ORIGINAL ARTICLE

A comparative study of digital nerve and digital arterial repairs performed using running versus interrupted suture techniques in finger replantations

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ABSTRACT

BACKGROUND: The present study aimed to retrospectively analyze replantations and compared the success rates of different suturing techniques.

METHODS: The data of 54 patients who underwent 82 finger replantations between January 2016 and April 2020 were retrospectively analyzed. Patients who underwent traumatic total finger amputations were included in the study. Arteries were repaired with two techniques, the simple running suture technique and the simple interrupted suture technique. Demographic patient data, comorbidities, operative data, post-operative care, the length of hospital stay, mechanism of injury, and site of injury were recorded. The groups were statistically analyzed. Functional outcomes were evaluated according to the Quick DASH score.

RESULTS: A total 54 patients with a mean age of 32.5±18.4 (range 1–75) who underwent finger replantation were included in the study. The mean duration of follow-up was 30.9±16.1 months. The mechanism of injury was guillotine-style injury in 29 (35.4%) fingers, avulsion injury in 15 (18.3%) fingers, and crush injury in 38 (46.3%) fingers. Forty-six fingers were repaired using a simple running suture technique, and 36 fingers were repaired using a simple interrupted suture technique. There was no statistically significant difference in terms of failure between the suture techniques (p=0.569). Further, although there was no statistically significant difference in Quick DASH scores according to the type of trauma in the simple running suture technique group (p=0.109), a comparison could not be made within simple interrupted suture technique group because of the small sample size. There was no statistically significant difference in failure rates between cases with an ischemia duration of <6 h and those with ischemia duration of 6–12 h (p>0.05). No statistically significant difference was found between the groups according to age, body mass index, arterial hypertension, or diabetes mellitus (p>0.05). Statistically significant differences were found in univariate analysis according to surgery time per digit, smokers, or vein repair (p<0.05). In total, 65 (79.3%) out of 82 finger replantations were successful. A total of 17 out of 30 fingers that could not undergo venous repair survived because of treatment with medicinal leeches.

CONCLUSION: Finger replantation is a difficult-to-perform surgical procedure requiring consideration of the surgical indications and the presence of an experienced surgical team. Regardless of the suture technique in finger amputations, performing venous anastomosis after arterial anastomosis is essential to restore circulation.

Keywords: Amputation; anastomosis; finger; replantation; running suture.

INTRODUCTION

Finger replantation is a technically difficult and lengthy surgical procedure. The most important factor in the success rate after finger replantation is the continuation of revascularization. In finger replantations, the aim is not only to provide the revascularization, but also accurate repair of bones and tendons lesions to obtain a functional finger.[1] The advances in microsurgical technique, microscopes, and surgical instruments have increased the chance of success and functional

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and cosmetic outcomes continue to improve. Replantation survival rates are reported as 60–90% in literature.[2–6] The use of microvascular technique in finger replantation, minimize ischemia times, guidelines for post-operative care, and strategies for treating complications has widely increased the survival rate in recent years.[7,8]

The decision to perform replantation is made by the surgeon and the patient. Appropriate patient selection is very important in terms of procedural success and functional outcomes. Expected functional outcomes following replant should be considered in the decision-making process.[9] Several authors have argued against attempted replantation in select cases where poor predicted function, stiff digits, or delayed return to work is expected.[10–12] Conditions such as age, occupation, the presence of comorbidities (diabetes and vascular disease), smoking status, severity and type of injury, time elapsed after trauma, dominant hand, the amputated finger, and the presence of additional injuries (thoracic, abdominal, and head trauma) should be considered when making a replantation decision. These data may affect post-replantation expectations and the replantation decision.[9] Pre-operative ischemia time, length of surgery, post-operative complications, and re-intervention requirement are the factors that affect survival rate. [1] Zhu et al.[13] demonstrated that increased age, non-sharp injury, heavy smoking, and prolonged ischemia time (>12 h) are associated with failure. In addition, drugs used perioperatively and postoperatively (dextran, heparin, acetylsalicylic acid, enoxaparin, and pentoxifylline) and the use of leeches are important in maintaining reperfusion. We used two different suture (the simple running suture technique and the simple interrupted suture technique) techniques in arterial repair in our study. To our knowledge, there is no specific literature that refers to the suture techniques in success of this type of surgery. We think that suture techniques used in cases where vascular tension is adjusted do not affect the failure rates. Failure in revascularization after vascular repair may develop due to an inverted or tensioned anastomosis. Although functional outcomes are influential in the replantation decision, conditions such as thumb amputation, multiple finger amputations, amputations in children, and transmetacarpal amputations should be considered as strong indications for finger replantation.[14] Replantation should be contraindicated in patients with active psychiatric disease who amputate their fingers themselves.[15]

The present study aimed to retrospectively analyze replantations and compare the influence of different suturing techniques on the success rates. We hypothesized that the suture technique used in vascular repair would increase the chance of success.

MATERIALS AND METHODS

This retrospective study evaluated the effect of suture techniques on replantation survival and revascularization after finger replantation. Data on finger replantations performed in Medline private hospital between January 2016 and April 2020 were retrospectively reviewed after obtaining the approval of the hospital ethics committee with decision number 0.1 dated June 16, 2020. All patients were operated by the first author. The first author has been doing finger replantation for 10 years. Patients with traumatic total finger amputations were included in the study. Patients who underwent revision surgeries in the first 24 h (after replantation at another center or at the study center), subtotal amputations, and amputations proximal to the metacarpophalangeal joint were excluded from the study. Demographic patient data (age and gender), comorbidities (type II diabetes, coronary artery disease, cerebrovascular disease, peripheral vascular disease, obesity, and Smoking), operative data (number of arterial anastomosis, number of venous anastomosis, vein graft, and surgery time), post-operative care (anticoagulation, leech therapy, re-exploration), and site of injury were recorded. Injury mechanism (guillotine-style, crush, or avulsion), injury level (according to the Komatsu and Tamai classification),[16] amputated finger, surgery time, blood transfusion, and the length of hospital stay were determined. Statistical analysis of the groups was performed using MedCalc® Statistical Software version 19.7.2 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2021), and the significance level was set at $p<0.05$. Success was defined as the presence of an appropriately replanted finger at the time of hospital discharge and the lack of need for secondary surgery, such as stump revision, during the follow-up. Failure was defined as shrinkage and necrosis of the replanted finger, or a bluish-black discoloration at discharge. Functional outcomes were evaluated according to the Quick DASH score at 6 months after surgery.[17]

Surgical Technique

The patient was taken to the operating room and the patient's arteries, veins, and nerves were marked with 10-0 nylon sutures under the microscope. Axillary brachial plexus block was administered to all the patients. A tourniquet was used during the exploration of the neurovascular structures at the site of the amputation. Dorsal veins and neurovascular structures were identified by creating a dorsal flap and volar flap over the dorsal extensor tendon with a midlateral incision. The flexor and extensor tendons were pulled with a fine-tipped clamp and fixed with a 21-gage needle. After all the structures were identified, the amputated finger was fixed with a Kirschner wire. Following this, the tendons, arteries and nerves, and dorsal veins were repaired in that order; the skin was then loosely and intermittently closed. Before anastomosis, the proximal and distal ends of the arteries were irrigated with heparinized fluid (5000 IU heparin in 100 cc saline), and pulsatile and rapid flow was obtained in the proximal end of the arteries. Arteries were repaired with 2 techniques, the simple running suture technique and the simple interrupted suture technique. Between 6 and 8 sutures were used in arteries repaired with simple interrupted suture technique. We aimed to repair at least two veins for the repair of each artery. 5 or 6 sutures were used in veins repaired with simple interrupted suture technique. The intima of the arteries was evaluated, and the vessel was shortened to a level where there was no intimal damage. In cases where tension in the arterial anastomosis area had to be reduced, a vein graft was harvested from the volar aspect of the wrist, or phalangeal shortening of 0.5–1.0 cm was performed. In cases where a shortening of more than 1 cm was required, arterial repair was performed using a vein graft (Fig. 1). The repair of both the arteries could not be performed in all of our cases. Artery and vein repairs were performed using 10-0 or 11-0 nylon sutures (Fig. 2). Digital nerve repair was performed with the simple running suture technique using perineural 10-0 nylon suture. None of our patients underwent nerve grafting. Extensor and flexor tendons were repaired using the simple running suture technique and the modified Kessler suture technique, respectively, using 4-0 nylon sutures. After arterial repair, heparin 5000 IU was administered as a bolus intraoperatively to all of our patients. Afterward, pentoxifylline 800 mg and heparin 10,000 IU in 1,000 cc of Pf Dextran (DHP fluid) were administered over 24 h in the following 3 days. Acetylsalicylic acid 300 mg and enoxaparin 0.4 mL once daily as well as paracetamol, nonsteroidal anti-inflammatory drugs, and narcotic analgesics were administered to all our patients during the hospitalization period. The surgical sites were covered with loose dressing and a thin sponge, and the involved hand was held at or slightly above the level of the heart after finger replantation. A towel heated with an iron was wrapped around the hand for 15 min/h.

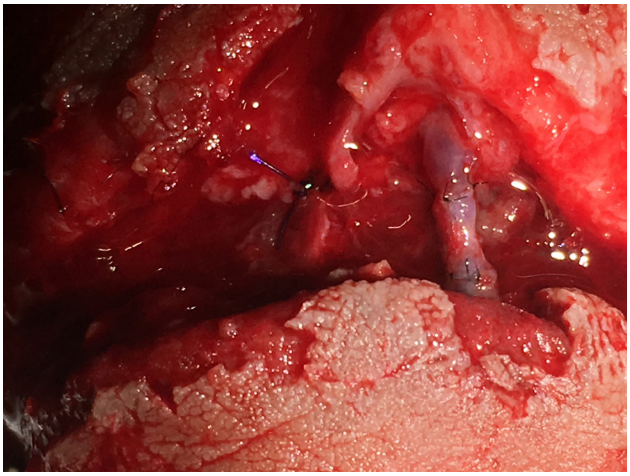

Figure 1. Repair with a simple interrupted single suture and a simple running suture in the distal and proximal part, respectively, using a vein graft after the vessel was shortened to a level where there was no intimal damage in a patient with finger amputation after an avulsion injury.

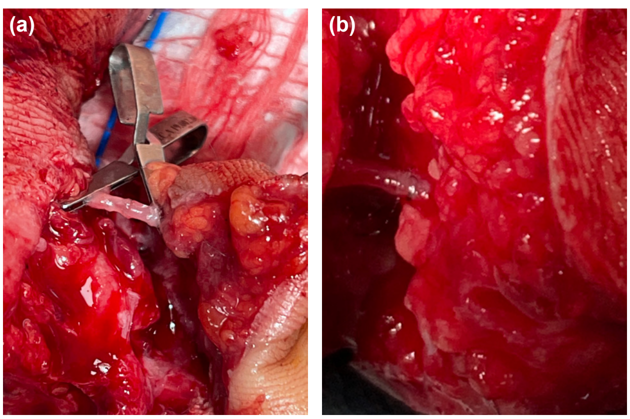

Image 2. (a) Perioperative view after anastomosis with simple running suture technique. **(b)** Perioperative view after anastomosis with simple interrupted suture technique.

RESULTS

A total of 54 patients were who underwent 82 finger amputations were included in the study. Finger replantation was performed in all patients without the need for surgical amputation and stump reconstruction. The mean duration of follow-up was 30.9±16.1 months (12–63). More than one finger was replanted in 18 (33.3%) patients (Fig. 3 and 4) and only one finger was replanted in 36 patients (66.7%); multi-digit amputations mostly occurred as a result of occupation-related accidents (Fig. 5). Amputations occurred after an occupation-related accident in 56% of the patients. Of the patients, 44 (81.5%) were male, and 10 (18.5%) were female. The mean age of the patients was 32.5±18.4 years (range 1–75). None of the patients had coronary artery disease, peripheral vas-

Figure 3. (a-d) Crush injury of multiple fingers.

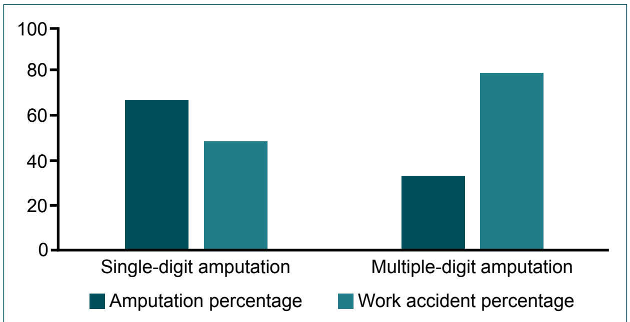

Figure 5. Occupational accident rates in single- versus multiple-digit amputations.

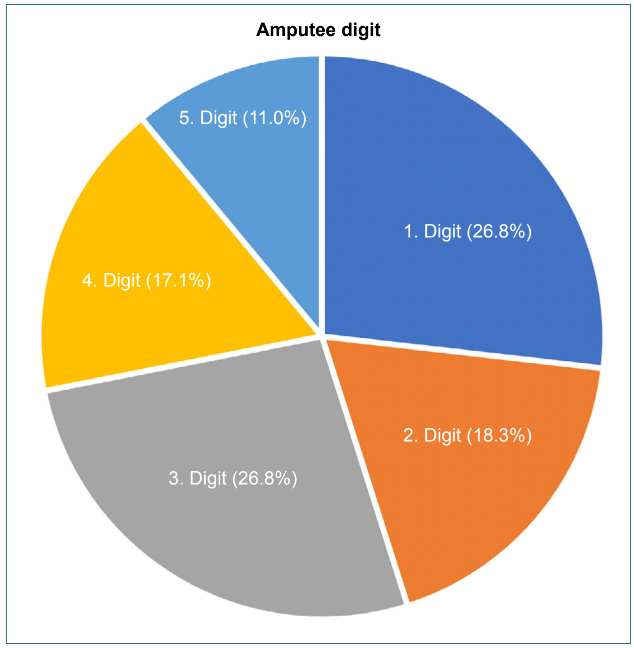

Figure 6. Replanted finger.

cular disease, and cerebral vascular disease. Forty-six fingers were repaired using the simple running suture technique (F/M: 8/38), whereas 36 fingers were repaired using the simple interrupted suture technique (F/M: 3/33). In total, 65 of the 82 finger replantations were successful, and our success rate was 79.3%. There was no statistically significant difference in the failure rates between the suturing techniques (p=0.569). The mean body mass index (BMI) was 26.4±2.6 (range: 22–32.4) months in running suture technique and 27.9±2.6 (range: 22.2–31.6) months in interrupted suture technique. No statistically significant difference was found between the groups according to age, BMI, arterial hypertension (HTA), or diabetes mellitus (DM) (p>0.05). Statistically significant differences were found in univariate analysis according to surgery time per digit, smokers, or vein repair (p<0.05) (Table 1).

Although there was no statistically significant difference in the failure rates between genders in the simple running suture technique group (p=1.0), the failure rate in women was significantly higher in the simple interrupted suture technique group (p=0.012). However, the injury type in these three female patients was crush injury (Table 2). Further, although

Table 1. Evalulation of risk factors on failure / univariate and multivariate logistic regression analysis

	Univariate analysis			Multivariate analysis		
	p	Odds ratio	95% CI	p	Odds ratio	95% CI
Tamai level	0.863			–	–	–
I vs 2	0.468	0.582	0.14–2.52	–	–	–
I vs 3	0.835	0.853	0.19–3.79	–	–	–
I vs 4	0.933	1.067	0.24–4.84	–	–	–
Quick Dash	0.565	1.017	0.96–1.08	–	–	–
Trauma mechanism	0.253			–	–	–
Guillotine-Crushing	0.113	3.095	0.77–12.51			
Guillotine-Avulsion	0.174	3.152	0.60–16.49			
Suture techniques	0.401	1.583	0.54–4.63	–	–	–
Venous anastomosis	<0.001	9.176	2.63–32.02	0.063	5.64	0.91–34.85
Surgery time per digit	0.016	1.011	1.002–1.020	0.220	1.008	0.99–1.02
Smoking	0.013	4.38	1.37–13.99	0.433	2.05	0.34–12.29
Diabetes mellitus	0.606	0.655	0.131–3.28	–	–	–
Hypertension	0.730	0.803	0.231–2.79	–	–	–
Body mass index	0.138	0.859	0.702–1.05	–	–	–
Ischemia time	0.345	1.100	0.90–1.34	–	–	–
Re-anastomosis during operation	0.437	2.033	0.340–12.17	–	–	–

CI: Confidence interval.

there was no statistically significant difference in Quick DASH scores in terms of the type of trauma in the simple running suture technique group (p=0.109), a comparison could not be made in the simple interrupted suture technique group because of the small sample size (Table 1).

Of the 82 replanted fingers, 22 (26.8%), 15 (18.3%), 22 (26.8%), 14 (17.1%), and 9 (11%) were thumbs, index fingers, middle fingers, ring fingers, and little fingers, respectively, (Fig. 6), and 21 (25.6%), 26 (31.7%), 19 (23.2%), and 16 (19.5%) were classified as the Tamai zone 1, 2, 3, and 4, respectively. No statistically significant difference was found in both groups according to the Tamai classification (p>0.05). The mechanism of injury was guillotine-style, avulsion, and crush injuries in 29 (35.4%), 15 (18.3%), and 38 (46.3%) fingers, respectively (Fig. 7–10; Table 1 and 3). When grouped according to injury type, success rates in guillotine-style, crush, and avulsion injuries were 89.6%, 73.7%, and 73.3%, respectively (Fig. 7). There was no statistically significant difference in replantation survival rate between the groups (p>0.05; Table 1 and 3).

Six patients had articular cartilage damage or bone loss. The mean ischemia time was 6.1±2.7 (range: 2–12) h. There was no statistically significant difference in failure rates between

Table 2. Demographic data

	Running suture technique		Interrupted suture technique		Total	p
Age						
Mean±SD	31.2±19.3		34±17.4		32.5±18.4	0.475
Med (min–max)	31.5 (1.5–75)		32.5 (1–57)		32 (1–75)	
	Success	**Failure**	**Success**	**Failure**		
Gender, n (%)						
Male	31 (81.6)	7 (18.4)	27 (81.8)	6 (18.2)	71 (86.6)	0.483
Female	7 (87.5)	1 (12.5)	0	3 (100)	11 (13.4)	
Ischemia time (hours), n (%)						
<6	22 (81.5)	5 (18.5)	14 (82.4)	3 (17.6)	44 (53.6)	1.0
6–12	16 (84.2)	3 (15.8)	13 (68.4)	6 (31.6)	38 (46.4)	0.451

Table 3. Injury mechanism

	Running suture technique		Interrupted suture technique		Total	p
	Success	Failure	Success	Failure		
Amputated finger, n (%)						
Thumb	13 (92.8)	1 (7.2)	6 (75)	2 (25)	22 (26.8)	
Index	3 (60)	2 (40)	9 (90)	1 (10)	15 (18.3)	
Middle finger	10 (90.9)	1 (9.1)	7 (63.6)	4 (36.4)	22 (26.8)	
Ring finger	7 (77.8)	2 (22.2)	4 (80)	1 (20)	14 (17.1)	
Little finger	5 (71.4)	2 (28.6)	1 (50)	1 (50)	9 (11)	
Trauma mechanism, n (%)						
Guillotine-style	15 (93.8)	1 (6.2)	11 (84.6)	2 (15.4)	29 (35.4)	0.021
Crushing	13 (76.5)	4 (23.5)	15 (71.4)	6 (28.6)	38 (46.3)	
Avulsion	10 (76.9)	3 (23.1)	1 (50)	1 (50)	15 (18.3)	
Tamai level, n (%)						
I	10 (83.3)	2 (16.7)	6 (66.7)	3 (33.3)	21 (25.6)	0.111
II	12 (92.3)	1 (7.7)	10 (76.9)	3 (23.1)	26 (31.7)	
III	6 (75)	2 (25)	9 (81.8)	2 (18.2)	19 (23.2)	
IV	10 (76.9)	3 (23.1)	2 (66.7)	1 (33.3)	16 (19.5)	

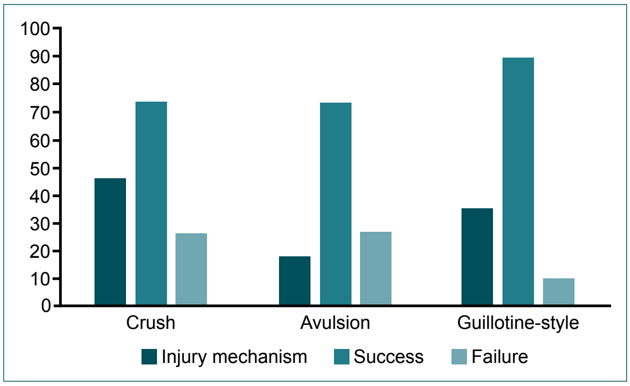

Figure 7. Percentage of replantation based on the injury mechanism, and the success rate for each mechanism.

cases with an ischemia time of <6 h and those with an ischemia time of 6–12 h (p=1.0 in the simple running suture group; p=0.451 in the simple interrupted suture group). The mean length of surgery was 170.06±59.34 (range: 85–310) min. Length of surgery did not affect the survival rate in both groups. The repair of one, two, or three veins was performed in 12, 31, and 9 fingers, respectively, whereas vein repair could not be performed in 30 fingers. The failure rate was significantly higher among patients in both the groups in whom vein repair could not be performed (p<0.05). The repair of one or two arteries was performed in 49 and 22 fingers, respectively, whereas artery repair could not be performed in 11 fingers. Arterial repair in these 11 fingers was performed using a vein

Table 4. Operative data

	Digits (n=82)
Ischemia time (hours), n (%)	
<6	44 (53.6)
6–12	38 (46.4)
Surgery time per digit, mean±SD	170.06±59.34
Arterial anastomosis, n (%)	
1	49 (59.8)
2	22 (26.8)
Vein graft	11 (13.4)
Venous anastomosis, n (%)	
0	30 (36.6)
1	12 (14.6)
2	31 (37.8)
3	9 (11)
DHP fluid, n (%)	82 (100)
Intraoperative heparin, n (%)	82 (100)

DHP fluid, pentoxifylline 800 mg and heparin 10.000 IU in 1.000 cc of Pf Dextran.

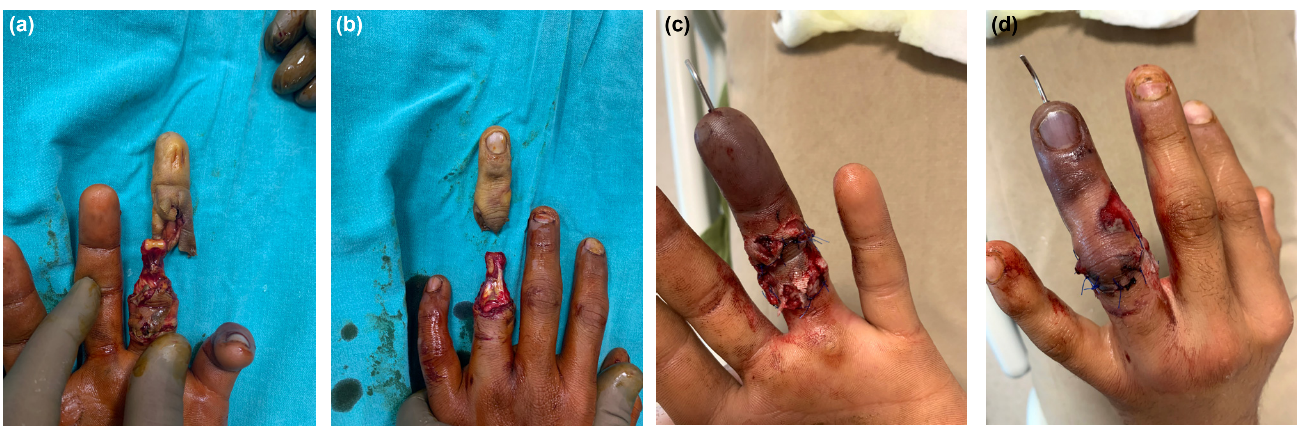

Figure 8. Degloving-style crush injury.

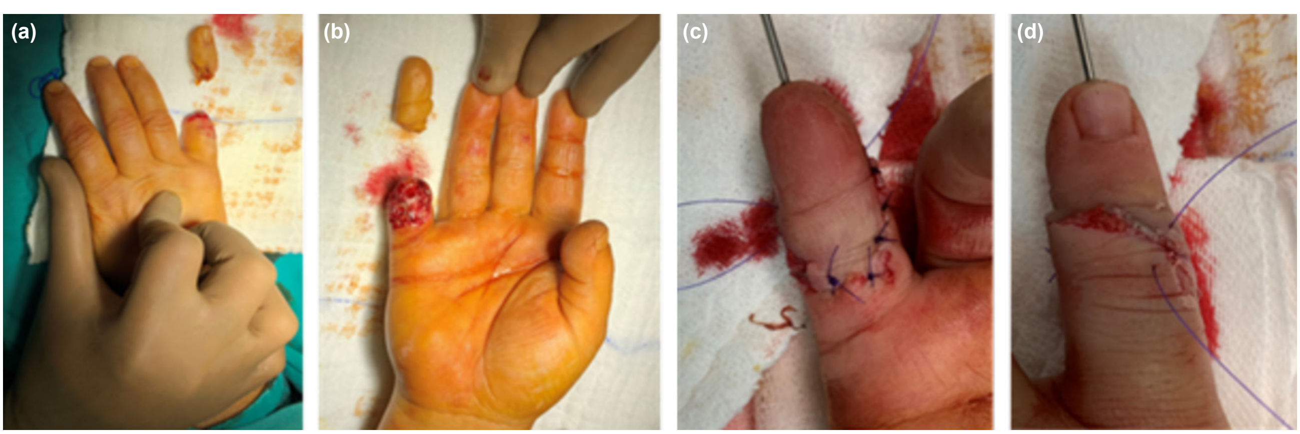

Figure 9. (a-d) Avulsion injury.

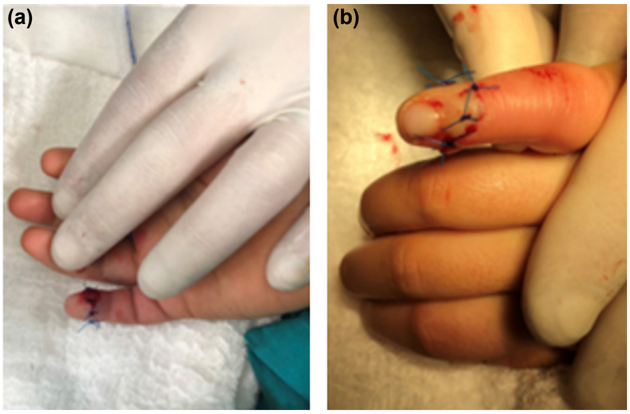

Figure 10. (a, b) Guillotine-style injury.

graft. Replantation survival was achieved in eight fingers who underwent repair using a vein graft (Table 4).

A total of 30 patients in whom venous circulation could not be restored underwent medicinal leech therapy and nail extraction and had their surgical sites dressed with heparinized sponges. Medicinal leeches were used every 2 h for the first 24 h, every 3 h on the 2nd and 3rd days, and 3 times daily between day 3 and 1 week (Fig. 11). Replantation survival was achieved in 24 out of 36 fingers in which venous circulation could not be restored but which received medicinal leech therapy. The failure rate was significantly higher among patients in both groups in whom vein repair could not be performed ($p<0.05$). One patient, in whom vein repair could not be performed and hemoglobin decreased after leech therapy, was administered one unit of erythrocyte suspension. In the simple interrupted suture group, six patients underwent re-anastomosis during surgery, and two of these patients later underwent surgical amputation. In the simple running suture technique group, re-anastomosis was not performed in any of the patients during surgery. Twenty-four patients were re-operated within 3 h due to compromise in arterial or venous circulation, and replantation survival was achieved in ten patients. A statistically significant difference was observed between re-anastomosis and failure in both the groups ($p<0.05$; Table 5). The mean length of hospital stay was 6.1±1.8 (2–9) days.

DISCUSSION

The decision to perform replantation after finger amputation depends on the condition of the stump, the level of injury, and the patient's physical condition and demands. The final decision regarding the replantation of a finger should be based on the long-term functional potential and the patient's general condition.[18] In our study, we found that the mechanisms of injury and smoking history were the most important preoperative factors affecting the survival rate. However, our study showed that factors such as age, gender, BMI, HTA, ischemia time, length of surgery, and DM were not affecting survival rate.

In some studies, it was stated that the age of patients had an affect on survival rate of digital replantation,[10,13,19] while in some studies it was stated that it had no affect.[1,4,20] In our study, we found that age of patients was not associated with the survival rate of digital replantation. In many studies, gender had not associated with the survival rate of digital replantation.[1,4,19–21] In their study, Oruç et al.[22] found that the chances of success were lower in women than those in men. In our study, we found that the success rate using the simple interrupted suture technique was lower in women than that in men; there was no difference between the sexes in

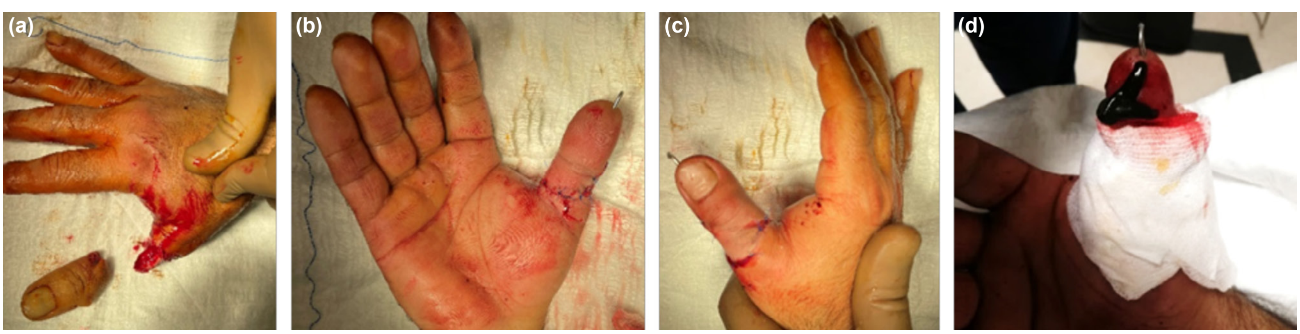

Figure 11. (a-d) The image of medicinal leech therapy in the early postoperative period in a patient with a degloving-style finger amputation caused by a thread in which venous anastomosis could not be performed.

Table 5. Postoperative care

	Running suture technique		Interrupted suture technique		Total	p
	Success	Failure	Success	Failure		
Leech use, n (%)	17 (68)	8 (32)	7 (63.6)	4 (26.4)	36 (43.9)	0.054
Re-operation for re-anastomosis, n (%)	5 (41.7)	7 (58.3)	5 (41.7)	7 (58.3)	24 (29.3)	0.627

terms of the simple running suture technique. We think that the low success rate in replantations performed with simple interrupted suture technique in women is due to the mechanism of injury. The chance of success decreases depending on the type of injury and not the gender.

Although the success or failure after finger replantation has been considered to be largely dependent on intraoperative decision, surgical skills, and technical competence, it is also significantly affected by the mechanism of injury.[23] The high success rate depends on the size, presence, and the degree of damage of the preserved vessels.[24] Zhu et al.[13] also reported a greater success rate in Tamai level II or more proximal level replants, likely due to greater vessel caliber facilitating technically easier repairs. When analyzing the injury mechanism and digit placement, we found no differences in success rate as in other studies.[1,4,25] Choi et al.[26] reported that the severe crush of parts was one of the contraindications of digital replantation. In the literature, reported survival after finger replantation is between 60% and 90%, whereas it has been reported to be 91.4%, 66.3%, and 68.4% in guillotine-style, avulsion, and crush injuries, respectively.[2–5,27] Similar to the rates reported in the literature, the replantation survival rates in our study were 89.6%, 73.3%, and 73.7%, respectively. Our results suggest that guillotine-style amputations, postoperative systemic heparin infusion, intact venous drainage, and acetylsalicylic acid use are associated with increased replant survival. Zhang et al.[28] found that robust venous drainage and the use of acetylsalicylic acid were associated with increased replant survival. Less consensus exists on the best post-operative anticoagulation regimen.[28] The anticoagulation regimen used by our center was acetylsalicylic acid, systemic heparin infusion, and enoxaparin. Surgical technique and injury type/mechanism are the main prognostic factors for the success or failure of finger replantation; however, post-operative anti-thrombotic regimens are also important in preventing thrombosis.[29]

Similar to our study, some meta-analysis studies showed that there was no significant association between ischemia time and replantation survival rate.[19–21] This can be attributed to the better tolerance of ischemia due to the lack of muscle tissue in the fingers. The success of survival rates in finger replantation depending on the level of amputation is controversial in the literature.[4,13,19–21,30] In their study, Navarro et al.,[1] longer ischemia time and length of surgery were found as predictive factors related to lesser graft survival. However, in this study, it was determined that ischemia time and operation time did not affect the graft survival rate statistically in patients who underwent revascularization. This is probably due to the presence of a certain venous drainage that may reduce the ischemic effects in cases of revascularization. In a meta-analysis by Ma et al.[19] reported a higher failure rate for digits following crush or avulsion injuries than after guillotine injuries. The present study found that the amputation level, length of surgery and ischemia time did not significantly affect the survival rate of digital replantation, but the success rate was higher in guillotine-style injuries although the mechanism of injury did not statistically affect the chance of success.

In some studies, it has been showed that smoking significantly correlate with replant failure,[19,21,25,31] while it does not affect the replant failure in some studies.[1,27,28,32] In our study, smoking showed significant influence on survival rate after digital replantation. In the other hand this study, similar to the reports in literature, other comorbidities factors (DM, HTA, and DM) showed no significant influence on survival rate after digital replantation.

In this study, we used tool was the quick DASH scores and found the average Quick DASH score was 6.44. In the meta-analysis study by Shaterian et al.,[9] they found the Quick DASH score of 12.8, and that patient-reported Quick DASH scores to correlate with the mechanism of injury and level of amputation ($p<0.05$). There was no such correlation in our study. The data examining postoperative strength, sensation, and DASH score are necessary to stratify patients who would benefit most from replantation.[9] By examining these data preoperatively, we can predict which patients will benefit after replantation. It will assist us in making the decision of stump revision or replantation. Ultimately, postoperative long-term functional outcomes should be considered when making the decision to replant.

Vascular repair can be performed using interrupted or running suture techniques. In both techniques, care should be taken to not invert the vessel at the anastomosis site as this may lead to thrombus formation because of luminal narrowing and turbulent flow and ultimately compromise arterial circulation in the early period. In our study, there was no statistically significant difference between the suture techniques in arterial anastomosis; however, there was no leakage at the anastomosis site after the flow was restored using the running suture technique. The absence of leakage after removal of the bulldog or approximator after achieving anastomosis shortens the operation time but may warrant re-anastomosis due to damage to the anastomosis line and secondary trauma to the vessel during reattachment. Six patients who underwent suturing using the interrupted suture technique required intraoperative re-anastomosis, and three of them underwent repair with a vein graft. Two of the six patients later underwent surgical amputation. We think that the use of the running suture technique along with appropriate equipment to avoid such complications will increase the chance of success.

Successful replantation of a finger depends on the restoration and maintenance of blood flow through the arterial anastomosis and venous outflow. This is one of the biggest challenges in replantation surgery. Traditional teachings have emphasized the importance of anastomosis of two tension-free veins for each repaired artery.[33] In their study, Matsuda et al.[34] concluded that the optimum number of veins repaired varied by region, although two or three vein repairs (88% survival) generally showed better replantation survival than the repair of only one vein (74%). Maintaining venous drainage plays a key role in replantation success. Arterial thrombosis and subsequent venous occlusion are among the most common causes of replantation failure.[35] It has been reported that the most common complication after replantation surgery is venous occlusion,[36] and failure rates of up to 32% have been reported after venous insufficiency.[24,37,38] The risk of arterial and venous thrombosis is highest in the first 2 days after surgery (80%) and decreases to 10% after the 3rd postoperative day.[39,40] The rate of re-exploration after a successful finger replantation has been reported to be 10–20%.[6,41] The decision and timing of re-exploration are also important determinants for successful outcomes after replantation.[42] Chia and Tay[43] found in their study that most of the cases undergoing re-exploration had arterial insufficiency and that most of them occurred within the first 48 h. Some studies showed that the chance of success increased after vein anastomosis with or without a vein graft in patients undergoing re-exploration due to venous congestion.[42–45] In our study, survival after re-anastomosis was achieved in 10 out of 24 patients who underwent re-exploration. As stated in other studies in the literature, close follow-up during the first 48–72 h is important for the success of replantation because arterial thrombosis may develop during this period. Venous anastomoses protect against postoperative external bleeding.[46] In addition, nail extraction, fish-mouth incision on the fingertip, dressing with heparinized sponges, and medicinal leeches can be used to increase the chance of success in patients in whom vein repair cannot be performed.[47,48] Need for leech therapy and operative re-exploration were significantly associated with eventually replant failure.[28] We also used medicinal leeches for treatment in our patients in whom vein repair could not be performed, and we preferred re-exploration first in our patients who developed venous congestion after vein repair. In our study, survival was achieved using these measures in 17 out of 30 patients who were could not undergoing vein repair. During the use of these alternative methods in patients in whom vein repair cannot be performed, the hemogram level should be closely monitored and blood transfusion should be performed when necessary. Buntic and Brooks,[49] in their study, reported that an average of 1.8 units of blood transfusion was required in 58% of their patients after fingertip replantation. In our study, we administered one unit of blood to a 6-year-old child because of the use of medicinal leeches for treatment after fingertip replantation, and no infection was observed in any of our patients after undergoing treatment with medicinal leeches. Likewise, Arami et al.[50] reported in their study that a 4-year-old boy required blood transfusion and that none of their patients had an infection after being treated with medicinal leeches. In a systematic review by Whitaker et al.[51] a 62.3% recovery rate was reported after treatment with medicinal leeches, mostly in cases with distal replantation. Hence, for successful replantation, the maintenance of blood flow is as important as establishing a good anastomosis using microsurgical techniques. On the other hand, although the inability to perform vein repair decreases the success rate in distal amputations compared with that in proximal amputations, the functional outcomes in distal amputations are better.[5,15]

There are several limitations in our study. The heterogeneity of the data for the various factors, such as age of patients, gender, mechanism of injury, amputation level, and the injured digits was high.

Conclusion

Replantation is a difficult surgical procedure requiring consideration of the indications and the presence of an experienced team. Many factors affect the chance of success, such as the team providing the transfer of the patient to the hospital, emergency service personnel, surgical equipment, postoperative care, and timing of re-operation. Similar to the reports in literature, the present study achieved high success rates in finger replantation. Regardless of the suturing technique used in finger replantation, performing venous anastomosis after arterial anastomosis is essential to restore circulation. Well-designed studies are needed to know the factors influencing the survival rates of finger replantations.

Ethics Committee Approval: This study was approved by the Private Medline Adana Hospital, Clinical Research Ethics Committee (Date: 16.06.2020, Decision No: 01).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Parmak replantasyonlarında devamlı ve kesintili dikiş teknikleri kullanılarak gerçekleştirilen dijital sinir ve dijital arter onarımlarının karşılaştırması

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AMAÇ: Bu çalışma, replantasyonları geriye dönük olarak analiz etmeyi ve farklı dikiş tekniklerinin başarı oranlarını karşılaştırmayı amaçladı.
GEREÇ VE YÖNTEM: Ocak 2016 ile Nisan 2020 arasında 82 parmak replantasyonu yapılan 54 hastanın verileri geriye dönük olarak incelendi. Travmatik total parmak amputasyonu yapılan hastalar çalışmaya dahil edildi. Arterler basit akan dikiş tekniği ve basit aralıklı dikiş tekniği olmak üzere iki teknikle onarıldı. Demografik hasta verileri, komorbiditeler, ameliyat verileri, ameliyat sonrası bakım, hastanede kalış süresi, yaralanma mekanizması ve yaralanma yeri kaydedildi. Gruplar istatistiksel olarak analiz edildi. Fonksiyonel sonuçlar Quick DASH skoruna göre değerlendirildi.
BULGULAR: Çalışmaya parmak replantasyonu uygulanan, yaş ortalaması 32.5±18.4 (dağılım 1–75) olan toplam 54 hasta alındı. Ortalama takip süresi 30.9±16.1 aydı. Yaralanma mekanizması 29 (%35.4) parmakta giyotin tarzı yaralanma, 15 parmakta (%18.3) avülsiyon yaralanması ve 38 (%46.3) parmakta ezilme yaralanmasıydı. Kırk altı parmak basit akan dikiş tekniği ile, 36 parmak ise basit aralıklı dikiş tekniği ile onarıldı. Dikiş teknikleri arasında başarısızlık açısından istatistiksel olarak anlamlı bir fark yoktu (p=0.569). Ayrıca basit akan dikiş tekniği grubunda travma tipine göre Quick DASH skorlarında istatistiksel olarak anlamlı bir fark olmamasına rağmen (p=0.109), örneklem büyüklüğünün küçük olması nedeniyle basit kesintili dikiş tekniği grubu içinde karşılaştırma yapılamadı. İskemi süresi <6 saat olan olgular ile iskemi süresi 6–12 saat olan olgular arasında başarısızlık oranlarında istatistiksel olarak anlamlı fark yoktu (p>0.05). Gruplar arasında yaş, VKİ, arteriyel hipertansiyon veya diabetes mellitus (DM) açısından istatistiksel olarak anlamlı fark bulunmadı (p>0.05). Basamak başına ameliyat süresine, sigara içenlere veya damar onarımına göre tek değişkenli analizde istatistiksel olarak anlamlı farklılıklar bulundu (p<0.05). Toplamda 82 parmak replantasyonundan 65'i (%79.3) başarılı oldu. Venöz onarımı yapılamayan 30 parmaktan toplam 17'si tıbbi sülük tedavisi nedeniyle hayatta kaldı.
TARTIŞMA: Parmak replantasyonu, cerrahi endikasyonların dikkate alınması ve deneyimli bir cerrahi ekibin varlığının gerekli olduğu, uygulanması zor bir cerrahi işlemdir. Parmak amputasyonlarında dikiş tekniği ne olursa olsun, arter anastomozundan sonra venöz anastomoz yapılması dolaşımın yeniden sağlanması için esastır.
Anahtar sözcükler: Ampütasyon; anastomoz; koşu sütürü; parmak; replantasyon.

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