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Original Research

Appearance Outcomes of Repositioned Native Nail Plate as a Free Graft and Artificial Nail Plate in the Reconstruction of the Fingertip Injuries

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Purpose: The aim of this study was to evaluate the cosmetic outcomes of native nail plate (NP) replacement as a free graft and using an artificial NP in reconstruction of the fingertip injuries.
Methods: Two prospective cohorts of patients with fingertip injuries and avulsed NPs were evaluated. In group 1 (54 patients with 61 fingertip injuries), the native NP was available and suitable for placement under the proximal nail fold. In group 2 (31 patients with 32 fingertip injuries), the native NP was either lost or highly damaged and it was not suitable for use. In this group, an artificial NP was used. The final cosmetic outcomes of regrown NPs were evaluated at a minimum of 4 months after surgery using the Oxford Finger Nail Appearance Score.
Results: "Trapped in a door" was the most common cause of injury in pediatric patients, whereas work-related injuries were the most common cause of injury in adults. The difference between the mean appearance scores of the two groups favored group 1 (native NP). There was a negative correlation between the patient age and appearance scores, irrespective of the treatment group. The presence of a distal phalanx fracture adversely affected the appearance scores.
Conclusions: Replacing the native NP for splinting in fingertip injuries is advantageous. Fingertip injuries in pediatric patients and fingertip injuries without distal phalanx fractures achieved better cosmesis scores.
Type of study/level of evidence: Therapeutic III.

Fingertip injuries are common traumatic events. Fingertip injuries are commonly combined with nail plate (NP) avulsion or damage. NP has an important role in the hand and digit functions. NP protects the dorsal surface of the distal phalanx of the digits, increases the sensitivity of the fingertip, facilitates the pinch of small objects, allows scratching, and has an important aesthetic role. Among fingernail injuries, 14% to 50% also involve a distal phalangeal fracture.[1–3] It is advantageous to reposition NP in its place so that it may act as a natural splint.[4] However, in some cases of fingertip injuries, NP is either lost or highly damaged and it cannot be used. In these situations, an appropriate NP substitute that is sterile, inexpensive, easily available, adaptable, and strong enough to protect the fingertip from painful stimuli may be used.[1]

A few studies have compared the use of a native NP and an artificial NP substitute in fingertip injuries; however, no consensus currently exists regarding the most appropriate treatment modality.[3,5–7] Draelos[8] indicated that a prefabricated transparent nail-shaped plastic plate called artificial NP or fake NP could be an appropriate NP-substitute device.

In this study, we evaluated the appearance outcomes of native NPs replaced as a free graft and used artificial NP in reconstruction of the fingertip injuries. We hypothesized that the cosmetic outcomes of native NP replaced as a free graft and using an artificial NP in the reconstruction of fingertip injuries would have no difference based on the Oxford Finger Nail Appearance Score.

Declaration of interests: No benefits in any form have been received or will be received related directly to this article.

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Figure 1. A 5-year-old child with fingertip injury and loss of the native NP. An appropriately sized artificial NP was chosen and fashioned for insertion.

Materials and Methods

Two prospective cohorts were created in September 2021 and February 2022 on the basis of consecutive patients with fingertip injuries, injured nail beds, and avulsed NPs. In group 1, the native NP was available and suitable for placement under the nail fold. In group 2, the native NP was either lost or highly damaged such that it was not suitable for use. The University Committee for Medical Research and Ethics approved both studies (registration numbers ir/IR.UMSU.REC.1401.011 and ir/IR.UMSU.REC.1401.323). All patients involved in this study provided informed consent for participation.

Group 1 included 54 patients with 61 fingertip injuries. The mean age of the patients (42 male [78%] and 12 female [22%]) was 22 ± 19 years (range: 1–65 years). The median age was 16 years. Eight digits (13%) had a distal phalange fracture. The mean follow-up period was 5.2 ± 1.3 months. In this group, the native NP was preserved, macroscopically cleaned, and disinfected by bathing it in povidone-iodine for 10 minutes.

Group 2 included 31 patients with 32 fingertip injuries. The mean age of the patients (26 males [84%] and 5 females [16%]) was 31 ± 17 years (range: 1–59 years). Twenty digits (64%) had a distal phalange fracture. The mean follow-up period was 6.8 ± 2.4 months. In this group, a prefabricated transparent nail-shaped plate known as the artificial NP or fake NP was substituted for the lost NP. The artificial NPs were sterilized with ethylene oxide gas and fashioned to an appropriate length and desired shape (Fig. 1).

The two groups had a common 3-year-old patient with three injured fingertips in her left hand. In this child, the original NPs of the index and ring fingers were suitable and used, whereas an artificial NP was used for the middle finger (Figs. 2–4).

In all patients, the nail bed and its surrounding tissue were repaired. The nail beds were meticulously repaired with 6-0 or 7-0 absorbable sutures. The native NPs or artificial NPs were trephined to prevent pus or hematoma accumulation. Distal phalangeal fractures, if present, were treated with closed or open reduction and a splint or K-wire fixation. The native NPs or artificial NPs were fixed to the nail bed with a U or a figure-of-eight suture. Each patient received tetanus prophylaxis, a single dose of intravenous cefazolin, and a 5-day course of cephalexin for prophylaxis against infection. In both groups, the sutures through the native NP or artificial NP were removed at 4 weeks after surgery,[1] and artificial NPs in group 2 were removed subsequently. In group 1, the adherence of the native NPs was observed. Table 1 summarizes the characteristics of the two groups.

The final cosmetic outcomes of the regrown NPs were evaluated at a minimum of 4 months after surgery. The Oxford Finger Nail Appearance Score,[9] which was developed from a simplified design of the Zook Score,[10] was used to evaluate the final appearance of NP. The Oxford Finger Nail Appearance Score included five components of NP shape, adherence of NP to the nail bed, the appearance of the eponychial fold, NP surface, and split NP. The comparative components of the score of NP shape, eponychium fold, and NP surface varied from either “identical to opposite” or “different to opposite” regarding the contralateral digit. A nonidentically shaped NP to the opposite NP was a narrower or shorter NP, or one having an abnormal longitudinal or transverse curvature. An eponychial fold different from the opposite NP could present with a notch or synechia. NP surface different from the opposite NP was categorized as slightly rough or very rough, and as having longitudinal ribs or transverse grooves. The adherence of NP to the nail bed was scored as either “complete” or “incomplete.” The split component was scored as “absent” or “present.” Therefore, the scores were a binary measure of 0 or 1. The overall score was calculated as the sum of the variations of the five components, with 0 being the least and 5 being the most optimal appearance.[9] The sum of variations for each fingertip was used to determine a grade of excellent (score 5); very good (score 4), good (score 3), fair (score 2), and poor (score 1) for each nail unite.

Student’s *t* test, chi-square test, and Pearson correlation tests were used for statistical analysis. A *P* value of <.05 was considered statistically significant.

Results

The two most common causes of injury in the current study were trapping the finger in a door and work-related injury. In 27 of 33 (82%) patients aged <16 years, the injury was caused by trapping the finger in a door. In contrast, in 15 of 52 (29%) patients aged >16 years, the cause of the injury was trapping the finger in a door (Table 1). This difference was statistically significant ($P < .01$). Work-related injuries were the most common cause of injury in the 52 patients aged >16 years.

All the replaced native NPs detached and fell off the nail beds at a mean of 11 ± 9 days after removal of the fixation sutures. Table 2 demonstrates the final appearance scores of the two groups. The mean Oxford Finger Nail Appearance Score of group 1 was 4.2 ± 1.4 and that of group 2 was 3.2 ± 1.3 ($P = .002$).

There was a negative correlation between age and appearance score in group 1 ($r = -0.4$, $P < .01$), group 2 ($r = -0.4$, $P = .008$) and in the 85 patients of the both groups ($r = -0.4$, $P < .01$).

In group 1, the difference between appearance scores of 53 digits without a fracture (4.3 ± 1.4) and 8 digits with a fracture (3.3 ± 1.6) was significant ($P = .03$). In group 2, the difference between appearance scores of 11 digits without a fracture (3.8 ± 1.4) and 20 digits with a fracture (2.9 ± 1.3) was significant ($P = .045$). In the

Figure 2. A 3-year-old child with fingertip injuries of the index, middle, and ring fingers. The original NPs of the index and ring fingers were available and suitable for reconstruction, whereas NP of the middle finger was unavailable.

Figure 3. The original NPs of the index and ring fingers were repositioned and an artificial nail was placed in the middle finger. NPs and artificial nail were fixed with a figure-of-eight suture.

total 93 digits, the difference between appearance scores of 65 digits without a fracture (4.2 ± 1.4) and 28 digits with a fracture (3 ± 1.4) was statistically significant ($P < .01$).

The standard errors (SE) of the Oxford Finger Nail Appearance Score were similar in both groups. In group 1, the SE of Oxford Finger Nail Appearance Score was 0.5 (95% CI, −0.16 to 1.9) for digits without a fracture and 0.5 (95% CI, −0.18 to 1.9) for digits with a fracture. In group 2, the SE of Oxford Finger Nail Appearance Score was 0.5 (95% CI, −0.1 to 2.1) for digits without a fracture and 0.5 (95% CI, −0.1 to 2.1) for digits with a fracture. There was no minimally clinically important difference based on distribution data analysis in patients with or without fractures in both groups.

Infection was a major concern regarding the native NP or its substitute because NPs may act as a foreign body and attract bacterial pathogens, although no infections were observed in any patient in this study.

Discussion

Replacement of NP in the setting of nail-bed injuries was first described in 1938 (85 years ago).[5] A firm fixation of NP to the nail bed prevents the eponychial pocket from collapsing, prevents the ingrowth of granulation tissue from the eponychium and paronychium, and provides a template for regenerating a new NP. NP exerts a direct compressive force on the healing nail bed that molds the injured nail bed. The combined effects of these factors t and encourage the regrown NP to be flat and adherent.[4]

Figure 4. At 4 months postreconstruction, the appearance outcomes were excellent (score 5) and comparable with the opposite fingers.

In the case of a lost or highly damaged native NP, an NP substitute may be used. Several simple improvised NP-substitute devices that are easily available in every operating room include a silicone sheet, a piece of X-ray film, a piece of the suture envelope, a polyvinyl chloride sheet obtained from an infusion bag, a polypropylene sheet obtained from the reservoir of an infusion set, a fashioned syringe, a fashioned nasogastric catheter, a nonadherent gauze, and a polyurethane sponge.[11–14] However, soft materials such as a silicone sheet may tear easily, do not seat firmly in the eponychial fold, and may not conform to the natural nail-bed curve. Ogunro[4] developed a specific prosthetic splint made from polypropylene as a NP substitute. A perfect NP substitute should adapt to the natural nail-bed curve and should have enough rigidity to protect the sensitive nail bed from painful stimuli during the healing phase.[3] In this study, we used a preformed artificial NP as a native NP substitute because it is inexpensive, easily available in different sizes, can be sterilized with ethylene oxide gas, can be stored for emergencies, and can be trimmed to an appropriate length and desired shape.[8] To the best of our knowledge, the use of an artificial NP as a native NP substitute has been not described before.

Table 1
Characteristics of Group 1 with 54 Patients and 61 Fingertip Injuries and Group 2 with 31 Patients and 32 Fingertip Injuries

Characteristics	Group 1: Native Nail Plate	Group 2: Artificial Nail Plate	*P* Value
Mean age (y)	22 ± 19	31 ± 17	.04 (Student's *t* test)
Median age (y)	16	31	—
Number of patients aged <16 y	27	6	.01(chi-square test)
Sex	42 males; 12 females	26 males; 5 females	.2 (chi-square test)
The individual digit	16 thumbs (26%)	6 thumbs (19%)	—
	15 index fingers (24%)	3 index fingers (10%)	
	12 middle fingers (19%)	9 middle fingers (29%)	
	9 ring fingers (15%)	8 ring fingers (25%)	
	9 little fingers (15%)	5 little fingers (16%)	
Presence of distal phalange fracture	8 of 61 digits (13%)	20 of 32 digits (64%)	.01 (chi-square test)
Follow-up (mo)	5.2 ± 1.3	6.8 ± 2.4	.01 (Student's *t* test)
Cause of injury: trapping finger in door	36 of 54 patients (67%)	6 of 31 patients (20%)	—
Cause of injury: work-related	15 of 54 patients (28%)	22 of 31 patients (71%)	—

Table 2
The Oxford Finger Nail Appearance Scores of the Two Groups

Oxford Finger Nail Appearance Score	Group 1: Native Nail Plate	Group 2: Artificial Nail Plate
Score 5: excellent	45 (74%)	9 (28%)
Score 4: very good	5 (9%)	4 (13%)
Score 3: good	2 (3%)	7 (22%)
Score 2: fair	1 (2%)	9 (28 %)
Score 1: poor	6 (10%)	3 (9%)
Score 0	2 (3%)	—
	61 (100%)	32 (100%)

There are limited comparative studies between replacing a native NP and a NP substitute in fingertip injuries. Dove et al[5] compared a polyurethane foam sponge and paraffin gauze as replacements for the native NP for dressing raw nail beds. Although the rates of healing in the three groups were not statistically different; however, they found that replacement of the native NP had significant advantages on adherence and pain compared with the other dressings. Weinand et al[6] compared 240 native NP and 161 silicone NP splints for fingernail splinting after fingertip injuries. In the native NP splint group, 63 of 240 patients (26%) showed nail deformities. In the silicone NP splint group, 77 of 161 patients (48%) showed nail deformities. The difference between the two groups was statistically significant in favor of the native NP splint group and there were twice as many infections in the silicone NP group. In our study, the native NP group showed significantly fewer NP deformities than the artificial NP splint group. This may be explained by the fact that when native NP was available and suitable for replacement, the fingertip suffered lesser damage than when the native NP was lost or highly damaged.

Fingertip crush injuries with NP avulsions are commonly observed in pediatric patients. A systematic review of the interventions for treating fingertip crushed injuries in children conducted in Cochrane Database of Systematic Reviews demonstrated that no sound evidence and consensus currently exists regarding the most appropriate treatment modality.[3] Several authors have questioned the need for NP reinsertion in pediatric patients. Miranda et al[15] compared nail-bed repair using NP replacement with repair where NP was discarded in pediatric (5 ± 0.5 years old) patients. They concluded that NP should be discarded during repair in pediatric patients because of increased morbidity, including delayed wound healing and infection with no cosmetic benefit. Seiler et al[16] prospectively followed pediatric patients with simple NP avulsion (no laceration or displaced fracture). In that study, 12 patients chose surgical reinsertion of NP or a NP substitute (silicone sheet) and 39 patients chose nonsurgical management with simple antibiotic ointment dressing. At the 6-month follow-up, there was no difference in the appearance of NP.[16] In a pilot study that replaced or discarded NP after nail-bed repair in patients aged <16 years, Greig et al[17] found no statistical difference between the groups. The outcomes were based on the Zook appearance score. Vergara-Amador et al[7] studied 66 children with fingertip injuries and avulsed NP. They recommended the replacement of the same nail or the use of a NP substitute to avoid secondary nail deformities.

Our study has several limitations. First, the age variables of both groups were not homogenous. Second, the fingertip injuries varied in severity. A description of the extension of fingertip injuries may be elaborated by dividing the pulp, nail beds, and NPs into areas and distal phalange fractures into zones, numbers, and displaced or nondisplaced fragments;[18] however, the focus of this study was whether the native NP was available and suitable for reposition. It is reasonable to assume that patients with lost or highly damaged NPs accompanied by a distal phalange fracture suffered a more severe injury.

Our study, along with other studies, demonstrates that the replacement of the native NP for splinting in fingertip injuries is advantageous.[4,5,7] If NP is available, it should be cleaned, disinfected, and repositioned firmly to the nail bed. In case of a lost or highly damaged NP, an artificial NP can be used. Fingertip injuries in pediatric patients and fingertip injuries without a distal phalanx fracture achieve better appearance scores.

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