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Clinical evaluation of occlusive dressing in fingertip reconstruction

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Purpose: **Evaluation of the clinical outcomes of occlusive dressings after fingertip amputations.**
Methods: **We conducted a prospective single-center clinical research involving 101 patients representing 112 fingertip amputations who were treated with occlusive dressings from October 2017 to October 2022. Patients were evaluated with the QuickDASH test scores, in relation to their symptoms as to their ability to perform certain activities, the cold intolerance and a two-point discrimination Weber test, allowing the assessment of the innervation of skin area at different time points (at 1, 8, 12 weeks, and at 1 year). The average wound closure, the number of dressings, the finger's trophicity and the adverse effects of the treatment were also analyzed. Data analysis was then conducted by an independent surgeon.**
Result: **The average wound closure time for the 112 fingertip amputations treated with occlusive dressing was 2.6 weeks (18 days). Aesthetic outcomes were excellent in 69,6% and good in 30.4%. The Weber test showed a two-point discrimination of 3.3mm on the injured fingertip and 2.7mm on the contralateral, healthy side. The rate of complication was estimated at 11%. Amputation zone 3 ($p<0.001$) and number of cigarettes smoked per day ($p=0.007$) were identified as independent factors of complications.**
Conclusion: **Occlusive dressing treatment is a viable option for fingertip amputation in zones 1, 2 and even 3 offering clinically favorable outcomes with minimal inconvenience.**

Keywords: Fingertip amputation, occlusive dressing, clinical results, daily activity.

INTRODUCTION

A fingertip injury or amputation involves trauma to the distal interphalangeal joint of the finger, distal to the insertion of the extensor and flexor tendon[1]. The fingertip is the most sensitive area of the hand, it takes part in hand aesthetics and is a very common reason for emergency room visits[1,2]. The techniques for its reconstruction are numerous, as each patient and each injured digit need a thorough assessment so that the right treatment is properly chosen[3].

The treatment approach for fingertip amputations typically depends on the level of amputation as categorized by Merle and Dautel (Fig.1)[4]. Zones 1 and 2 are usually managed with occlusive or gauze dressings, while zones 3 and 4 often require coverage flaps[5-7].

Surgical interventions involving skin grafts, flaps and replantation have many complications such as necrosis, infections, stiffness, and hypoesthesia or anesthesia of the digit[8-11]. The use of occlusive dressing treatment, though well documented in the literature for zones 1 to 2[12-22], remains underutilized as compared to the surgical approach[23-27].

In this work, we gathered one of the largest series of patients with fingertip amputation in zone 1 to 3 according to Merle and Dautel's classification and we sought to assess the impact of occlusive dressing treatment on various clinical endpoints up to one year of follow-up. The primary objectives encompassed assessing finger sensitivity, healing duration, and aesthetic results, alongside determining adverse event prevalence comparing with surgical alternatives listed in the literature. We hypothesize that occlusive dressing in zone 1 to 3 will result in faster healing and improved aesthetic outcomes compared to the typical surgical interventions, while

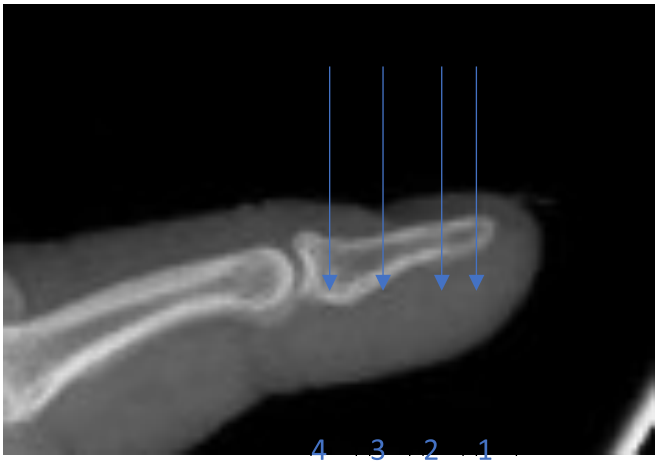

Fig. 1 — Classification of finger distal amputations according to Merle and Dautel (2017).

maintaining similar or superior finger sensitivity and safety profiles.

MATERIALS AND METHODS

Study population

From October 2017 to October 2022, a prospective clinical study was conducted involving 112 patients who suffered distal fingertip amputations and were treated with occlusive dressings when direct suturing or reimplantation was not feasible. These cases accounted for a total of 129 fingertip injuries located in zones 1 to 3.

The study was approved by local ethical committees of our hospital and protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki[28]. Written informed consent was obtained from all participants. The characteristics of these participants are detailed in Table I.

The inclusion criteria for the study were individuals aged between 10 and 100 years, of any sex, with hand trauma involving pulp lesions or non-replantable finger fragments in zone 1 to 3, and possessing a comprehension of the underlying medical condition and willingness to engage in patient management procedures. The exclusion criteria were patients with macroscopically infected wounds, zone 4 amputations and non-compliant patients.

Unfortunately, five patients, accounting for 8 fingertip injuries, were lost to follow-up, primarily due to the distance to our consultation center. Additionally, 6 patients with 9 fingertip injuries were excluded from the study because their dressings were prematurely opened by either home care nurses or general practitioners before they could be evaluated in consultation.

Design of the intervention

Patients with distal fingertip amputations in zones 1 to 3 received care in the emergency room following the study protocol. Initially, the injured hand was elevated above the lever of the heart to halt bleeding (Figure 2-A). This was followed by washing the wound with sterile water and cleansing with ether proximally. A semipermeable dressing named Comfeel (Coloplast, USA) was then applied, covered with Opsite Flexifix (S&N, USA) up the proximal interphalangeal joint (Figures 2-A to 2-D). For aesthetic reasons, a bandage called Velpeau (L&R, France) was placed on the injured finger (Figure 2-E). Additionally, patients were prescribed a 5-day course of antibiotic therapy with Augmentin 875/125 when bone was exposed, administrated three times daily. The dressing was changed once per week during hand surgery consultation until complete healing was achieved. At change, the dressing exhibited a purulent exudate, skin maceration, and a malodorous scent (Figure 2-F).

Follow-up and assessments

An independent investigator assessed the patients at various times: at 1, 8, and 12+/- 2 weeks, as well as at 1 year (+/- 2 weeks), following their injury (Figure 3). The evaluation included the trophicity of the fingers compared to the contralateral side, time to return to work, the number of occlusive dressings used, time to healing, the QuickDASH test scores, adverse effects, patient satisfaction, cold intolerance, a two-point discrimination Weber test and a basic economic evaluation.

Table I. — Characteristic of participants (n=101 participants – 112 fingers).

	Mean (Standard Deviation) or % (n)
Age (years)	40.5 (15.7)
Body Mass Index (%)	24.9 (2.8)
Time to healing (days)	17.8 (6.58)
Smokers (% (n)	44.5% (45)
Sex (% (n)	Female : 25.7% (26) / Male : 74.3% (75)
Cost of care (euros)	146.3 (64.6)

Affected fingers (n)	D1 18.8% (21)	D2 22.3% (25)	D3 28.5% (32)	D4 19.7% (22)	D5 10.7% (12)	
Side (n)	Right 67.9% (76)	Left 32.1% (36)				
Amputation zone (n)	1 : 46.4% (52)	2 : 34.8% (39)	3 : 18.8% (21)			
Mechanism of lesion (n)	Knife cut 51.8% (58)	Cutting machine 27.7% (31)	Crush injury 7.1% (8)	Milling 6.2% (7)	Sawing machine 4.5% (5)	Wood splitting 2.7% (3)
Work accident	No 63.4% (71)	Yes 36.6% (41)				
Number of dressings (n)	2 : 28.6% (32)	3 : 42.9% (48)	4 : 18.7% (21)	5 : 8.9% (10)	6 : 0.9% (1)	
Complications	None 89% (100)	Hook nail 5.4% (6)	Botryomycoma 3.6% (4)	CRPS 2.0%(2)		
Lost to follow (n): 6.2% (8); Opened the dressing (n): 6.9% (9)						

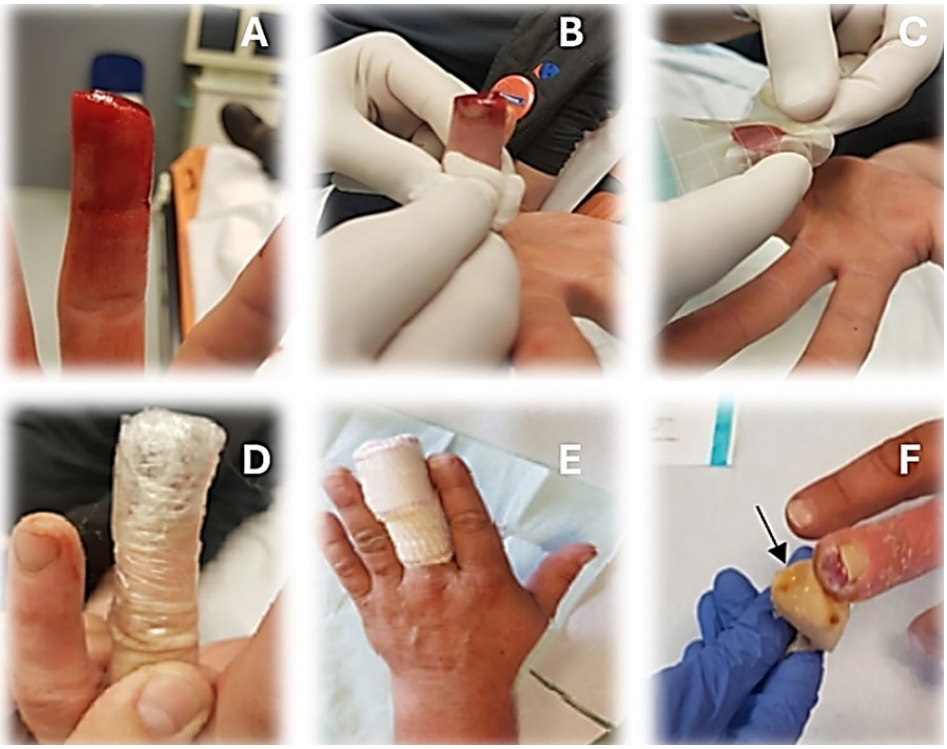

Fig. 2 — The figure illustrates the various steps involved in implementing occlusive dressing treatment. A. Hemostasis; B. Ether application; C. Comfeel application; D. Opsite Flexifix; E. Bandage; F. Exudate.

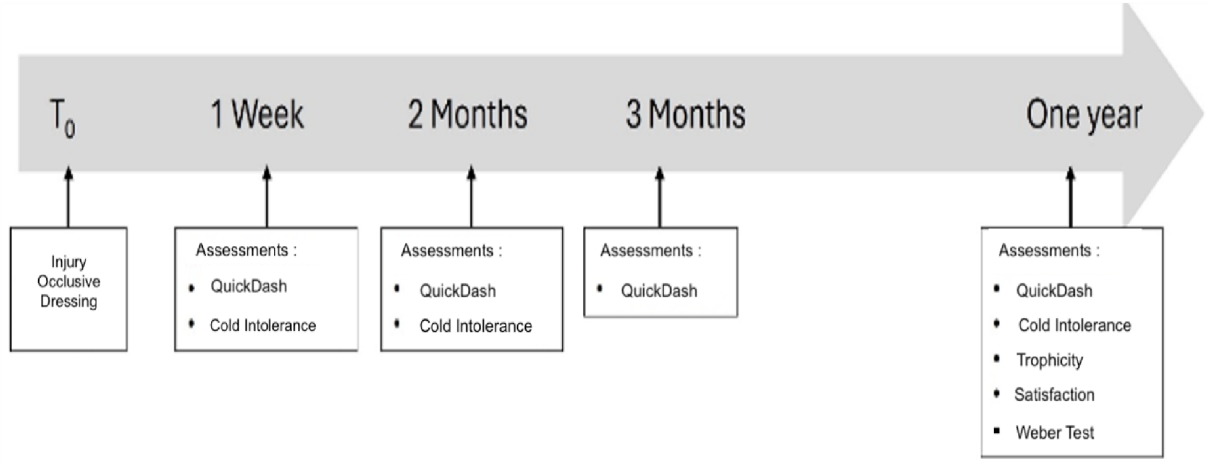

Fig. 3 — Flowchart of various clinical evaluations at different times following injury.

Trophicity, or aesthetic outcome, of the fingers was evaluated using photographs taken from the front and lateral views. It is deemed excellent if it matches the unaffected side, good if there is up to a quarter of substance loss, and poor if more than a quarter of the substance is lost[20]. Time to return to work and number of occlusive dressings used were in accordance with the time the wound needed to heal. The wound was considered healed when the surgeon decided that the epithelialisation process was satisfactory and that the wound was closed. The QuickDASH consists of 11 items, requiring at least 10 to be completed for a score calculation. Each item has five response options (none, mild, moderate, severe, to unable) allowing for a scale score ranging from 0 (no disability) to 100 (most severe disability).

Adverse effects included hook nail dystrophy, botryomycoma and Complex Regional Pain Syndrome (CRPS) of the injured finger. These had also an impact on the level of patient satisfaction. The level of satisfaction was evaluated using an ordinal qualitative scale: “very satisfied”, “satisfied”, “dissatisfied”.

Cold intolerance was assessed by asking the patient at 1 week, 8 weeks and 1 year after the injury about cold hyperesthesia during day-to-day life. It was also measured by touching the skin with a cold metal object with the examiner recording any instances cold shock upon contact. The two-point discrimination Weber test was used one year after the injury. This assessed the ability to discern two distinct points, after touching the skin of the finger, at two different positions on the pulp’s surface[9].

Finally, patients were asked to provide their overall expenses (consultation fees, x-rays and dressing cost) at the end of their treatment.

Statistical analysis

Participants characteristics, including demographic and clinical variables, were expressed as mean ± SD or median (IQR) for continuous variables, depending on distribution normality, and categorical data as numbers (percentages).

The Weber discrimination test was assessed using a paired t-test to compare the distances measured in injured fingers to those in non-injured fingers at 1 year following injury.

QuickDASH scores at 1, 8 and 12 weeks are analysed using Friedman’s repeated measures analysis of variance, as the scores were not normally distributed. These scores were presented as medians and interquartile ranges (Q1-Q3).

Subsequently, we identified independent predictors for the risk of complications using adjusted multivariate logistic regression. Variables with a variance inflation factor (VIF) greater than 10 were excluded from the analysis to account for collinearity. Quantitative predictors that significantly explained the risk of complication underwent Receiver Operating Characteristic (ROC) analysis to determine their specificity, sensitivity, and cut-off (Figure 4). The significant level was set at 0.05.

RESULTS

The patient characteristics are detailed in Table I. The study conducted from October 2017 to October 2022, included 112 patients with a total of 129 distal fingertip injuries. Unfortunately, five patients, accounting for 8 fingertip injuries, were lost to follow-up, primarily due to the distance to our consultation center. Additionally, 6 patients with 9 fingertip injuries were excluded from the study because their dressings were prematurely opened

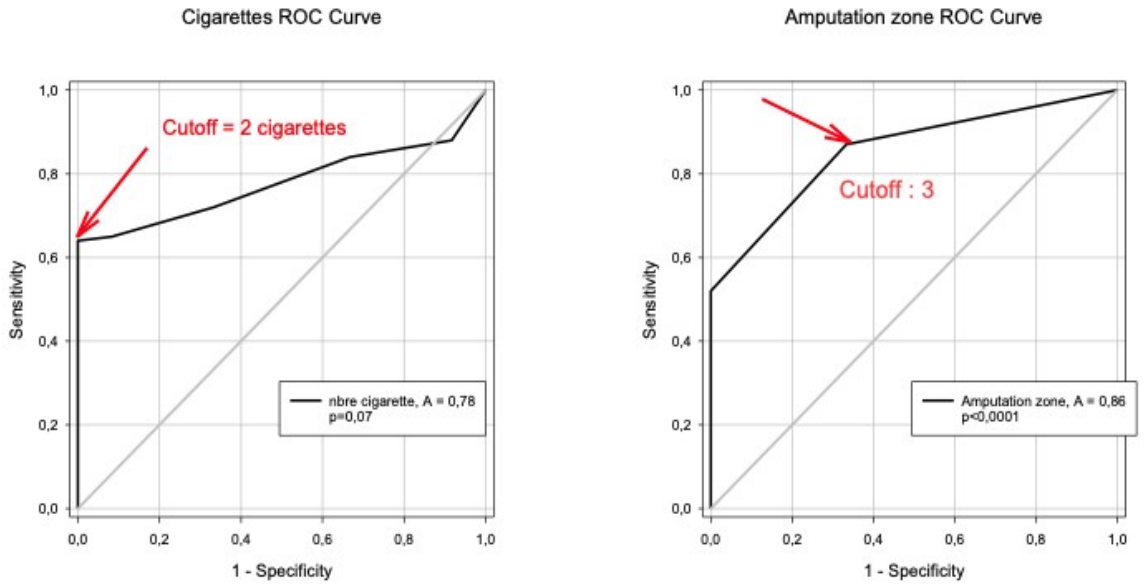

Fig. 4 — Quantitative predictors that significantly explained the risk of complication underwent Receiver Operating Characteristic (ROC) analysis to determine their specificity, sensitivity, and cut-off. Those predictors were cigarettes per day and zone of amputation.

by either home care nurses or general practitioners before they could be evaluated in consultation, leaving 101 patients and 112 fingertip injuries for assessment (Figure 5).

The average age of the participants was 40.5 years, ranging from 13 to 79, with a predominance of males (74.3%) compared to females (25.7%). The injury primarily resulted from knife cuts (48.8%) and cutting machines (30%). Healing occurred after an average of 17.8 days, ranging from 9 to 37 days, and typically required an average of 3 dressings (ranging from 1 to 6). The average time for patients to return to work was 21 days, with a range from 7 to 48 days.

The adverse effects (in 11% of cases) included 6 cases of hook-nails that were not treated surgically, 4 instances of botryomycoma treated with silver nitrate, and 2 cases of complex regional pain syndrome which resolved after 8 and 10 months, respectively (Figure 6).

The results of clinical assessments are detailed in Table II. The Weber two-point discrimination test showed a significantly ($p<0.0001$) greater distance for the injured fingertip (mean (standard deviation) mean 3.3 (±0.59) mm) compared to the contralateral healthy side (mean 2.7 (±0.49) mm). Cold intolerance was significantly diminished ($p<0.0001$), with 70.5% of participants presenting cold intolerance after 1 week, 23.2% after 2 months, and none after 1 year. Skin trophicity was excellent in 69.6% of participants in one-year followup.

The median QuickDASH score was 5.8 (range 4.2-9.2) at one week, 0 (range 0-2.5) at 8 weeks, and 0 (range 0-0) at 12 weeks after injury, respectively ($p<0.001$). The QuickDASH score was the same at 3 months and 1 year. Most patients (87.6%) reported being very satisfied, 12 (10.7%) reported being satisfied and only 2 reported being dissatisfied (1.7%). Figure 7 illustrates one case with excellent clinical outcomes where the patient was very satisfied.

Lastly, the economical aspect of the study involved calculating the direct expenses for each patient based on the number of consultations, hand X-rays, the cost of each dressing used. The total cost for the 101 patients included in the study amounted to 14.773,5 EUR (16.167 USD), averaging 146 EUR or 159 USD per patient at the time of writing this paper.

	Zone 1	Zone 2	Zone 3	Total
Finger injuries	56	48	25	129
Loss of follow up	1	4	3	8
Dressing prematurely opened	3	5	1	9
Included	52	39	21	112

Fig. 5 — Flowchart of our participants as well as those who were lost to follow-up.

Table II. — Results of clinical assessments.

Discrimination (Weber test)	Affected side	Non affected side	p-value
(At 1 year post injury)	3.30 (0.59) mm	2.77 (0.49) mm	<0.001
Cold intolerance	At 1 Week Yes : 70.5% No : 29.5%	At 2 months Yes : 23.2% No : 76.8%	At 1 year Yes : 0% No : 100%
Trophicity (At 1-year post injury)	Great : 69.6% Good : 30.4%		
Satisfaction (At 1-year post injury)	Very satisfied 87.6% Satisfied 10.7% Dissatisfied 1.7%		

QuickDash/100	Median	[Quartiles]	p-value
At 1 week	5.8	[4.2-9.2]	<0.0001
At 2 months	0	[0-2.5]	
At 3 months	0	[0-0]	

Post hoc test (Tuckey test): 1-week vs 2 months: p<0.001; 1-week vs 3 months: p<0.001.

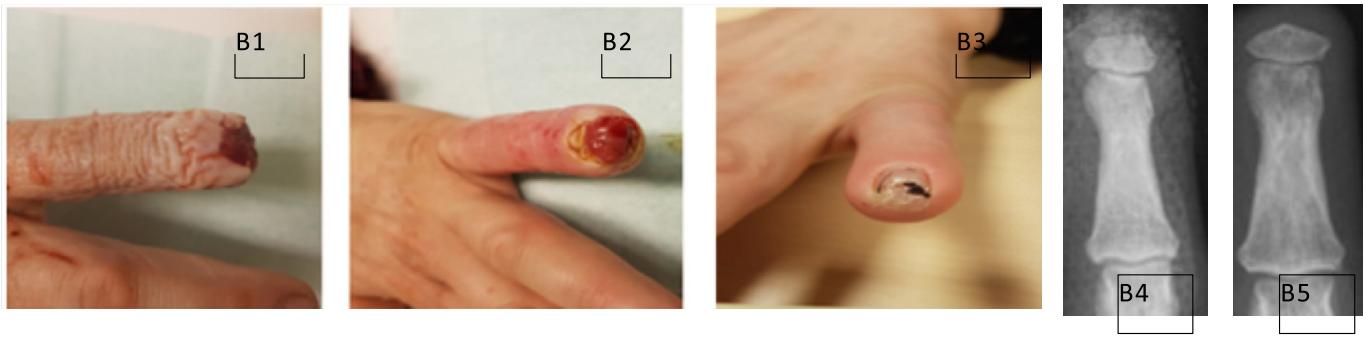

Fig. 6 — Clinical outcome of a male patient of 59 year's old who had a domestic accident with a cutting machine. He had a zone 3 amputation of his small finger on his non dominant left hand (B1). A botryomycoma appeared on his finger on the 3rd week post-injury (B2). It took 6 dressings and 37 days to heal (B3). We needed to treat this adverse effect with silver nitrate. X-rays were taken before (B4) and after the treatment (B5).

Finally, the multivariate logistic regression model was then conducted to identify significant independent predictors of complications. After adjusting for covariates, the amputation zone 3 (p<0.001, sensitivity 0.87, specificity 0.67, cut-off greater than 2), and the number of cigarettes smoked per day (p = 0.07, sensitivity 0.61, specificity 0.99, cut-off 2 cigarettes), were identified as independent factors associated with an increased risk of complications (Table III) (Figure 4).

DISCUSSION

The main findings of our clinical study highlight it as one of the largest prospective case series with the longest follow-up period, focusing on distal fingertip amputations in zones 1 to 3 treated with occlusive dressings, revealing excellent clinical outcomes with minimal adverse effects.

The average healing time in our study was 2.6 weeks (18 days), with patients requiring an average of 3 dressings each. These results align with other studies implementing occlusive dressing techniques[12-22]. Trophicity was rated as excellent in 70% of cases and good in 30% when compared to the unaffected side. This outcome becomes even more significant when considering the findings of Hoigné et al, who utilized ultrasonography to quantify fingertip regeneration, reporting nearly 90% restoration of the fingertip following occlusive dressing therapy[19]. The healing process of fingertip regeneration is due to bacterial proliferation and angiogenic factors, which are crucial for the neovascularization and include PDGF, VEGF, and EGF[32-35]. Occlusive dressings, with their moisture-retaining effect, increase the presence of mesenchymal cells while reducing fibroblast proliferation. This leads to superior scar quality and trophicity compared to non-occlusive dressings and flap coverage[36].

All our participants underwent a two-point discrimination Weber test one-year post-injury.

Table III. — Adjusted multivariate logistic regression predicting risk of complications.

PREDICTORS	OR	95% CI Lower	95% CI Upper	p-value
Age	1.004	0.95	1.07	0.888
Sex M/F	0.52	0.04	7.58	0.633
Body Mass Index	0.92	0.66	1.28	0.615
Affected fingers	0.92	0.42	2.007	0.838
Amputation zone	10.92	2.87	41.56	<0.001
Mechanism of lesion	0.82	0.46	1.46	0.501
Number of cigarettes per day	7.44	0.85	65.27	0.07

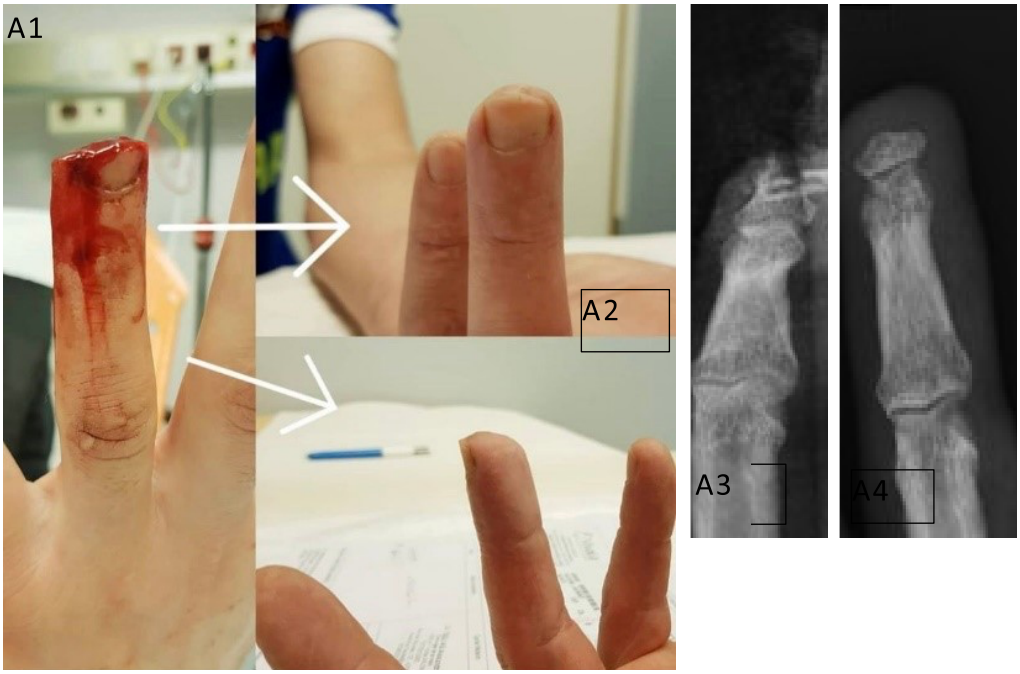

Fig. 7 — Clinical outcomes of two patients with zone 2 amputations using occlusive dressings. Patient A was a 22-year-old male who had a domestic accident with a cutting machine at the time of the injury (A1). It took three dressings and 17 days for the healing process (A2). Preoperative and postoperative X-rays were taken (A3 and A4).

The results demonstrated a discrimination ability of 3.3mm on the injured finger compared to 2.7mm on the contralateral hand. These outcomes surpass those reported in the literature[12-22], likely due to our substantial patient cohort and because the prevalence of injury in zone 1. This contrasts with the results from the most used flaps such as the Atasoy and Hueston flaps, which reported sensibility of 6.4 and 4.5mm respectively[9].

We did not detect any cold intolerance in patients at 1 year follow up. However, at one week and two months post-injury, two-thirds and one-third of our patients exhibited symptoms of cold intolerance, respectively. This pattern aligns with findings in the literature, where cold intolerance is commonly reported in the early stages of treatment but generally diminishes after 3 months[20]. Cold intolerance for Atasoy flaps has a percentage that goes up to 50% in the literature[8,25].

None of our patients displayed digital stiffness or necrosis. We encouraged all participants to mobilize their injured fingers early in the recovery process. In contrast, flap coverage procedures such as Atasoy or Venkataswami & Subramanian's techniques report significant rates of stiffness, up to 20% and 33% respectively, and necrosis rates ranging from 3.2 to 3.5%[8-10]. Our study also reported no infections among our patients, despite the occasional purulent appearance of the dressing and its sometimes-nauseating smell. The literature suggests that occlusive dressings result in a lower infection rate compared to non-occlusive methods (2.6 vs 7.1%)[29,30].

The most common adverse effect observed in our study was the hook nail effect, which occurred only in patients who experienced a zone 3 amputation. In our study we had six cases out of 21(29%) in zone

3 with hook nail complication. In the literature, when using an Atasoy flap this percentage goes up to 50% for the same zone[6,7]. None of the six patients underwent surgery to correct this issue due to uncertain outcomes[31]. Subsequently, patients with a zone 3 amputation have to be carefully advised before treatment regarding this adverse effect. If replantation is feasible, it should be performed[3]. If not, an occlusive dressing treatment has a better chance of avoiding this complication.

Four patients developed botryomycoma, which were effectively treated with silver nitrate, resulting in full recovery. Additionally, two patients experienced complex regional pain syndrome (CRPS) and had a prolonged recovery period. One of the biggest inconveniences was the malodorous smell that sometimes occurred from the dressing. This did not stop our patients from continuing with their treatment as we helped overcome this issue by adding essential oil on the bandage.

We acknowledge several limitations of this study. This was a prospective, single-center, single-arm study without a concurrent control group; therefore, causal inference versus surgical alternatives is not possible. Several outcomes relied on subjective assessments (photograph-based "trophicity" grading and patient satisfaction), and healing was defined by the treating surgeon, introducing potential assessment and observer bias; blinding was not performed. Outcomes were assessed by an independent observer; however, inter- and intrarater reliability were not evaluated, which may introduce assessment variability. Sensory recovery was evaluated only with static two-point discrimination, without complementary modalities (e.g., Semmes–Weinstein monofilaments or functional dexterity testing), which may limit granularity. Attrition and protocol deviations may have introduced selection bias (five patients [eight injuries] lost to follow-up; six patients [nine injuries] excluded after premature dressing removal). The economic analysis was intentionally limited to direct medical costs (consultations, radiographs, dressings) and did not include indirect costs, productivity losses, or health utilities (QALYs), precluding cost-effectiveness or cost-utility conclusions. Finally, the uneven distribution across amputation zones (predominantly zone 1) may limit generalizability to more proximal injuries or severe crush mechanisms, and the multivariable model was exploratory and potentially underpowered, warranting external validation.

CONCLUSION

There is a myriad of ways to manage fingertip injuries. This large cohort of patients with fingertip amputations in zones 1,2 and 3 offer new insight for the management of this type of injury. Occlusive dressing appeared as a viable therapeutic option, offering favorable clinical results with minimal inconvenience. This data should encourage clinicians to adopt this conservative approach in their daily practice.

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