Ishikawa zone II fingertip replantation

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Abstract

Purpose: Venous anastomosis is the key procedure for Ishikawa zone II fingertip replantation. Both palmar and lateral veins provide efficient venous drainage. This study compared the clinical effects between these venous anastomoses for fingertip replantation. Methods: In 2016–2018, 61 patients underwent Ishikawa zone II fingertip replantation with venous anastomosis (28 and 33 cases with palmar and lateral anastomoses, respectively). Retrospective comparative analyses evaluated surgical technique and function, including operative time; rates of finger survival, venous congestion, and infection; sensation; joint motion; cold intolerance symptom severity (CISS), Disabilities of the Arm, Shoulder, and Hand (DASH), and Vancouver scar scores; and chronic regional pain syndrome (CRPS) rates. Results: There were 33 patients with lateral vein anastomosis and 28 patients with palmar vein anastomosis. The average patient follow-up was 18.2 months. The survival rates did not differ significantly between groups (87.8% (29/33) vs. 85.7% (24/28), \( p > 0.05 \)); however, the operative time was shorter in the lateral vein group than in the palmar vein group (78.57 ± 7.08 min vs. 67.88 ± 5.77 min, \( p < 0.05 \)). Venous congestion and infection rates did not differ significantly between groups (\( p > 0.05 \)). The replanted finger function, including joint motion, sensation, DASH scores, Vancouver scar scores, and CRPS rates, did not differ significantly between groups (\( p > 0.05 \)). However, the CISS score was higher in the palmar vein group than in the lateral vein group (44.39 ± 5.16 vs. 38.09 ± 4.49, \( p < 0.05 \)). Conclusions: Venous anastomosis with either palmar or lateral veins showed high survival rates and good function in fingertip replantation. The lateral vein had a shorter operative time and benefit to arterial revision and was especially suitable for patients with finger pulp damage.

Keywords
digital replantation, fingertip amputation, venous anastomosis

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Introduction

Fingertip refers to the part of the finger distal to the insertion flexor and extensor tendons.¹ Fingertip amputation is common, especially in young people engaged in physical labor.² Replantation can be a choice for this injury to retain the nail and digital length for restoring excellent function and appearance.³,⁴ However, for Ishikawa zone II fingertip amputation, microsurgical replantation is technically difficult because of the small vessel size and avulsion injury of the arterial and venous systems.⁵ Adequate venous drainage is key for successful replantation, for which various methods have been reported. The common methods used for restoration of the vein include venous anastomosis or arteriovenous shunting; however, the latter is nonphysiological and is a substitute method.⁶,⁷ Venous anastomosis
can be conducted in Ishikawa zone II and is divided into palmar and lateral anastomoses. Palmar vein anastomosis is relatively common; however, the vessels are small and located superficially and irregularly. Although lateral venous anastomosis is less frequently reported, the veins are typically located at the lateral nail fold and have relatively large caliber. Therefore, the present study compared the clinical outcomes of replanted fingers between palmar and lateral nail fold vein anastomosis to evaluate the validity of the two surgical techniques. A better understanding of the outcomes of these procedures may help surgeons to choose the best method for vein reconstruction in the treatment of Ishikawa zone II fingertip amputations.

Materials and methods

Patients

The study protocol was approved by the Ethics Committee of Wuxi 9th People’s Hospital affiliated with Soochow University. We retrospectively studied all Ishikawa zone II fingertip amputations between 2016 and 2018. The inclusion criteria were single-digit replantation, Ishikawa zone II, with both arteries and veins (1:1) including both palmar and lateral veins, and patient age of 20–50 years. The exclusion criteria were history of hypertension, diabetes, hyperlipidemia, and smoking. Finally, this study included 61 patients with replantation in Ishikawa zone II. Age, sex, injured digit, hand dominance, and the mechanism of injury according to the Yamano classification are presented in Table 1. All surgeries were performed by microvascular surgeons with 5 years of experience.

Surgical technique

The fingertips were replanted under brachial plexus block. The debridement of the amputated part was performed first under an operating microscope with additional skin incisions as necessary to assist the vessels or nerve exploration. The central artery at the distal portion of the digital artery arch was identified and marked with microsurgical suture, as was the digital nerve or its branch. Shortening of the distal phalanx was cautiously performed to prevent damage to the nail matrix and nail bed. The proximal portion was prepared similarly while keeping the basal articular surface intact. A 0.8-mm Kirschner wire was inserted longitudinally through the distal interphalangeal joint for stability. The proximal arteries were easily located by blood outflow while compressing the fingers, which always corresponded to the distal end. The adventitia of the artery was trimmed while leaving the intima intact. Arterial anastomosis was performed with an 11-0 nylon suture. Afterward, vein repair was performed. The palmar vein was hard to identify because of its variable anatomical distribution. One efficient way was to compress the finger pulp to cause vein bleeding. A certain length of the subcutaneous vein was dissected to facilitate anastomosis (Figure 1). The lateral veins running along the nail from the lateral to the dorsal side were repaired (Figure 2). A longitudinal incision along the junction between the nail bed and the lateral nail fold was made to easily expose the vein and perform anastomosis as described by Jeon et al.9 The soft tissue over the vein was dissected and pulled away to provide sufficient exposure. Anastomosis was performed with 11-0 nylon sutures. Direct venous anastomosis was not always possible due to the length defect, for which vein grafts harvested from the
forearm were used (Figure 3). In all cases, one artery and one vein were repaired for each finger. Nerve repair was also performed for the branch of the proper nerve. Damaged nail beds were repaired. Tendon repair was not required because the amputation was distal to the tendons in Ishikawa zone II.

Postoperative care

The patients were administered 5000 U heparin as subcutaneous injections, in which 500 mL low-molecular-weight heparin was injected intravenously 7 days after surgery. The patients also received oxygen therapy and were advised bed rest and quiet surroundings. If venous congestion occurred, we performed fish mouth incision to drain the extravasated blood. If an arterial crisis occurred, intramuscular injection of papaverine was adopted first, followed by surgical exploration of the artery if the medication failed. Passive and active motion began 1 and 3 weeks after surgery, respectively.

The patients were followed up by the same therapist to evaluate the function of the replanted fingers, including Disabilities of the Arm, Shoulder and Hand (DASH) score, Semmes-Weinstein test (S-W), total active motion (TAM), cold intolerance symptom severity (CISS) scores, Vancouver scar scores, and chronic regional pain syndrome evaluated with the Budapest criteria.10

Statistical analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 24.0. The rates of replantation survival, venous congestion (defined as tension vesicle), wound infection, and chronic regional pain syndrome were calculated as percentages. Operative times, DASH scores, TAM, CISS scores, Vancouver scar scores, and two-point discrimination are presented as means ± SD. Comparative studies between the two groups were performed using \( \chi^2 \) and \( t \)-tests. The value of \( p < 0.05 \) was considered statistically significant.

Results

Patient demographics, including age, sex, involved finger and injury mechanism, did not differ significantly between the palmar and the lateral groups. There were 33 patients with lateral vein anastomosis and 28 patients with palmar vein anastomosis. The operative time of the lateral vein
According to Ishikawa classification, the distal portion distal interphalangeal joint and the tendon insertion. as well as to maintain good joint movement based on intact the first choice to restore finger length and nail appearance as crush or avulsion injury. Digital replantation is always amputation is a common hand trauma that typically occurs as the most distal part of the upper extremity, fingertip Discussion

|                           | Palmar vein group | Lateral vein group | p Value |
|---------------------------|-------------------|--------------------|---------|
| Follow-up time (months), mean ± SD | 18.64 ± 3.96      | 17.67 ± 2.77       | 0.263   |
| Operation time (min), mean ± SD   | 78.57 ± 7.08      | 67.88 ± 5.77       | 0.000   |
| Rate of venous congestion       | 7/28              | 5/33               | 0.335   |
| Survival rate                  | 24/28             | 29/33              | 1.000   |
| Infection rate                 | 4/28              | 3/33               | 0.817   |
| DASH score, mean ± SD          | 9.64 ± 2.25       | 9.76 ± 1.89        | 0.829   |
| TAM, mean ± SD                 | 40.68 ± 3.02      | 38.73 ± 6.32       | 0.141   |
| CISS score, mean ± SD          | 44.39 ± 5.16      | 38.09 ± 4.49       | 0.000   |
| S-W score, mean ± SD           | 3.25 ± 1.11       | 3.15 ± 1.86        | 0.807   |
| Vancouver scar score           | 8.21 ± 2.22       | 8.76 ± 1.89        | 0.305   |
| CRPS                          | 1/28              | 2/33               | 1.000   |

DASH: Disabilities of the Arm, Shoulder, and Hand; TAM: total active motion; CISS: cold intolerance symptom severity; S-W: Semmes-Weinstein test; CRPS: chronic regional pain syndrome.

group was shorter than that in the palmar vein group (67.88 ± 5.77 min vs. 78.57 ± 7.08 min, p < 0.05). Venous congestion occurred in five patients in the lateral vein group (5 of 33, 15.2%), one of which was relieved by small incision bleeding, while the other four fingers necrosed. Seven patients (7 of 28, 25.5%) in the palmar vein group experienced venous congestion, four of whom were successfully rescued; the other three necrosed. Arterial crisis occurred in two patients in the lateral vein group and in one patient in the palmar vein group. Early surgical explorations were performed for the three cases with anastomoses revision; the two cases of the lateral vein group were successfully rescued, while the single case in the palmar vein group was not. Therefore, the final survival rates were 87.8% (29 of 33) in the lateral vein group and 85.7% (24 of 28) in the palmar vein group, a difference that was not statistically significant (p > 0.05).

The mean follow-up duration was 18.2 months (range 13–25 months; lateral vein group: 17.67 ± 2.77 months; palmar vein group: 18.64 ± 3.96 months). The CISS was 38.09 ± 4.49 for the lateral vein group and 44.39 ± 5.16 for the palmar group; a statistically significant difference was observed between these two groups (p < 0.05). No statistically significant differences were observed in the infection rates, TAM, S-W score, Vancouver scar score, and DASH score between the two groups. As a complex complication, chronic regional pain syndrome occurred in one and two cases in two groups without significant difference (Table 2).

Discussion

As the most distal part of the upper extremity, fingertip amputation is a common hand trauma that typically occurs as crush or avulsion injury. Digital replantation is always the first choice to restore finger length and nail appearance as well as to maintain good joint movement based on intact distal interphalangeal joint and the tendon insertion. According to Ishikawa classification, the distal portion from the midpoint of the nail is always treated with composite regrafting due to the deficiency of the repairable artery.12 However, for zone II amputation, ranging from the midpoint of the nail to the nail base, artery reconstruction is relatively easy using the central branch of the distal digital arch, while venous drainage, the key factor of successful fingertip replantation, is more challenging.

The available techniques for venous drainage include palmar or lateral vein anastomosis, arteriovenous shunting, and fingertip bleeding by small incisions or leeches. While the latter two approaches are unphysiological with potential complications, they may also improve venous congestion. Many studies have reported venous anastomosis as the best method to promote venous congestion for fingertip replantation, with the advantages of simple postoperative care and low complication rate, making it the first choice for digital replantation.13,14 Unlike proximal digital replantation, no dorsal vein is available to repair due to the presence of the nail. Therefore, palmar or lateral veins have become common methods for venous drainage reconstruction in Ishikawa zone II fingertip replantation. However, few studies have compared the two vein repair techniques.

The palmar cutaneous vein is frequently used for venous reflux reconstruction as it has caliber sufficient for adequate venous drainage. Cheng et al. conducted an anatomical study on palmar vein at the eponychial level and found 303 palmar veins in 100 fingers with calibers exceeding 0.3 mm, mainly distributed in the 3-5 and 7-9 o’clock areas on the cross sections, with the midpoint of the nail root defined as the 12 o’clock position.15 Based on the anatomical results, they also performed a clinical study and reported a high success rate (26 of 28) and a low operative time of 2 h. Wen et al. reported on 21 cases of pediatric fingertip replantation with palmar vein anastomosis with a success rate of 95.2%.8 Another comparative study showed a higher success rate as well as a lower rate and severity of venous congestion for fingertip replantation with palmar vein anastomosis than without vein repair, although the operative time was prolonged by approximately 30 min. In our study,
the success rate of the palmar vein group was similar to that reported in previous studies; however, the operative time was shorter. However, it is still time-consuming to search for the palmar vein due to its inconsistent anatomical distribution. In contrast, because the palmar vein is in the superficial layer, it is difficult to reopen the palmar wound to perform early surgical arterial exploration once the vein has been anastomosed, which is another disadvantage of palmar vein reconstruction in fingertip replantation. Among cases in the palmar vein group with arterial crisis in the present study, although surgical exploration was performed with careful retraction of the repaired vein, the artery anastomosis finally failed due to the poor surgical field for arterial revision.

Lateral veins, typically constantly parallel to the lateral nail folds, have also been reported as an effective way to reconstruct venous drainage. In Cheng et al.’s anatomical study, 207 lateral veins were reported with the diameter greater than 0.2 mm at the eponychial level in 100 fingers. However, they did not describe the anatomical distribution of these veins. In our study, we observed two types of lateral veins with different anatomical distributions. In most cases, the veins ran to the dorsal aspect and merged with the contralateral veins to form the dorsal vein at the distal interphalangeal joint level. However, in a few cases, the veins ran to the palmar aspect and communicated with the palmar veins. Regardless, the veins invariably ran along the lateral nail fold, which facilitated surgical exposure and dissection. We believe this is the reason why the operative time of the lateral vein group was shorter than that in the palmar vein group. Compared to the palmar vein, the lateral vein is at a relatively deeper layer and covered with a fat pad, which may protect the blood vessel. This also makes it relatively difficult to expose the blood vessels directly through the traumatic wound. Jeon et al. designed an additional longitudinal incision across the amputation between the nail bed and the paronychium and elevated the skin flaps proximally and distally from the wound to achieve adequate vein exposure. They also reported a lateral vein size of 0.6–1.3 mm, which was big enough to perform anastomosis and could supply adequate venous reflux. The present study found that both lateral and palmar veins could effectively relieve venous congestion without significant differences between the two approaches. Furthermore, surgical exploration of the arteries at the palmar aspect was unrestricted in the cases with lateral venous anastomosis, which was another advantage compared to palmar venous repair.

Regarding functional evaluation, cases with either palmar or lateral vein anastomosis showed similar outcomes, including joint movement, sensation, pain, and DASH scores. These findings demonstrated that fingertip replantation can restore good hand function with adequate venous drainage. However, the CISS scores were higher in the palmar vein group, indicating higher cold sensitivity in the replanted fingers. The reason was not clear, but it was believed that cold intolerance was related to the severity of peripheral nerve injury.

The limitation of this study was its small sample size. This study utilized an uncommon venous anastomosis method (lateral vein anastomosis) to compare with the more common venous anastomosis method (palmar vein), therefore the number of patients may be limited. Another weakness was that this nonrandomized controlled study may be subject to selection bias. As a retrospective study, the surgical procedure was selected according to the injury characteristics. Palmar veins were often used in patients with mild pulp injury and lateral veins for those with crushed or avulsed pulp. Thus, randomized controlled trials are needed to obtain objective results.

Conclusion
Anastomosis with either palmar or lateral veins ensures high survival rates and good function in fingertip replantation. The lateral vein has the advantages of shorter operative time and benefits to arterial revision and is especially suitable for patients with finger pulp damage.

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References
1. Jazayeri L, Klausner JQ, and Chang J. Distal digital replantation. Plast Reconstr Surg 2013; 132(5): 1207–1217.
2. Sorock GS, Lombardi DA, Hauser RB, et al. Acute traumatic occupational hand injuries: type, location, and severity. J Occup Environ Med 2002; 44(4): 345–351.
3. Hattori Y, Doi K, Ikeda K, et al. A retrospective study of functional outcomes after successful replantation versus amputation closure for single fingertip amputations. J Hand Surg 2006; 31(5): 811–818.
4. Sebastin SJ and Chung KC. A systematic review of the outcomes of replantation of distal digital amputation. Plast Reconstr Surg 2011; 128(3): 732–737.
5. Koshima I, Yoshida S, Imai H, et al. Recent topics on fingertip replantations under digital block. Hand Clin 2019; 35(2): 179–184.
6. Kim DH, Yang S, Seo KB, et al. Serial stab incision venous drainage technique for simple artery-only fingertip replantation. J Orthop Surg 2019; 27(1): 2309499019831480.
7. Hsu CC, Lin YT, Moran SL, et al. Arterial and venous revascularization with bifurcation of a single central artery. *Plast Reconstr Surg*. 2010; 126(6): 2043–2051.

8. Wen G, Xu J, and Chai YM. Fingertip replantation with palmar venous anastomoses in children. *Ann Plast Surg* 2017; 78(6): 692–696.

9. Jeon BJ, Yang JW, Roh SY, et al. Lateral nail fold incision technique for venous anastomosis in fingertip replantation. *Ann Plast Surg* 2016; 76(1): 67–71.

10. Irwin MS, Gilbert SEA, Terenghi G, et al. Cold intolerance following peripheral nerve injury. Natural history and factors predicting severity of symptoms. *J Hand Surg* 1997; 22(3): 308–316.

11. Harden RN, Bruehl S, Stanton-Hicks M, et al. Proposed new diagnostic criteria for complex regional pain syndrome. *Pain Med* 2007; 8(4): 326–331.

12. Ishikawa K, Ogawa Y, Soeda H, et al. A new classification of the amputation level for the distal part of the fingers. *J Jpn Soc Microsurg* 1990; 3: 54–62.

13. Hattori Y, Doi K, Ikeda K, et al. Significance of venous anastomosis in fingertip replantation. *Plast Reconstr Surg* 2003; 111(3): 1151–1158.

14. Hasuo T, Nishi G, Tsuchiya D, et al. Fingertip replantations: importance of venous anastomosis and the clinical results. *Hand Surg* 2009; 14(1): 1–6.

15. Cheng L, Chen K, Chai YM, et al. Fingertip replantation at the eponychial level with venous anastomosis: an anatomic study and clinical application. *J Hand Surg Eur Vol* 2013; 38(9): 959–963.

16. Aksoy A, Gungor M, and Sir E. Fingertip replantation without and with palmar venous anastomosis: analysis of the survival rates and vein distribution. *Ann Plast Surg* 2017; 78(1): 62–66.

17. Hattori Y, Doi K, Sakamoto S, et al. Fingertip replantation. *J Hand Surg* 2007; 32(4): 548–555.

18. Zhao G, Mi J, Rui Y, et al. Correlation of volumetric flow rate and skin blood flow with cold intolerance in digital replantation. *Medicine (Baltimore)* 2017; 96(51): e9477.