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# Semiocclusive Therapy Versus Full Thickness Skin Grafts Versus Reverse Flow Homodigital Island Flaps in Reconstruction of Volar Oblique Fingertip Injuries

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***Abstract***

***Background:*** *Fingertip amputations are among the most common injuries seen in the hand. The mechanism, level, and direction of amputation are important factors in choosing the appropriate reconstructive option. Optimal management is a much-debated topic with advocates for operative and non-oper¬ative treatment .**Aim of the Work:** To compare the outcome of healing by secondary intention, full thickness skin grafts from the ulnar border of the hand, and reverse flow homodigital island flaps in the management of volar oblique fingertip amputations in the hand according to time of complete healing, aesthetic outcome, return to work timing and according to complications rate . **Patients and Methods:** This study was conducted on 75 patients who were presented to ER department, with volar oblique fingertip injury. Patients are classified into three equal groups, each group contain 25 patients. First group was managed conservatively with semiocclusive dressing. Second group was reconstructed with full thickness skin grafts. Third group was reconstructed with reverse flow homodigital island flaps .Results: In this study, we can confirm that surgical intervention with either technique, reconstruction with full thickness skin graft or reconstruction with reverse flow homodigital island flap is too much better than healing with secondary intention. With better results with full thickness skin grafts over homodigital island flaps specially in small defects with no exposed bones, a lesion represent most of fingertip cases in surgery. On the other hand homodigital island flaps are better in big defects and in cases with exposed bones. **Conclusion:** Fingertip injuries are the most common injuries in hand trauma patients. The major cause for adult patients is occupational accidents etiology. There are several classifications for fingertip injuries. Treatment options vary depending on the injury mechanism, defect's size and plane, surgeon's intention, patient's needs, condition of the stump and the amputated part. Despite ongoing publication of new flaps for fingertip reconstruction, there is a paucity of evidence to support improved healing and function in a surgically reconstructed fingertip compared to conservative wound management. Controlled trials are sorely needed to distill the truth as to whether surgery is superior to secondary healing or not .*



***Keywords:*** *Distal interphalangeal, Extensor carpi ulnaris muscle,*

## 1. Introduction

Fingertip injury is a mechanical injury distal to the DIP joint of the fingers and distal to the IP joint of the thumb (1).

Fingertip amputations are among the most common injuries seen in the hand. The mechanism, level, and direction of amputation are important factors in choosing the appropriate reconstructive option. (2)

Optimal management is a much-debated topic with advocates for operative and non-operative treatment. (3)

Injuries can be classified according to the level (Allen's classification) into four types: Type 1: involves only the pulp. Type 2: involves the pulp and nail bed. Type 3: includes partial loss of the distal phalanx. Type 4: injury that is proximal to the lunula. (4)

Fingertip injuries can also be classified as transverse or oblique (either dorsal or volar), according to the plane of amputation. (5)

Treatment decisions for fingertip injuries are dictated by the individual needs of the patient, the nature of the wound, and the knowledge and experience of the attending clinician. The main goals of fingertip reconstruction are the restitution or recreation of a sensate pain-free tip in a fully mobile digit of the maximum possible length, rapid healing, and a limited duration of functional disability. Treatment options for these injuries include primary closure, skin grafting, local or regional soft tissue flaps, and healing by secondary intention. (6)

In a semi-occlusive dressing, the fingertip is covered with "Opsite" once a week only. The dressing provides a temporary skin, making the finger painless. This semi-occlusive "skin" allows the healing environment to reach an optimal milieu (e.g. pH, oxygen, tension, immunoagents) actively promoting granulation tissue formation and epithelization. (7)

The semi-occlusive dressing acts as a skin, allows inspection, and is comfortable, allowing early return to work. It is cheap and simple to use, and can be done by an untrained person. Occlusive dressings have a granulation inducing influence which replaces lost tissue and speeds up epithelialization. (7)

Grafting of the volar surface of the hand and digits is often needed to cover skin defects resulting from trauma, burns, treatment of congenital anomalies, and flap elevation. The instep area of the foot, great toe skin, and hypothenar eminence are donor sites that can provide matching skin in terms of color, texture, and hair-bearing characteristics. As originally described by Lie et al. (8) the exact ulnar border of the palm is suitable for full-thickness grafting of appropriately sized palmar and volar digital defects. (9)

Among various methods of reconstruction available, reverse-flow homodigital island flaps have been found to be very useful. These flaps are raised from the lateral/medial aspects of the same finger. These flaps require dissection of proper digital artery and digital nerve, but provide a wide arc of motion for soft tissue coverage to preserve the length of the finger and esthetic nail appearance. In addition, these flaps can provide single-stage reconstruction with a short period of immobilization and offer durable skin coverage with similar color, thickness, and elasticity. However, some complications, including venous congestion, partial flap necrosis, flexion contracture, and cold intolerance are associated with these flaps. (10)

The treatment of fingertip injuries usually involves a compromise between function, appearance, and time. (11)

## AIM OF THE WORK

To compare the outcome of healing by secondary intention, full thickness skin grafts from the ulnar border of the hand, and reverse flow homodigital island flaps in the management of volar oblique fingertip amputations in the hand according to time of complete healing, aesthetic outcome, return to work timing and according to complications rate.

## PATIENTS AND METHODS

Fingertip injuries can also be classified as transverse or oblique (either dorsal or volar), according to the plane of amputation (5).

In this study we select patients with volar oblique fingertip injuries.

This study was conducted on 75 patients who were presented to ER department, Elfayoumy hospital in the Industrial area of Elobour city, starting from (Jan. /2018) till (Jan. /2023).

The patients were complaining of fingertip injury were either single fingertip injury (52 patients) or multiple fingertip injuries (23 patients) and included: Index: twelve cases. Middle finger: fourty five cases. Ring finger: eight cases. Little finger: ten cases and they were sixty nine males and six females.

Inclusion criteria: Age: >18 years and <60 years. Gender: no gender predilection (males and females). Primary cases (no previous interventions). Acute injury. Volar oblique amputation of the fingertip apart from the thumb. Medically free

Exclusion criteria: Pediatric patients and elderly (>65 years). Old lesions. Previous surgical interventions. Any condition affecting peripheral vascular conditions e.g. D.M. , ischemic heart disease, smoking…etc.

Surgical management: Patients were admitted to ER department they were examined clinically to assess the fingertip injury and were investigated. The investigation included: Routine labs. Radiology (x-ray) hand. The patients were also assessed by preoperative photography. The patients were prepared for surgical intervention using either full thickness skin graft harvested from hypothenar eminence or using homodigital island reverse flow flap or is let for healing with secondary intension.

Patients are classified into three equal groups, each group contain 25 patients: Group (A) includes patients who underwent healing by secondary intention. Group (B) includes patients who underwent reconstruction by full thickness skin grafts harvested from the ulnar border of the hand. Group (C) includes patients who underwent reconstruction by reverse flow homodigital island flaps.

Randomization were performed by selecting one of three identical closed folded papers that each contains the name of one treatment modality to avoid bias.

**Management details:**

Group A: (Healing with secondary intention group)

The healing by secondary intention were performed according to the method described by de Boer and Collinson (12), modified by Mennen and Wiese (13); as follows: The method of application was quite simple and involved a piece of "Opsite" which is covered with a crepe bandage for protection. The bandage was held in place with a piece of elastoplast to prevent it slipping off. The patient was encouraged to make full use of the hand, including the finger. Post injury dressing twice weekly was done until complete healing is achieved. The patients were followed up after the injury for six months.

Group B: (Full thickness skin graft group)

Local anesthesia using combined wrist and finger (ring) block was used in all patients.

Figure (1): Ring anaesthia

Peri-operative antibiotics were given in all patients (Penicillin group).

The full thickness grafts were harvested according to the method described by Lie et al. (8) as follows: The exact ulnar border of the palm is suitable for full-thickness grafting (FTG) of appropriately sized palmar and volar digital defects. A number 15 scalpel was used to cut the skin and harvest the graft, taking care to remain immediately subdermal above the fat plane. The graft is put to cover the defect and secured with a tie-over dressing. The donor site is closed immediately using polypropylene 4-0 simple interrupted sutures. Undermining is not necessary for closure unless the width of the harvested graft exceeded 2 cm.

Figure (2): Marking of the graft

Postoperatively the 1stdressing for the graft was done 5 days post-operative with normal saline and antibiotic ointment (as Fucidic acid ointment) the stitches were removed after two weeks and the donor site was exposed after three weeks. The patients were followed up post operatively for six months.

Group C: (Homodigital island flap group)

General endotracheal anesthesia was used in all patients. Peri-operative antibiotics were given in all patients (Penicillin group). Loop magnification was helpful. Tourniquet was used.

The reverse homodigital island flaps were performed as described by Weeks and Wray (14), modified by Lai et al. (15) in 1989 and Kojima et al. (16) in 1990. As follows:

The flap was designed according to the shape and size of the defect and located at either the radial or ulnar side near the base of the finger. The pivot point was set either proximal to or at the midpoint of the middle phalanx, depending on the defect area.

The flap was symmetric to the midaxial line. With the midaxial approach to the finger, the artery and nerve were meticulously dissected and separated proximally and distally to the flap. The Grayson's ligament was dissected, and the volar aspect of the flap freed. The artery was ligated proximally to the flap, the flap was freed, and then, the perivascular soft tissue was preserved for better venous drainage. The vascular pedicle was buried under the lateral midaxial incision with loose stitches or without stitches. The flap was sutured loosely with 5-0 nylon. The donor site was closed primarily or to minimize the defect.

Figure (3): Marking of the flap

Postoperative dressing was done twice weekly until complete healing was achieved. The patients were followed up post operatively for six months.

**RESULTS**

Table (1): Showing the age periods and number and percentage of cases involved in the study.

| Age Range | # | % |
|---|---|---|
| Below 20 | 6 | 8 |

| | | |
|---|---|---|
| 20-30 | 27 | 36 |
| 30-40 | 21 | 28 |
| 40-50 | 18 | 24 |
| Above 50 | 3 | 4 |

Table (2): Number and percentage of injured fingers

| Finger | # | % |
|---|---|---|
| Index | 12 | 16 |
| Middle | 45 | 60 |
| Ring | 8 | 10.6 |
| Little | 10 | 13.4 |

Table (3): Comparison between three techniques according to time of complete healing

| | < 20 | | 21 – 25 | | 26 - 29 | | > 30 | |
|---|---|---|---|---|---|---|---|---|
| Dressing | 0 | 0% | 12 | 48% | 8 | 32% | 5 | 20% |
| Full thick. graft | 15 | 60% | 7 | 28% | 1 | 4% | 2 | 8% |
| Homodig. flap | 5 | 20% | 7 | 28% | 2 | 8% | 11 | 44% |

Table (4): Comparison between three techniques according to aesthetic outcome

| | Normal | | Near-normal | | Slightly disfigured | | Moderately disfigured | | Severely disfigured | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dressing | 3 | 12% | 8 | 32% | 7 | 28% | 2 | 8% | 5 | 20% |
| Full thick. Graft | 3 | 12% | 14 | 56% | 7 | 28% | 1 | 4% | 0 | 0% |
| Homodig. Flap | 1 | 4% | 4 | 16% | 8 | 32% | 7 | 28% | 5 | 20% |

Table (5): Comparison between three techniques according to return to work timing.

| | ≤ 3 weeks | | 3 weeks- 1.5 month | | >1.5 month | |
|---|---|---|---|---|---|---|
| Dressing | 6 | 24% | 15 | 60% | 4 | 16% |
| Full thick. Graft | 15 | 60% | 9 | 36% | 1 | 4% |
| Homodig. flap | 5 | 20% | 13 | 52% | 7 | 28% |

Table (6): Comparison between three techniques according to complications rate.

| | Graft failure / flap loss | | Secondary contracture | | Painful stump | | Donor sites morbidity | | Delayed or absent healing | | Cold intolerance | | Joint stiffness | | Neuroma formation | | Nail deform |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dressing | 0 | 0 | 0 | 0 | 10 | 40% | 0 | 0 | 13 | 52% | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Full thick. Graft | 2 | 8% | 1 | 4% | 0 | 0 | 1 | 4% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Homodig. flap | 11 | 44% | 5 | 20% | 0 | 0 | 2 | 8% | 13 | 52% | 12 | 48% | 7 | 28% | 0 | 0 | 0 |

**DISCUSSION**

Fingertip amputations are very common injuries, they account for 45% of all emergency department hand injuries. The middle fingertip is most commonly injured, followed by the index fingertip, while ring tip injury is least common.

Fingertip injuries are generally classified as transverse or oblique (either dorsal or volar), according to the plane of amputation.

Immediate repair is preferable for the best outcome. The management of these injuries can be challenging because of the lack of locally available tissue for reconstruction.

Injuries to the fingertip are generally regarded as those of the distal phalanx, distal to the insertions of the extensor and flexor tendons. Their potential for disability as a result of loss of fingertip mobility, sensation, or strength is substantial. Fingertip injuries that occur at the workplace may lead to significant costs associated with treatment, lost work, and functional disability. Treatment decisions for fingertip injuries are dictated by the individual needs of the patient, the nature of the wound, and the knowledge

and experience of the attending clinician. The main goals of fingertip reconstruction are the restitution or recreation of a sensate pain-free tip in a fully mobile digit of the maximum possible length, rapid healing, and a limited duration of functional disability. Treatment options for these injuries include primary closure, skin grafting, local or regional soft tissue flaps, and healing by secondary intention (17).

The three main goals of treatment are the restoration of sensation and durability in the tip and assuring proper bone support to allow for nail growth. The fingertip is vital for sensation since it has a high concentration of sensory receptors; hence, restoration of sensation is the preeminent focus of the treatment. Moreover, the durability of the tip is essential for finger motion as well as hand action, and, finally, the allotment of nail growth is a key factor in maintaining appearance. Improper treatment of fingertip amputations may lead to defects in the appearance such as hook nail deformity, and intolerance to cold, and skin tenderness. Deficiencies may also present in the form of stiffness and long-term functional loss (18).

There were many important previous studies related to our study, for example Mennen and Wiese (13) studied semiocclusive dressing technique on 200 patients with good results, with healing time between 20 and 30 days.

Hoigne et al. (19) found that fingertip amputations treated by semi-occlusive dressing therapy regenerated in different aspects. After the semi-occlusive treatment there was a two-point discrimination of 4 mm, which is much better than the sensibility of a non-sensible flap and very close to the sensible flap. The patient with the increased sensitivity to touch at the tip of the finger at 6 months follow-up was the only one with a measured thickness under 3.0 mm, the soft tissue thickness measuring 2.5 mm. Perhaps this represents the critical thickness for a good functional result. The treatment duration with an average of 6.5 weeks may seem relatively long. The same type of injury treated with the same method by Quell et al. (20) had a treatment period of 49 days and Richter (21) described duration of 6 weeks. This is a remarkable consistency between the three studies. Unfortunately we cannot directly correlate the length of treatment with the duration of the disability to work.

Sebastin et al. (22) in their systematic review of outcomes of fingertip replantation concluded that fingertip replantation provides satisfactory functional gain. The overall survival rate was 86% including partial survivals. Complications include nail deformities (about 24% of the patients) and pulp atrophy (about 14 % of the patients).

Wang et al. (23) in their systematic review concluded that the revision amputation treatment for fingertip amputation can achieve normal sensibility and satisfactory range of motion. His review included studies that reported outcomes of primary revision amputation following distal digital amputation, where treatment included open treatment, primary closure, full-thickness skin grafting, local, or regional flap closure (10).

Several articles have reported the disadvantage of sacrificing an important artery of a finger and the long scar along the lateral aspect of finger through joint (24).

No difference between sensate and insensate flaps regarding objective and subjective sensory recovery view over a long period (25).

Chen et al. (26) studied reverse flow homodigital island flap on 32 patients, with 100% survival rate.

Hashem (9) studied full thickness skin grafts taken from the ulnar border of the hand on 22 patients, with 95% survival rate.

This study attempts to compare the outcome of healing by secondary intention, full thickness skin grafts from the ulnar border of the hand, and reverse flow homodigital island flaps in the management of volar oblique fingertip amputations in the hand covering 75 cases of fingertip amputation

In these instances, the reconstructive surgeon is confronted with the dilemma of choosing the best reconstruction technique that meets the patient's needs. Options for treatment of fingertip injuries include primary spontaneous healing, shortening of bone and primary closure, composite grafts, and the wide variety of homodigital or heterodigital flaps.

In this study, 75 cases were followed over a 5 years period. Age ranged between 18-60 years. Ninety two percent of the cases were males (69 cases) while the rest were females, 96% were occupational according to the cause and the rest were traumatic/household, according to the Allen's classification the majority (53.3%) of cases showed amputation level class II. Only 12 cases (16%) did have bone exposed. The middle finger was the most injured in our study (60%). twelve (16%) cases showed postoperative infection. Nine (12%) cases got involved in the physical treatment/ occupational therapy. Thirty (40%) cases had numbness over the injured finger.

The first technique, dressing method is the easiest, with no any surgical intervention, yet it is the worst according to time of complete healing, worst according to aesthetic outcome, worst according to return to work timing.
The advantages of this method are undeniable. No hospitalization is required. No operative intervention is necessary. The time off work is short. More important even, objective sensibility as judged by two-point discrimination is restored to 6 mm compared with the normal 3mm for the intact pulp. In addition the appearance of the pulp is satisfactory particularly for the more distal amputations (27).
Full thickness skin graft is an easy technique, with minimal donor site disfigurement, yet its size is limited, that's to say that it's not suitable for large defects. As compared to homodigital island flap, full thickness skin graft is better according to time of complete healing, better according to aesthetic outcome, and according to return to work timing. The main disadvantages of full thickness skin graft technique are painful stump in 20% of cases and cold intolerance in same percentage of patients.
Homodigital island flap is a very good option in larger defects and in cases with exposed bones with no limitation in flap size. In this study we succeeded to close the donor site primarily with no need to reconstruct it with full thickness skin graft as planned before the study. But, as compared to full thickness skin graft in general it has longer healing time, worse aesthetic outcome and prolonged return to work timing. We noticed another big challenge in this technique which is inconsistent anatomy of digital bundles, which may result in flap failure.
Main disadvantages of homodigital island flap are its higher rate of failure (about 44% of our cases) compared to other techniques, longer time needed to achieve full healing, higher donor site morbidity compared to full thickness skin graft ( about 8% of our cases), numbness over the side of sacrificed bundle, and higher percentage of cases developed contracture of finger joints due to scar contracture, so we don't recommend linear incision.
Another notice is that, even in cases of graft loss/flap failure, we get benefit of biological dressing done by them in healing with secondary intention.
A common misconception is that range of motion should be delayed until the wound is healed. Waiting for wound closure can result in significantly decreased range of motion. It is important to educate the patient on this fact as it is counterintuitive for patients to move when a wound is present. Reassurance that the wound will heal and that range of motion and function are more likely to be preserved with prompt initiation of active movement is necessary (9).

## CONCLUSION

Fingertip injuries are the most common injuries in hand trauma patients. The major cause for adult patients is occupational accidents etiology. There are several classifications for fingertip injuries. Treatment options vary depending on the injury mechanism, defect's size and plane, surgeon's intention, patient's needs, condition of the stump and the amputated part. Despite ongoing publication of new flaps for fingertip reconstruction, there is a paucity of evidence to support improved healing and function in a surgically reconstructed fingertip compared to conservative wound management. Controlled trials are sorely needed to distill the truth as to whether surgery is superior to secondary healing or not.
In this study, we can confirm that surgical intervention with either technique, reconstruction with full thickness skin graft or reconstruction with reverse flow homodigital island flap is too much better than healing with secondary intention. With better results with full thickness skin grafts over homodigital island flaps specially in small defects with no exposed bones, a lesion represent most of fingertip cases in surgery. On the other hand homodigital island flaps are better in big defects and in cases with exposed bones.

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