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Long-term Outcomes of Semi-Occlusive Film Dressing versus Homodigital Neurovascular Island Flap Reconstruction for Fingertip Amputations: A Retrospective Comparative Cohort Study

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Abstract

Introduction: Fingertip amputations are common hand injuries that may be managed surgically or conservatively. Semi-occlusive film dressing (SOFD) is an established non-operative treatment, but comparative long-term data are limited. This study evaluated long-term functional, sensory, and patient-reported outcomes after SOFD and compared them with a previously published historical cohort treated with homodigital neurovascular island flaps (HNIF).

Materials and Methods: This retrospective comparative cohort study included adults with isolated fingertip defects distal to the distal interphalangeal joint. The SOFD cohort comprised 20 patients (25 fingers) with a mean follow-up of 74 ± 21 months. Outcomes were compared with a previously published historical HNIF cohort of 28 patients (29 fingers) with a mean follow-up of 105 ± 42 months. Assessments included range of motion, grip strength, Disabilities of the Arm, Shoulder and Hand (DASH) score, sensory testing, nail and scar outcomes, pain, patient satisfaction, and return to work.

Results: Patients in the SOFD cohort were older at the time of injury than those in the HNIF cohort (52.5 ± 15.7 vs. 42.9 ± 15.5 years; $p = 0.042$), and follow-up was shorter (74 ± 21 vs. 105 ± 42 months; $p = 0.020$). Time to complete wound healing was shorter after SOFD (7.3 ± 3.2 vs. 14.6 ± 9.6 weeks; $p < 0.001$). Grip strength, DASH score, and overall patient satisfaction did not differ significantly between cohorts. Static two-point discrimination differed statistically between cohorts (3.85 ± 1.2 vs. 4.0 ± 1.1 mm; $p = 0.015$), whereas Semmes-Weinstein monofilament testing showed no significant difference ($p = 0.752$). No patient in the SOFD cohort required physiotherapy or reoperation, compared with 57.1% and 17.9%, respectively, in the historical HNIF cohort.

Conclusions: In this retrospective comparison with a historical HNIF cohort, SOFD was associated with shorter healing time and similar long-term functional and patient-reported outcomes. The small absolute difference in two-point discrimination should be interpreted cautiously. These findings support SOFD as a less invasive treatment option for selected fingertip amputations, while the non-concurrent cohort design precludes causal conclusions.

Introduction

Over recent decades, the management of fingertip amputations has evolved from a predominantly surgical approach toward increasing use of conservative semi-occlusive film dressings (SOFD). Initially described by Mennen and Wiese in the early 1990s, semi-occlusive dressings create a moist wound environment that facilitates secondary healing without flap coverage.[1] Case series and prospective studies have reported high healing rates, low complication rates, and high patient satisfaction for Allen type I–IV fingertip injuries treated with semi-occlusive dressings.[2] However, follow-up in most studies is limited, and evidence on durable functional and sensory outcomes remains sparse.[2]

Homodigital neurovascular island flaps (HNIF) remain an established reconstructive option for fingertip defects requiring sensate, vascularized soft-tissue coverage. Surgical reconstruction may be particularly

appropriate for complex defects with substantial tissue loss or exposed critical structures. Although favorable functional and sensory outcomes have been reported, long-term comparative data between HNIF reconstruction and conservative SOFD treatment are limited.[3, 4] This evidence gap is clinically relevant when balancing invasiveness, rehabilitation requirements, complications, and long-term function.

The aim of the present study was therefore to evaluate long-term clinical, functional, sensory, cosmetic, and patient-reported outcomes after a standardized SOFD protocol and to compare these findings with a previously published historical HNIF cohort.[4] We hypothesized that SOFD would provide durable functional and sensory outcomes while reducing treatment burden compared with flap reconstruction.

- Methods

Study Design and Patient Selection

This retrospective comparative cohort study was conducted in accordance with the Declaration of Helsinki and was approved by the responsible institutional ethics committee (approval number withheld for blinded review). Written informed consent was obtained from all participants. Patients treated with a standardized SOFD protocol at the study center between January 2015 and December 2021 were identified retrospectively. Their long-term outcomes were compared with those of a previously published historical cohort treated with HNIF reconstruction.[4]

Inclusion criteria were:

1. Age ≥ 18 years
2. Isolated fingertip defect distal to the distal interphalangeal (DIP) joint
3. Treatment with a standardized SOFD protocol or HNIF reconstruction
4. Minimum follow-up of 24 months

Exclusion criteria were:

1. Systemic conditions impairing wound healing (e.g., diabetes mellitus, peripheral vascular disease)
2. Prior surgery on the affected digit

SOFD Intervention and Post-treatment Care

All SOFD treatments were performed by or under the supervision of a hand surgeon at the study center. After debridement and hemostasis under digital anesthesia, a transparent semipermeable polyurethane film dressing was applied to cover the wound and its margins completely. The initial dressing was left in place for 7 days. Thereafter, dressings were changed every 4.8 ± 2.1 days until complete epithelialization. Active digital mobilization was encouraged, and no formal physiotherapy was prescribed.

Outcome Measures

Primary outcome measures were:

- Sensory recovery, assessed by static two-point discrimination (2PD) and Semmes–Weinstein monofilament testing (SWMT)
- Patient-reported functional outcome, measured using the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire

Secondary outcome measures included:

- Range of motion (ROM) of DIP, PIP, and MP joints
- Grip strength (Jamar® dynamometer)
- Nail deformity and cosmetic outcome (Vancouver Scar Scale, nail shortening, hook-nail deformity, clubbing)
- Patient satisfaction (11-point numeric scale)
- Pain at rest and during motion (11-point numeric scale)
- Return to work

Data Collection

Follow-up assessments were conducted by an independent examiner at a mean of 74 ± 21 months after treatment (minimum 35 months). Range of motion was measured using a standard goniometer. Grip strength was recorded in kilograms and expressed relative to the contralateral side. Sensory recovery was assessed using SWMT (2.83, 3.61, and 4.31 g) and static 2PD. Nail and scar appearance were documented photographically and graded. Patient-reported outcomes included pain, DASH score, and satisfaction.

Comparative Analysis with the Historical Flap Cohort

Key outcomes were compared with data from the previously published historical HNIF cohort [4]. Continuous variables were assessed for normality using the Shapiro-Wilk test. Normally distributed variables were compared using unpaired Student's t-tests and non-normally distributed variables using Mann-Whitney U tests. Categorical variables were analyzed using chi-square tests or Fisher's exact tests, as appropriate. All tests were two-sided, with a significance threshold of $p < 0.05$. Continuous data are reported as mean ± SD (range; median) and categorical data as n/N (%). Because the comparison involved non-concurrent cohorts, between-group findings were interpreted as associations rather than causal treatment effects.

- Representative Clinical Cases

Two representative cases illustrate the clinical course and long-term appearance observed with the two treatment approaches.

Case 1

A 48-year-old man sustained a crush injury to the right middle finger, classified as an Allen type III injury (A). The defect was reconstructed with a radial homodigital neurovascular island flap (B). At 71 months, follow-up demonstrated a stable, well-healed pulp reconstruction (C).

Case 2

A 60-year-old man sustained a crush injury to the left thumb, classified as an Allen type II injury (A). The injury was treated with a semi-occlusive film dressing. Images at 27 months show the long-term result (B, C).

Results

Patient Cohort and Follow-up

Twenty patients with 25 injured fingertips were available for long-term follow-up. Mean age at injury was 52.5 ± 15.7 years (range 19–79; median 55 years), and mean follow-up was 74 ± 21 months (range 37–115; median 70 months). Dressing changes were performed by private hand surgeons in four patients (20%) and in the study center outpatient clinic in 16 patients (80%). Five patients (25%) required inpatient admission because of concomitant injuries, with a mean hospital stay of 2.2 ± 1.3 days (range 1–4; median 2 days). Patient demographics are summarized in Table 1.

Table 1
Patient Demographics

Parameter	SOFD Cohort (n = 20, fingers = 25)	HNIF Cohort (n = 28, fingers = 29)	p-Value
Age at injury (years)	52.5 ± 15.7 (19–79; median 55)	42.9 ± 15.5 (11–73; median 44.5)	0.042
Gender (M/F)	17/3	24/4	1.0
Dominant hand affected	8/20 (40%)	14/28 (50%)	0.695
Manual labor	12/20 (60%)	17/28 (60.7%)	0.960
Follow-up (months)	74 ± 21 (35–115; median 70)	105 ± 42 (42–169; median 112)	0.020

Healing and Complications

All injuries achieved complete epithelialization after a mean of 7.3 ± 3.2 weeks (range 2–12; median 6.5 weeks). No complications were observed in the SOFD cohort, and no additional surgical procedures were

required. Dressings were changed at a mean interval of 4.8 ± 2.1 days (median 4 days). No patient received formal physiotherapy.

Functional Outcomes

Range of Motion: Total active motion of the DIP, PIP, and MP joints was equivalent to the uninjured contralateral side in all patients.

Grip Strength: Mean hand grip strength was 36.7 ± 10.5 kg, corresponding to 100% of the contralateral hand (median 39 kg). Individual finger grip strength ranged from 79.2% to 88.3% of the uninjured side.

Sensory Outcomes

Static two-point discrimination (2PD) averaged 3.85 ± 1.2 mm (median 3.5; range 2–6) in injured fingertips and 3.9 ± 1.3 mm in the contralateral fingers ($p = 0.908$). Semmes-Weinstein monofilament testing (SWMT) showed normal or near-normal thresholds in all fingertips, with no significant difference from the contralateral side ($p = 0.841$). Six patients (24%) reported mild tingling along one digital nerve, one patient (4%) reported reduced sensation, three patients (12%) reported transient numbness, and one patient (4%) had a mild Tinel sign on examination.

Patient-Reported Outcomes

Pain at rest averaged 0.24 ± 1.0 and pain during motion 1.2 ± 2.5 on an 11-point scale (medians 0 and 0, respectively). Twenty-three of 25 fingers (92%) had no resting pain and 20 of 25 fingers (80%) had no motion-induced pain. Cold sensitivity occurred in four fingertips (16%). Mean DASH score was 1.0 ± 3.1 (median 0), with work and sport modules averaging 1.79 ± 4.5 and 2.23 ± 8.3, respectively. Overall satisfaction was 8.35 ± 1.8 (median 9), and 19 of 20 patients (95%) indicated that they would choose the same treatment again. Seventeen of 20 patients (85%) were employed at the time of injury; all returned to their original occupation after a mean absence of 4.7 ± 3.8 weeks (range 0–12; median 6 weeks).

Nail and Cosmetic Outcomes

Mean defect size at follow-up was 1.9 ± 0.9 cm in length and 1.5 ± 0.54 cm in width (median 1.8 × 1.5 cm). The mean Vancouver Scar Scale score was 1.1 ± 1.2 (median 1). Nail preservation was 100%; six fingertips (24%) showed nail shortening (mean 3.5 ± 2.2 mm; median 3 mm), and hook-nail deformity was present in eight fingertips (32%).

Comparative Outcomes: SOFD versus HNIF

Patients in the SOFD cohort were older at the time of injury than those in the historical HNIF cohort (52.5 ± 15.7 vs. 42.9 ± 15.5 years; $p = 0.042$; Table 1). No statistically significant differences were observed in sex distribution, dominance of the affected hand, or the proportion engaged in manual labor. Follow-up

duration was shorter in the SOFD cohort (74 ± 21 vs. 105 ± 42 months; p = 0.020), reflecting the later treatment period of the SOFD cohort.

Time to complete wound healing was shorter in the SOFD cohort (7.3 ± 3.2 vs. 14.6 ± 9.6 weeks; p < 0.001). At final follow-up, grip strength, DASH scores, and overall patient satisfaction did not differ significantly between cohorts. In the historical HNIF cohort, 16 of 28 patients (57.1%) required physiotherapy because of scar formation or impaired range of motion, with a mean of 15.3 ± 14.6 sessions (range 2–60), whereas no patient in the SOFD cohort required physiotherapy. Reoperation for bleeding or wound-healing complications was reported in 17.9% of the HNIF cohort, compared with no reoperations in the SOFD cohort.

Sensory outcomes are presented in Table 2. Static 2PD was statistically different between cohorts (3.85 ± 1.2 mm after SOFD vs. 4.0 ± 1.1 mm after HNIF; p = 0.015), although the absolute difference was small. The distribution of SWMT thresholds did not differ significantly between cohorts (p = 0.752; Fig. 1).

Table 2. Sensory Outcomes

Parameter	**SOFD Cohort (n = 25)**	**HNIF Cohort (n = 29)**	**p-Value**
2PD (mm)	3.85 ± 1.2 (median 3.5; range 2–6)	4.0 ± 1.1 (median 4; range 2–6)	0.015
SWMT 2.83 g (%)	52%	48%	0.752
SWMT 3.61 g (%)	29%	48%	0.752
SWMT 4.31 g (%)	19%	4%	0.752

Discussion

This retrospective comparative cohort study provides long-term outcome data after SOFD treatment of fingertip amputations and contextualizes these findings against a previously published historical HNIF cohort.[4] SOFD was associated with shorter time to complete wound healing, while long-term grip strength, DASH scores, and overall satisfaction were similar between cohorts. No patient in the SOFD cohort required physiotherapy or reoperation. These findings suggest that SOFD can provide durable recovery with a comparatively low treatment burden in appropriately selected fingertip injuries. Because the cohorts were non-concurrent and differed in age and follow-up duration, however, the between-group findings should not be interpreted as evidence of a causal treatment effect.

Semi-occlusive treatment has gained increasing attention as a non-operative option for fingertip amputations. Since the work of Mennen and Wiese,[5] multiple clinical series have reported high healing rates, low complication rates, and satisfactory sensory and cosmetic outcomes after conservative management.[1, 2] A moist, occlusive wound environment may support angiogenesis, keratinocyte migration, and epithelial regeneration, providing a biological rationale for secondary healing under semi-

occlusion.[7] The favorable long-term sensibility and pulp quality observed in the present cohort are consistent with this concept.

Previous series have reported healing times of approximately 20–30 days after semi-occlusive treatment.[1, 2] In the present cohort, patient-reported complete wound healing occurred after a mean of 7.3 weeks. Although longer than in some published series, this interval was shorter than the 14.6 weeks reported in the historical HNIF cohort. Differences in definitions of complete healing, injury severity, and follow-up methodology may limit direct comparisons across studies.

HNIF reconstruction remains an important option for fingertip defects requiring vascularized, sensate tissue coverage and remains relevant to reconstructive training, particularly for larger or more complex defects. Long-term studies have demonstrated preserved motion, functional grip strength, and favorable sensory recovery after HNIF reconstruction.[4] Systematic reviews and recent clinical series report static 2PD values commonly around 4–5 mm, together with high flap survival rates and predictable anatomical restoration.[4, 8, 9] Accordingly, the present findings should not be interpreted as eliminating the role of flap reconstruction, but rather as supporting SOFD as an alternative in appropriately selected injuries.

Sensory recovery in the SOFD cohort was favorable. Static 2PD and SWMT were comparable with the contralateral uninjured digits. In the between-cohort comparison, static 2PD differed statistically (3.85 vs. 4.0 mm; $p = 0.015$), whereas SWMT did not ($p = 0.752$). Given the absolute 2PD difference of only 0.15 mm, its clinical relevance is uncertain and the result should be interpreted cautiously. Pastor et al. [6] likewise reported comparable sensory outcomes after semi-occlusive treatment and surgical reconstruction, although with shorter follow-up.

The absence of reoperations and formal physiotherapy in the SOFD cohort is consistent with the low treatment burden reported for semi-occlusive management. Pastor et al.[6] also observed fewer complications with semi-occlusive treatment, and the systematic review by Esmaeili et al.[2] reported that only a small proportion of conservatively treated patients subsequently required surgery. These observations are clinically relevant, but comparisons with the historical HNIF cohort may also reflect differences in patient selection, injury characteristics, treatment era, and rehabilitation practice.

Several limitations warrant consideration. First, the retrospective design and use of a historical, previously published reference cohort preclude causal inference and introduce potential selection and temporal bias. Second, the cohorts differed significantly in age and follow-up duration, and residual differences in injury characteristics may have confounded between-group comparisons. Third, the sample size was limited, and multiple outcomes were tested without adjustment for multiplicity; isolated p values, particularly the statistically significant but very small difference in 2PD, should therefore be interpreted cautiously. Fourth, time to healing in the SOFD cohort was based on the available clinical documentation/patient-reported course and may not be directly equivalent to the definition used in the historical cohort. Nevertheless, the long follow-up, objective sensory testing, and inclusion of patient-reported outcomes provide clinically useful information on the durability of SOFD treatment.

In conclusion, SOFD was associated with shorter healing time and similar long-term functional and patient-reported outcomes compared with a historical HNIF cohort. Sensory recovery was favorable with both approaches, and the small absolute difference in static 2PD is of uncertain clinical relevance. SOFD may therefore represent a less invasive treatment option for selected fingertip amputations. Prospective, contemporaneous comparative studies are needed to define treatment-specific advantages more reliably.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and was approved by the responsible institutional ethics committee (approval number withheld for blinded review). Written informed consent was obtained from all participants.

Consent for publication

Written informed consent for publication of clinical details and images was obtained from the participants.

Author Contribution

All authors contributed to the study conception and design. N. B. collected and analyzed the data and wrote the first draft of the manuscript. A. A.-W. revised the manuscript. All authors reviewed and approved the final manuscript.

Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Figures

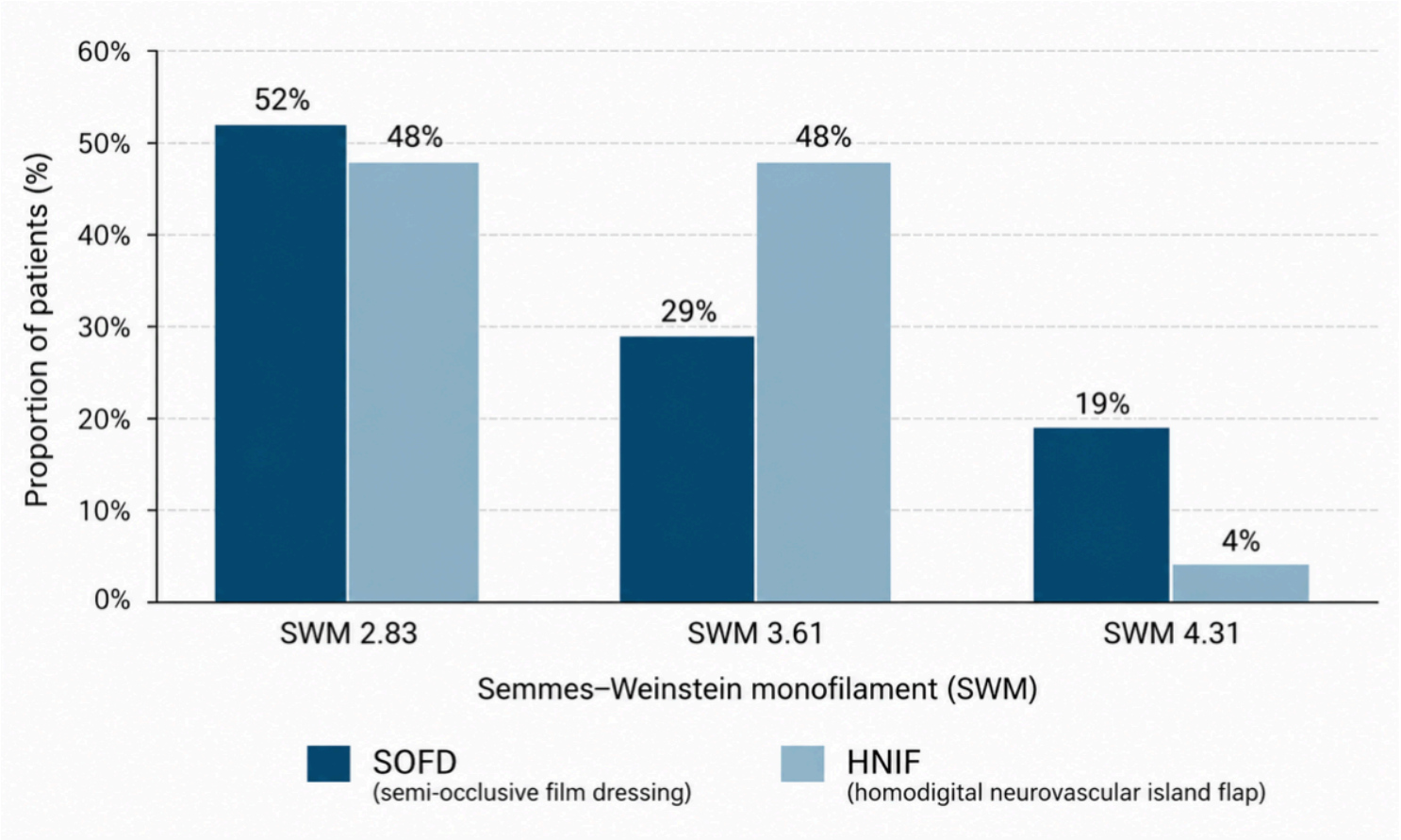


Figure 1

Distribution of Semmes-Weinstein monofilament (SWMT) thresholds after semi-occlusive film dressing (SOFD) and homodigital neurovascular island flap (HNIF) reconstruction. The distribution did not differ significantly between cohorts (Mann-Whitney U test, p = 0.752).



Figure 2

Unnumbered image in the Methods section.

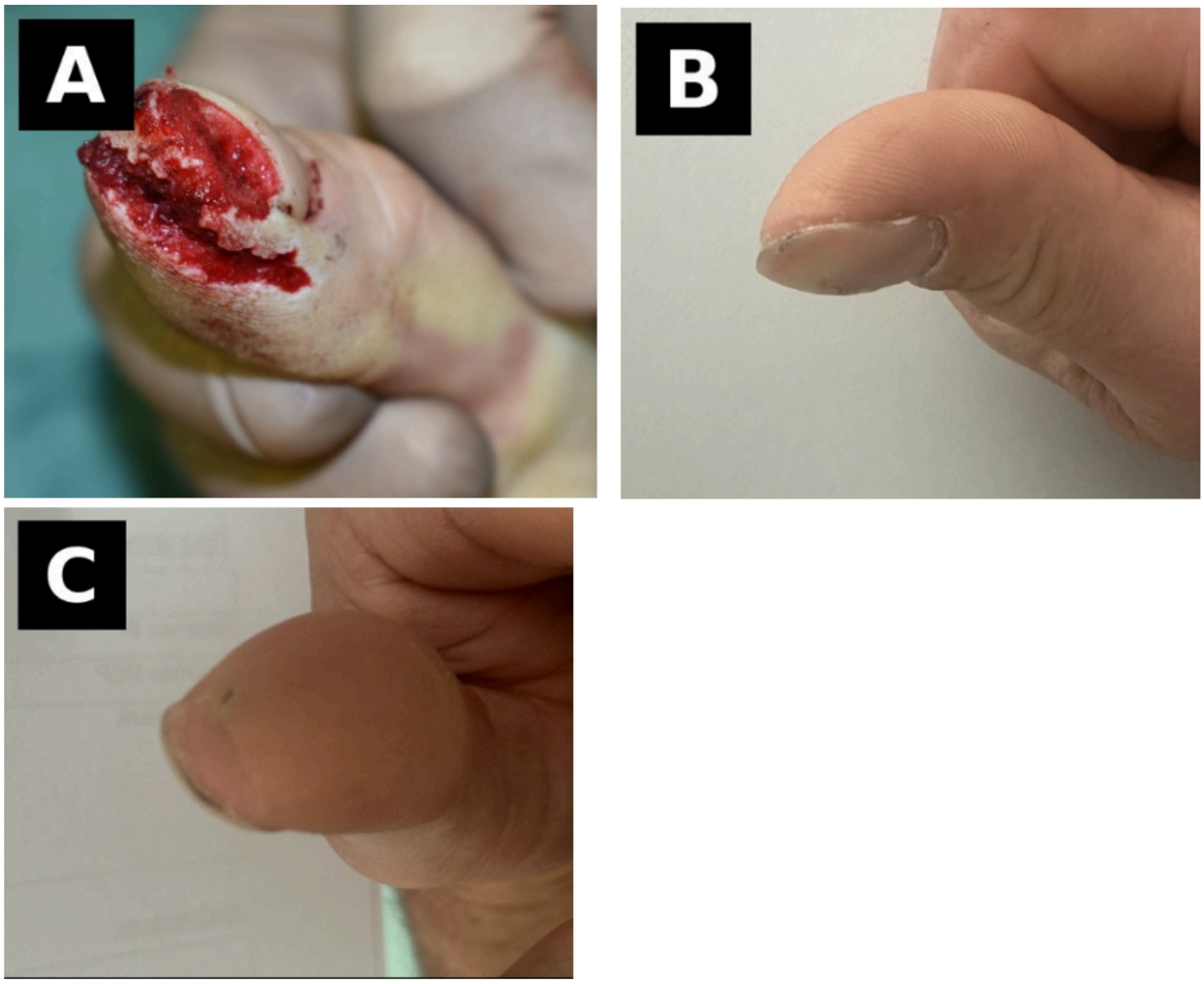


Figure 3

Unnumbered image in the Methods section.