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Our finger replantation results in the SARS-COV-2 pandemic

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ABSTRACT

Purpose: Finger injuries are important causes of emergency department admissions. In order to perform daily activities, the fingers must work fully and flawlessly. Replantation surgery aims to keep the injured finger alive and perform its functions almost completely. Our study aims to evaluate the reasons affecting the success of replantation during the SARS COV-2 pandemic period and to question the functional recovery after replantation.

Methods: Finger and hand replantation performed in a single center by the same surgeon were reviewed retrospectively. Preoperative, intraoperative, and postoperative and demographic data of the patients, mechanism of injury, ischemia duration, complications, surgical treatment approaches, and functional evaluation scales after rehabilitation were collected and statistically evaluated.

Results: In our study, 88 fingers of 56 patients were replanted. While single finger replantation was performed in 38 patients, multi-finger replantation was performed in 18 patients. The total success rate of replantation was 73.2%. While successful results were obtained in 81.6% of 38 patients with single finger replantation, 55.6% of 50 fingers in 18 patients with multiple finger replantation were successful. We found that 3 patients after surgery and 11 patients in the six months before surgery were positive for SARS COV-2. No finger loss or complications occurred in these 14 patients after replantation.

Conclusion: We concluded that SARS COV-2 disease had no significant effect on finger replantation surgery. Our study found that the most important variables affecting surgical success were the mechanism of injury, injury level, age, gender, anesthesia technique applied, number of repaired veins, smoking, and ischemia duration.

Key words: *Finger, amputation, replantation, SARS COV-2*

Introduction

Studies show that the SARS COV-2 virus, which affects the whole world, affects microcirculation, forms endothelial damage, microscopic clots, capillary vessel occlusion, and vascular integrity, and negatively affects tissue repair and angiogenesis [1]. Replantation success depends on injury type, injury level, ischemia duration, comorbidities, smoking, age, and gender [2]. One in ten patients admitted to the emergency department has a hand or finger injury [3]. Finger amputations occur mostly in young people, workers, and those with psychiatric illnesses [4]. When the recovery time and the time to return to work after finger injuries are calculated, it causes high economic losses [5].

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Our study aims to evaluate the patients with hand finger amputation during the SARS COV-2 pandemic according to their demographic data and injury mechanisms and investigate the effect of SARS COV-2 on the replantation outcome.

Materials and Methods

Study design

Ethics committee approval was obtained from the local ethics committee for this study (Date: 07.03.2022, approval no: 05). All hand finger replantation performed in a single center in the east of the country between October 2020 and February 2022 was retrospectively analyzed. Follow-up was 3-12 months. Finger replantation performed on amputation cases between the carpometacarpal (CMC) joint and the distal interphalangeal joint was included in our study. The replantation procedure was performed by a single surgeon in the same hospital. PCR testing was performed for each hospitalized patient during the COVID pandemic period and for all patients prior to surgery. Data of the study were obtained from patient files, surgery notes, preoperative and postoperative photographs, and replantation follow-up forms (Figure 1-2). Early control of the patients was done in the second week after discharge. Routine control examinations of the patients were performed at the 2nd, 4th, 6th, and 8th weeks.

Figure 1. Preoperative photographs.

Figure 2. Postoperative photographs.

K-wires were removed in the eighth week. The patients were considered as the pediatric group between the ages of 0-12, young adults between the ages of 13-18, and adults between the ages of 19-59. The cases were evaluated regarding age, gender, etiologic cause, mechanism of injury, affected fingers, amputation level, ischemia time, smoking, microsurgical repairs, revision, and success rates.

Surgical Technique

Patients were operated on under general anesthesia (GA), axillary block anesthesia (ABA), or digital block anesthesia (DBA). As described in the literature, the finger replantation procedure was repaired by microsurgical methods of bone fixation, extensor tendon, digital artery-vein-nerve, and flexor tendons, respectively [6]. Finger perfusion follow-up and warm application were performed at clinically frequent intervals for ten days after the operation. Intraoperative anticoagulant, 1 cc heparin, was administered intravenously. In postoperative follow-up, systemic low molecular weight heparin subcutaneous, antibiotic cefazolin IV in clean injuries, and cefazolin and gentamicin IV combination in dirty injuries were given for the open fracture treatment procedure. In case of venous insufficiency,

the replanted nail was pulled, and blood supply was ensured, elevation was applied. Anastomosis renewal and vein graft procedures were performed in patients with early complications.

Statistical Analysis

Statistical analyzes were performed with the Statistics for Social Sciences (SPSS) v18 package program. As descriptive statistics, arithmetic mean±standard deviation and median (minimum, maximum) were used to summarize numerical data, and numbers and percentages were used to summarize categorical data. The relationship between categorical data was analyzed with the Chi-square ($\chi 2$) test. P values below 0.05 were considered statistically significant.

Results

In our study, 88 fingers of 56 patients were replanted. 11 patients had positive SARS- COV-2 antigen test within six months before replantation surgery and three patients had positive SARS-COV-2 antigen test after surgery. Digit replantations in all 14 patients were successful. Single finger replantation was applied to these 13 patients. There were no postoperative early or late complications in these patients. In isolated or multiple finger replantation, the second finger was most frequently replanted (n=22). While single finger replantation was performed in 38 patients, multi-finger replantation was performed in 18 patients. The total success rate of replantation was 73.2%. While successful results were obtained in 81.6% of 38 patients with single finger replantation, 55.6% of 50 fingers in 18 patients with multiple finger replantation were successful. While the success rate in men after replantation was 75% (n=36), the success rate in women was 62.5% (n=5). The demographic data of the patients and the characteristics of the injury are given in detail in Table 1.

The mean age of the patients was 30.27±13.14 (min:3, max:59), and the mean follow-up period was 9.77 ± 1.84 (min:7, max:14) months. 16.1% (n=9) of the patients were smokers. While the success rate of replantation surgeries performed in smokers was 55.6%, the success rate in non-smokers was 76.6%. Thrombus and vasospasm were observed in 2 of 9 smokers, while finger loss occurred in 5 patients. There was no statistically significant relationship between smoking status and the operation's success (with or without finger loss) ($\chi 2$ =1.705 p=0.192).

Table 1. Demographic data of patients and characteristics of injury.

		n	%
Gender	Male	48	85.7%
	Female	8	14.3%
Age group	<13	4	7,1%
	13-18	6	10.7%
	19-59	46	82.2%
Smoking	Yes	9	16.1%
	No	47	83.9%
Zone of injury	Dorsal	34	60.7%
	Volar	12	21.4%
	Dorsal-volar	10	17.9%
Replanted side	Right	42	75%
	Left	14	25%
Number of amputated fingers	One	38	67.9%
	Two	9	16.1%
	Three	4	7,1%
	Four	5	8.9%
Amputation level	Zone 2	12	21.4%
	Zone 3	28	50%
	Zone 4	16	28.6%

While the success rate after replantation was 66.7% in those with amputation at zone 2 level, it was 75% in zone 3 and zone 4. The highest success rate was seen in zone 3 and zone 4, while the least success was seen in zone 2.

Two artery anastomosis was performed in 55.4% of the patients, and single artery anastomosis was performed in 44.6% of the patients. While the success rate was 68% (n=17) in those who had single artery anastomosis, it was 77.4% (n=24) in those who had two artery anastomosis. There were two vein incisions in 46.4%, three in 28.6%, single in 16.1%, and four in 8.9% of patients. While the success rate was 66.7% (n=6) in

Table 2. Injury mechanisms of patients and replantation success rate by injury mechanisms.

Injury mechanism	N	%	Success rate
Crushing	23	41.1%	60.9%
Guillotine	18	32.1%	83.3%
Firearm injury	8	14.3%	75%
Avulsion	7	12.5%	85.7%

those who had single vein anastomosis, 65.4% (n=17) in those who had two-vein anastomosis, 81.3% (n=13) in those who had three-vein anastomosis, and 81.3% (n=13) in those who had five-vein anastomosis 100% (n=5).

Vein grafting was performed in 20 patients. The majority of those who underwent vein grafting consisted of crushed (50%) and gunshot wounds (25%). While the success rate of replantation with vein grafting was 60% (n=12), the success rate in patients without vein grafting was 80.6% (n=29).

Replantation was applied to the patients due to crushing (41.1%) and guillotine injury, the second most common (32.1%). Injury mechanisms of the patients, injury types, and success rate of replantation according to injury mechanisms and types are given in Table 2 and Table 3.

The ischemia time was less than six hours in 75% of the patients, and between six and ten hours in 25%. While the success rate of replantation performed on fingers with an ischemia time less than six hours was 80.4% (n=37), the success rate was 80% (n=8) in patients with ischemia time between six and ten hours.

The success rate in finger replantation for those younger than 13 years old was 75%. The success rate was 83.3% in finger replantation performed in patients aged 13-18 years. The success rate in finger replantation performed in those aged 19-59 years was 71.7%.

While the most frequent crushing injuries occurred in men, 39.6% and 31.3%, guillotine injuries occurred in women, 50% crushing and 37.5% guillotine injuries.

Table 3. Injury types of patients and success rate of replantation according to injury types.

Type of injury	N	%	Success rate
Injury with a sharp object	11	19,7	90.9%
Crushing with a heavy object	9	16,1	66.7%
Injury with farm machinery	9	16,1	55.6%
Injury with a power tool	6	10,7	83.3%
Injury with explosive material	5	8,9	80%
Ring induced injury	4	7,1	75%
Tangling to chain	4	7,1	75%
Firearm injury	4	7,1	50%
Tangling to rope	2	3,6	100%
Injury due to traffic accident	2	3,6	50%

In all patients younger than 13 years of age, crush injury occurred; the most common type of injury was crushing (50%) at the age of 13-18 years, while guillotine (37%) and then crushing (34.8%) injuries occurred most frequently between the ages of 19-59.

The achieved success rates were as follows; isolated thumb replantation 80% (4/5), isolated index finger 87.5% (14/16), isolated middle finger 100% (5/5), isolated ring finger 57.1% (4/7), isolated pinky finger 80% (4/5).

53.6% of the patients were operated on under axillary block, 26.8% under the digital block, and 19.6% under general anesthesia. The success rate was 73.3% (n=11) in those performed with digital block, 72.7% (n=8) in those performed under general anesthesia, and 86.7% (n=26) in finger replantation performed with axillary block.

We evaluated the intraoperative, early postoperative, and late postoperative complications; 24,9% of the patients(n=14) had intraoperative complications. Thrombus and vasospasm occurred as intraoperative complications. Intraoperative hot application, papaverine, and prilocaine application were applied to 9 patients who developed vasospasm. Two of the five patients who developed thrombus underwent re-anastomosis, and three patients underwent vein grafting.

Early complications occurred in 12.5% (n=7) of the patients. Postoperative venous insufficiency developed in six patients, the nail bed was retracted and bled in these patients, and elevation was applied. Three patients were reoperated, and their vein anastomoses were renewed. Postoperative arterial insufficiency developed in two patients, they were operated on again, and their arterial anastomoses were renewed.

Late postoperative complications developed in 19.6% (n=11) of the patients. The complication was the loss of one or more fingers. Necrosis developed on the fingertip of a patient who was replanted from the proximal phalanx level, and three weeks later, the necrotic part was amputated. No union was observed in the patient who was replanted from the proximal and middle phalanx level of three fingers, and bone graft and plate application were performed between four and six months due to instability development. Tenolysis-z plasty was performed in five patients due to flexion limitation. Epidermolysis was observed in one patient, and debridement and skin grafting were performed.

While the success rate in patients who underwent revision after replantation was 42.9% (n=3), it was 77.6% (n=38) in those who did not need revision.

Bone shortening was performed in 33.9% (n=19) of the patients. The success rate of those who underwent bone shortening (73.7%) and those who did not (73%) was almost similar.

K-wire was used for bone fixation in 78.6% (n=44) of the patients, and k-wire+external fixator was used in 21.4% (n=12). While the success rate was 75% in the replantation performed with only k-wire used for bone fixation, the success rate was 66.7% in those using k-wire + external fixator.

Postoperative two-point separation of patients with successful replantation was good in two patients, moderate in 31 patients, and poor in eight patients. Postoperative Seddon sensory tests of patients with successful replantation were S3+ in 20 patients, S3 in 19 patients, and S4 in two patients.

The mean Sollerman function test score of the patients who completed the clinical follow-up and physical therapy period was calculated as 64.30±6.02 (min: 52, max: 74).

Discussion

Inflammation secondary to SARS COV-2 infections increases thrombus formation with endothelial cell damage and dysfunction, activation of the secondary coagulation cascade, high levels of von willebrand factor and secondary cytokines.[7] In addition, fingertip ischemia has been reported in patients infected with SARS-COV-2 where they treated in intensive care unit.[8] In the study of Eray et al., it was stated that the negative effects could last up to 6 months after the COVID-19 infection [9]. In the study of Etkin et al., it was stated that all cases of acute arterial thromboembolism consisted of patients over the age of 65 and with additional disease.[10] However, in our patient series, all of the patients who underwent replantation with COVID-19 were patients under the age of 65 and had no additional disease. Although systemic circulatory disorder occurs in SARS COV-2 infection and impaired thrombotic balance in early studies, it was seen in our study that SARS COV-2 does not negatively effect on results of finger replantation.[11, 12] The main reason for this may be the anticoagulant treatment we apply after surgery.

It has been reported that the results of multiple finger replantation are less successful than the results of single finger replantation.[13] In our study, the chance of success decreased as the number of fingers replanted for the same patient increased. The reason for this is the prolongation of the ischemia time due to the prolongation of the surgical time in multi-finger replantation, the increase in the early complications that may occur after the replantation, and the decrease in the surgeon's concentration over time.

Since the thumb is the most important finger for hand functions, the current conditions must be forced to replant thumb amputations, and efforts must be made

to replant the thumb even in the worst-case.[14] In our study, all thumb amputations meeting the replantation criteria were replanted. It was reported that thumb replantation is difficult, and the chance of success is low compared to other fingers.[15] In our study, however, isolated thumb replantation results were found to be less successful than second and third finger replantation results. The most successful results were obtained in isolated third finger replantation. The fourth finger replantation had the least chance of success.

Despite a good microsurgery application, vascular occlusions reduce the chance of success. In the first days after surgery, 90% of arterial thrombosis occurs due to platelet aggregation. Venous thrombosis is seen at a rate of 42% on the 1st postoperative day.[16] In our study, venous insufficiency developed in the postoperative follow-up of six patients, the nail was pulled out, and the nail bed bled, elevation was applied. Three patients were reoperated on postoperative day one, and their vein anastomoses were renewed. Postoperative arterial insufficiency developed in two patients, they were re-operated, and their anastomoses were renewed. In our study, loss of one or more fingers occurred in 11 patients after replantation.

Therefore, we applied the Sollerman function test, which shows the functional status after physical therapy, and we found that the patients did not experience a functional limitation in their work and daily activities, with an average score of 64.30±6.02. Post-replantation functional evaluation studies are limited in the literature. In a meta-analysis, it was seen that the grip strength was 78.7%, the sense of two-point separation was 7.8 mm, and the DASH score was 12.81 compared to the fingers of the opposite hand after replantation.[17] The separation of two points was measured as 10 mm in replantation after total avulsion and 8 mm in incomplete ones.[18]

The limitation of this study is that it was a single-center study. The fact that SARS COV-2 was detected in only three patients limited the possibility of evaluating the effects of SARS COV-2. The ischemia time was less than 10 hours for all cases, and the comparison could be made clearer if the number of cases with longer ischemia duration was higher. Since the number of smokers was limited, the effect of smoking could not be revealed as clearly as stated in the literature.

In conclusion, our study showed that SARS COV-2 did not affect replantation success, contrary to what was predicted. Despite developing microsurgery, experience, and opportunities, finger amputations continue to cause serious economic loss and functional disability for the individual and society. In our study, we found that the most important variables affecting surgical success were the mechanism of injury, injury level, age, gender, anesthesia technique applied, number of repaired veins, smoking, and ischemia duration.

Author contributions

NA: trial conduction, data analysis, writing of the manuscript. ND, MY, and OO: trial design and conduct, performing surgery, data analysis, and critical revision of the manuscript. ND and OO: data analysis and critical revision of the manuscript.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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