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Evaluation of the Effectiveness of Extreme Atasoy Flap in The Reconstruction of Apical Injuries of The Fingers

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Abstract

***Aim*: Decreasing patient morbidity and enhancing satisfaction with the aesthetic outcome and function of fingertip injuries. *Methods:* In this uncontrolled clinical trial study, 20 patients with fingertip injuries were evaluated. The functional outcome is determined using a points discrimination test, assessment of healing time, operative time as well and partial and complete flap necrosis. While the aesthetic outcome is evaluated using VAS for pain. *Results:* Only one major complication was present. The average healing time was 4 weeks. The patients reported good aesthetic and functional outcomes. *Conclusion:* Extreme Atasoy flap is a reliable choice for coverage of fingertip injuries, Ishikawa zones 1 and 2, and even distal zone 3. It could be mobilized safely up to 20 mm and cover oblique defects. The good esthetic outcome, color match, good sensation, and very low donor area morbidity recommend it to be the first choice in fingertip distal half reconstruction in cases of tissue loss, with or without bony loss.**

Keywords: Fingertip amputation; fingertip reconstruction, V-Y flap; island flap, oblique defect, rotational flap.

Introduction

From 1997 to 2016, a weighted estimate of 464,026 patients sustained finger amputations in the US with an estimated yearly incidence of 7.5/100,000 person per year. Doors were the most common injury mechanism in children (aged less than 5 years old), whereas power saws were most common in teens and adults (aged more than 15 years old)[1]. Different reconstructive techniques have been used; simple skin grafts, dermal matrix, local cutaneous, adipose-fascial flaps, and microsurgery techniques. Local flaps are the best choice, if feasible in case of exposed bone or important volume loss [2]. For dorsal and transverse amputations, the classical Atasoy V-Y advancement flap is a common choice. It has the advantages of other local flaps of being rapid, easy, and safe. In addition, it establishes several important functional and aesthetic outcomes, preserving sensitivity, finger length, and no additional scarring. However, the major limitation of the Atasoy flap is the range of mobilization as it cannot be extended further than 1 cm. In addition, it is not suitable for oblique defects[3]. The "Extreme Atasoy" technique overcomes this inconvenience of classical

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Atasoy: it allows advancement up to 18 mm. Furthermore, it theoretically could be manipulated to cover oblique defects[4]. The purpose of this study is to describe and evaluate the effectiveness of the extreme Atasoy flap technique in the reconstruction of apical injuries of the fingers. As this technique was not evaluated before in Suez Canal University Hospitals, this study will evaluate the outcomes of this technique in our setting. Furthermore, the publications didn't tackle the problem of the oblique defect.

Patients and Methods

From August 2020 to July 2021, a total of 20 patients with fingertip injuries presented to the plastic surgery department (Suez Canal University Hospital) were identified and included in this study. Suez Canal University's ethics and research committee approved this study. This research adheres to the tenets of the Declaration of Helsinki. The exclusion criteria applied were; patients with congenital anomalies on the same hand, patients who had any previous operation on the same hand, patients who have any contraindications for surgery, patients who refuse surgery, and patients who refused to sign the consent of participation in the study. Before surgery, the visual analog scale for pain to time is written. *Anesthesia:* Bilateral digital nerve block in adults and general anesthesia in children.

Flap design and harvesting: After injecting the local anesthesia, or induction of general anesthesia in children, the hand was elevated and squeezed to decrease congestion. Then, a tourniquet was placed at the base of the injured finger. Using a magnification loupe (2.5x), A "U" shaped marking was drawn from the fingertip up to the distal inter-phalangeal fold; when necessary, the design was drawn at a lower point. Then, an incision was made with 15-blade scalpel until the subcutaneous tissue. The flap was then dissected using a small curved blunt scissors making perpendicular movements to the cutaneous incision and parallel to the fibrous septa. More dissection was allowed down below the DIP when needed. Only one surgeon performed this technique. Using the scissors, the terminal segments of the vascular pedicles was skeletonized until satisfactory coverage was achieved. we believed that extreme skeletonization might be the cause of flap necrosis as the venous drainage is mostly through tiny venules in the surrounding soft tissue. The flap was then detached from its deep and bilateral connections, saving the sheath of the deep digital flexor tendon and its insertion as shown in Figure 1. The flap, based on the bundle was to be then advanced to close the defect, leaving the donor area to heal with secondary intention.

Documentation

Preoperative, Postoperative, and late postoperative photos and detailed history were taken for all the patients. Preoperative X-rays were done for all patients.

Statistical Analysis

Data were collected in the form of an Excel sheet and were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using numbers and percentages. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (min and max.), mean, standard deviation, median, and interquartile range (IQR).

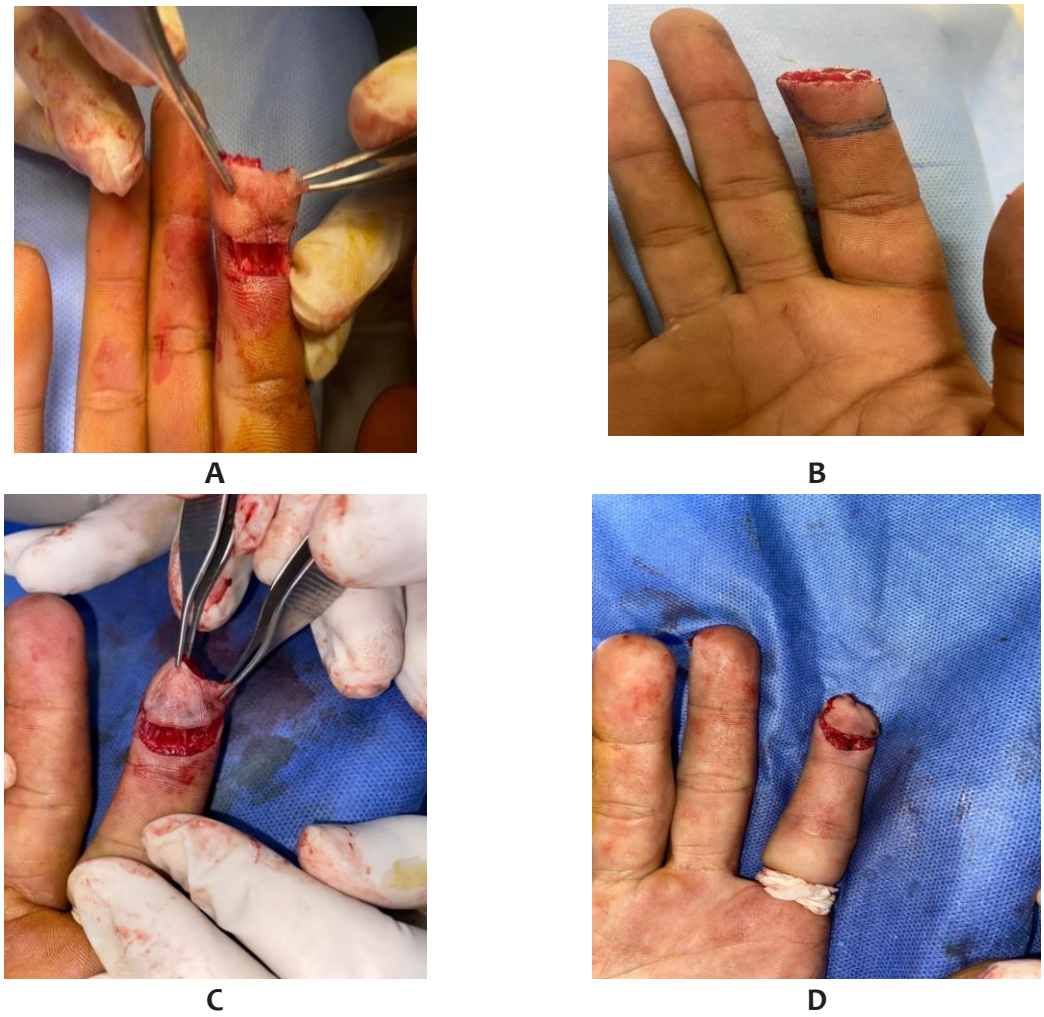

Figure 1: A: The design of The Extreme Atasoy Flap, B: Flap advancement. C: Flap advancement on 2 pedicles. D: Flap in setting [4].

The significance of the obtained results was judged at the 5% level. The used tests were: McNemar Test used to analyze the significance between the different stages. ANOVA with repeated measures for normally distributed quantitative variables, to compare between more than two periods or stages, and Post Hoc test (Bonferroni adjusted) for pairwise comparisons. Friedman test for abnormally distributed quantitative variables, to compare between more than two periods or stages, and Post Hoc Test (Dunn's) for pairwise comparisons. Pearson coefficient to correlate between two normally distributed quantitative variables.

Results

The mean age of our patients was 34.1 ± 14.74 years, with the most common age group between 30 and 50. All our patients were males, with 12 patients (60%) living in urban areas. Sixty % of the patients included in the study were non-smokers and most of them (85%) had no chronic illnesses. None of them had congenital anomalies or a history of previous operation in the hand. All the amputations were caused by trauma, mostly by heavy machines and 80% of them were zone III Ishikawa subzone. Mean operative time was 26.20 ± 7.60 minutes and most of the pa

tients (95%) stayed only 1 day in the hospital. The mean healing time was 4.70 ± 2.00 weeks. The mean advancement of the flap was 15.25 ± 2.17 mm. Ten patients (50%) presented within 6 hours of the trauma, 7 patients (35%) presented within 6-12 hours and 3 patients (15%) presented after 12 hours. Eleven patients (55%) healed in 4 weeks while 9 patients (45%) healed more than 4 weeks. The Visual Analogue Scale for pain to time was 10% mild, 85% moderate, and 5% severe at T0 (Day 0). It was 65% mild, 30% moderate, and 5% Severe with a mean of 2.30 ± 1.81 at T30 (Day 30). Only 1 patient (5%) had complete flap necrosis, 6 patients (30%) had partial flap necrosis and 5 patients (25%) had sensitivity disorder. There was no significant difference in the incidence of sensitivity disorders, complete or partial flap necrosis according to smoking status, residence, presence of chronic illness, or Ishikawa subzone. While 16 patients (80%) had extensive flap advancement (15-20 mm), only 5 of them had partial flap necrosis with no case of complete flap necrosis.

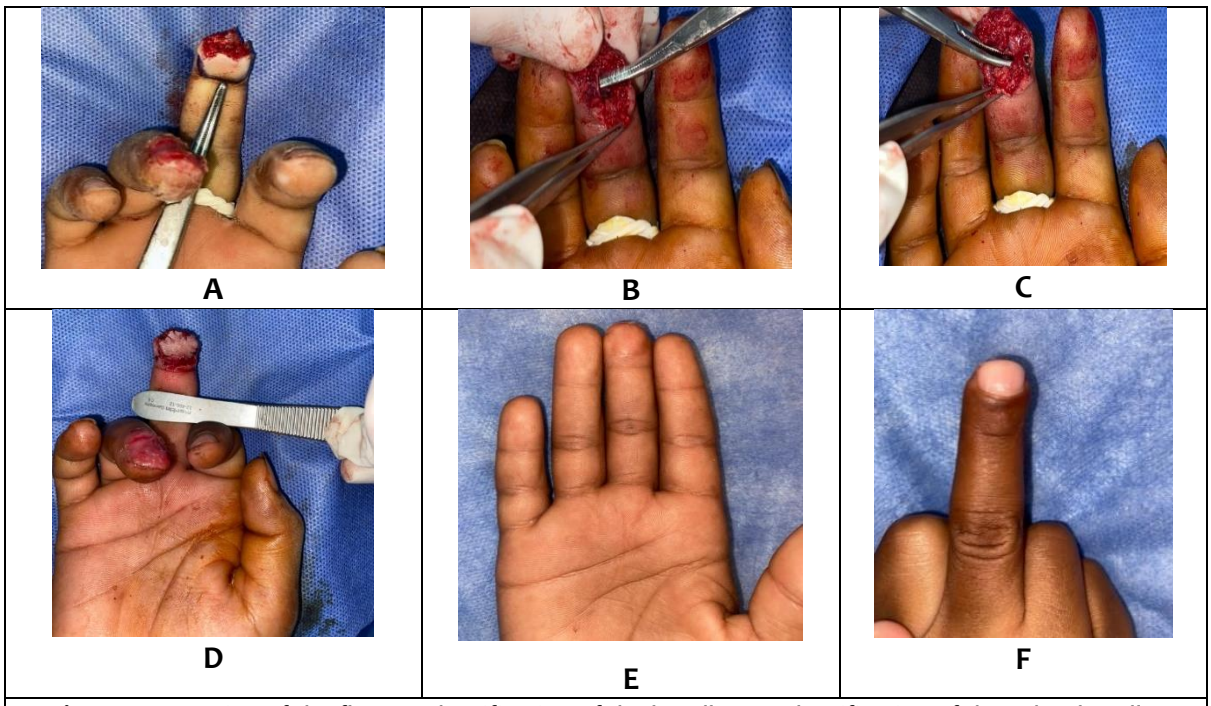

Figure 2: A: Design of the flap. B: Identification of the bundles. C: Identification of the other bundle. D: Immediate post-operative. E: 6 months post-operative volar view. F: 6 months post-operative dorsal view.

Case (1): Ten-year-old male, NCI, DT to Right middle finger, amputated distal tip with exposed bone, Ishikawa zone 2, with defect 1.8 cm. The patient has normal sensation, is satisfied with the esthetic outcome, has no pain or hook nail, and has an excellent color match (Figure 2). *Case (2)*: A 49-year male, NCI, carpenter, DT to Right thumb caused amputated tip with exposed bone, Ishikawa zone 3 and a 2 cm defect. Patient has normal sensation, satisfied esthetic outcome and color match, but delayed healing due to tip necrosis after excessive skeletonization (Figure 3).

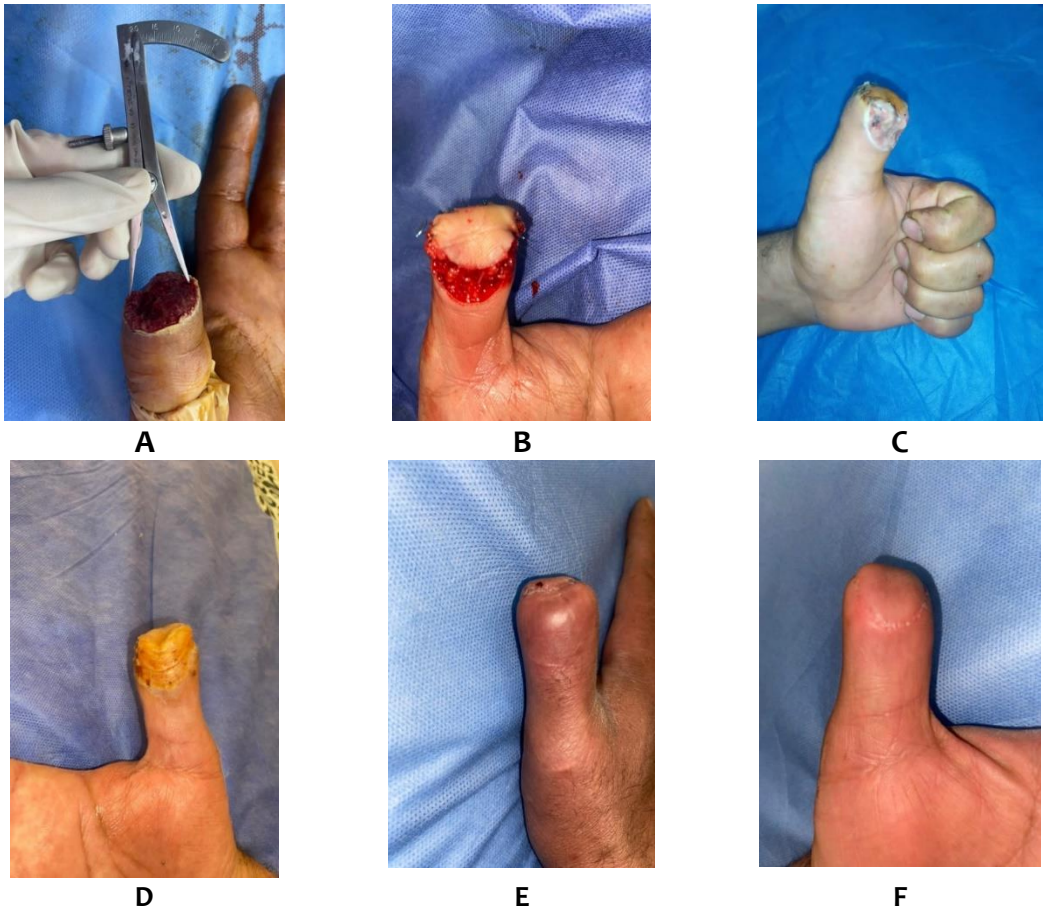

Figure 3: *A: Defect size 2 cm. B: Immediate post-operative. C: partial flap necrosis after two weeks. D: Healing of partial necrosis after 1 month. E, F: complete healing after two months.*

Discussion

Fingertip amputations are very frequent in hand surgery after traumatic injuries. Many reconstructive choices have been described, ranging from healing by secondary intention, bone shortening and primary closure, Skin grafts, and Local and regional flaps, to sophisticated re-plantation of the amputated part and microsurgical techniques [5]. The goal of a good reconstructive technique is to preserve feeling in the fingers and the function and length and enable a speedy return to work[2]. Local skin flaps represent a valid choice in the treatment of fingertip amputations. The classic V-Y flap, first described by Tranquilli-Leali and later by Atasoy, remains a current and often-used choice. The limit of the V-Y advancement flap is that it can't be advanced more than 0.5-1 cm[3,6,7]. In the "Extreme Atasoy flap" technique, Francesco also let the donor site heal by secondary intention, unlike Thoma et al., who used a "U" shape flap. The classic Atasoy flap was carried out to the maximum extent with this technique. The key points of this modified technique are as follows: preoperative design, secondary intention healing of the donor site, and the extreme skeletonization of the neurovascular pedicles[4]. In our study, held in Suez Canal University Hospital, the mean age of the patients included in the study was 34.10 ± 14.74 years, with a range of (10 - 60 years), unlike the mean age of the research of Francesco et al held in Italy

where the mean age was 40 years, with the range of (21-70). Kim's research, held in Korea, the age ranged from 17 to 65 years, with an average age of 32.5 years. Kayalar et al research, held in Turkey, showed a mean age of 31.4 ± 12.1 with a range from 3 to 65 years[4,8]. We think this difference is because in Egypt, children work from an early age unlike Korea, Italy, and the rest of Europe. Regarding the gender, all our patients were males. This is more or less similar to Francesco's research where almost all the cases (90%) were males. Similar to our finding, crush injury was the most common cause of trauma in most of the researches [4]. The mean operative time of our study was 26.20 ± 7.60 minutes and most of the patients (95%) stayed in the hospital for one day only. This correlates with Francesco et al. results as their average operative time was 25 minutes. On the contrary, most of their hospital stay was 2 nights. This might be justified by the COVID pandemic, as it is not recommended to allow long hospital stays except for absolute emergencies. The mean healing time was 4.70 ± 2.00 weeks, this time is a little bit longer than that of Francesco et al and Atasoy results which was 2-3 weeks. This might be related to the large donor area, due to the massive mobilization of the flap more than that mentioned by both articles, and the higher rate of partial flap necrosis following extreme skeletonization of the bundles to cover defects 15-20 mm with extensive flap mobilization up to 20 mm. Another possible reason is the learning curve, we noticed rapid wound healing in the late cases after gaining experience and doing modifications to the flap minimizing extreme skeletonization [4,6]. The mean advancement of the flap in our study was 15.25 (11-20) mm, this is a little bit more than Atasoy and Francesco et al which was 7.5 (5-10) and 13.5 (11-18) mm respectively. Eleven patients (55%) healed in 4 weeks while 9 patients (45%) healed more than 4 weeks. In contrast, Francesco et al had a healing time of 3-4 weeks. This difference might be explained by smart dressings which were expensive to our patients [4,6]. Regarding the complications, only 1 patient (5%) had complete flap necrosis (major complication) which was mainly due to a technical mistake. Six patients (30%) had partial flap necrosis and 5 patients (25%) had sensitivity disorder (minor complications). In Franceso et al study, 5% had complete flap necrosis and 40% had minor complications such as partial flap necrosis, delayed healing, or sensitivity disorders. This agrees with Francesco et al results who claimed a higher success rate of the flap when performed by a senior surgeon, and this didn't affect the reliability of the flap in our experience. There was no significant difference in the incidence of sensitivity disorders, complete or partial flap necrosis in correlation to smoking status, residence, presence of chronic illness, or Ishikawa subzone[4,6]. In the late cases of our study, we used a mixture of Tranquillli and Fransceco et al techniques. This was through avoiding extreme skeletonization of the bundles and by dissection in both dead lateral and proximal planes. Avoiding extreme skeletonization was to reduce the incidence of partial flap necrosis, as most hand surgeons claimed that the fingertip is drained by tiny venules in the soft tissues rather than venae commitants. The dissection was carried out to give more safe advancement of the flap without excessive tension. This led to the avoidance of partial flap necrosis and sensory problems in the flaps done by these new modifications[4,6,7].

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