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Review of Cross-Finger Flaps – Indications and Modifications

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Abstract: ***Background: Cross-finger flaps, over time, have become the one of the best reconstructive method in order to reconstruct fingers with significant soft tissue loss. Through various advancements and modifications, this technique helps deal with various types of finger injuries. Patients and methods: This study comprised of 21 patients with finger injuries with exposed vital structures, undergoing cross-finger flaps or its modifications in FMMCH under the Department of Plastic Surgery from November 2014 to November 2015. Results: All patients showed a survival of the flap and a good wound healing without complications. The functional and aesthetic results were satisfactory in all patients, the average DASH score was 16.2, after an average follow-up of 10 months. Conclusion: The technique of cross-finger flap and its various modifications used in our study provide durable cover of suitable dimensions at the most appropriate area, enabling coverage of the exposed vital structures, with minimal morbidity.***

Keywords: Cross-finger flap, reverse cross finger flap, dorsal flag flap, distally-based flap

1. Introduction

Since its introduction many years ago, the use of cross-finger flaps has become the single best reconstructive method in order to resurface fingers with significant soft tissue loss.[1] Studies have testified to its superiority in terms of sensibility, durability, efficiency and reliability in terms of patient's return to his or her previous occupation.[2]

Finger injuries account for potential morbidity. There are principles on which a surgeon can base his or her sound management plan. A stable, durable, preferably sensate cover is a deciding factor for a functional finger. Treatment should be expeditious, simple, reliable and cost-effective, taking into consideration the age, gender, occupation, hobbies, hand dominance, health and needs of the patient. A thorough understanding of the various limitations, possible complications and likely outcomes of the various treatment modalities is a must. Therefore, a thorough knowledge, along with a sound judgement, can transform a potentially debilitating injury into a functional hand.

This study evaluates the various indications of cross-finger flaps, its advantages over other treatment modalities, the technique employed for various finger injuries and also highlights its three major modifications suited for a different injury patterns.

1.1 Indications

There are various indications for the use of cross-finger flaps clearly enlisted by various authors. This procedure has been reliable and efficient in providing sensibility, preserving the finger length, and also coverage of exposed tendons and bones. The cross finger flap also provides a source for resilient and stable hand skin. It can be primarily used to replace an avulsed finger pad or secondarily to release a scar or to replace a hyperaesthetic scar or an inadequate skin graft. Other indications include the need for tactile gnostic ability, length preservation and bulk restoration with cosmetic appearance.[3,4,5]

1.2 Contraindications

Contraindications to this procedure have also been well documented in literature.[6] Multiple injuries to the hand, especially if they include the donor finger, may increase the risk of stiffness; however, having the shoulder and hand entirely free, preserving the length in multiple amputations, and covering repaired structures may offset that risk. Vasospastic conditions such as Raynaud's disease, diabetes mellitus and Buerger's disease may represent absolute contraindications. Pre-existing disabling problems, such as Dupuytren's contracture, rheumatoid arthritis and advanced age, present an increased hazard to the outcome of cross-finger flap.

1.3 Advantages

There are numerous advantages to the procedures. It provides a tough resiliency[7] unmatched by any tissue from other parts of the body. The need for immobilization is limited to the involved fingers and leaves the shoulder free. Sweating in the composite tissue may return, and this will help avoid slipperiness of a smooth scar or graft. The abundant vascularity of the hand also makes the properly raised flap quite reliable as well as flexible in terms of flap orientation. In loss of fingertip, its chief competitors are V-Y flaps (either volar or dorsal), shortening of the bone and primary closure, healing by secondary intention, split- or full-thickness skin grafts, palmar flaps or distal pedicle flaps.[8] In a study involving 235 patients, Sturman and Duran found cross-finger flap equivalent or superior to these other methods in terms of lack of tenderness, better touch sensation, better size and texture discrimination and less cold sensitivity.[5] Patients who have undergone cross-finger flaps also had less subjective disability and tended to avoid their areas of repair less.

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1.4 Patients and methods

Twenty one patients, between the age group of 18-42 years presenting with degloving injuries to their fingers in FMMCH under the Department of Plastic Surgery from November 2014 to November 2015, were subjected to cross-finger flap or the various modifications (as mentioned below), which was maintained for 3 weeks, following which it was divided and patient was subjected to physiotherapy.

The present study consisted of sixteen males and five females. Thirteen patients had workplace injuries while eight patients had injury following road traffic accident. Twelve patients underwent the classic (palmer) cross-finger flap, three underwent distally based cross-finger flaps, four underwent reverse (dorsal) crossed finger flaps and two underwent flag flaps.

This study mainly dealt with the results of finger injuries treated with cross finger flaps and its three different modifications (as per the situation).

1.5 Conventional or classic (palmar) cross finger flap

Indicated mainly for soft-tissue defects in the proximal or middle phalanges not suitable for skin grafting.[9]

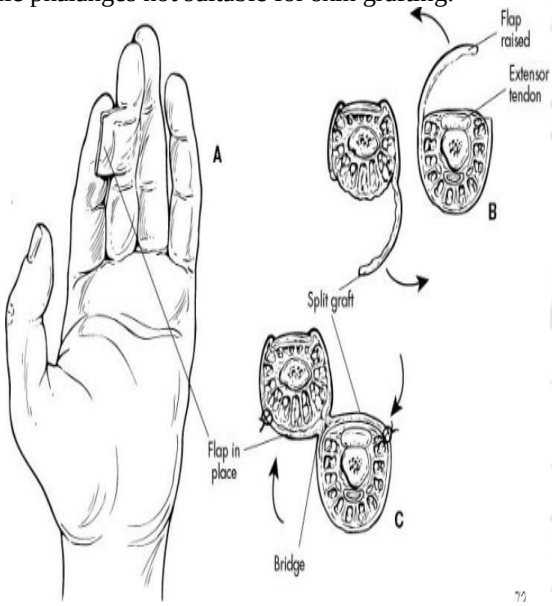


Figure 1: Cross-finger flap (schematic representation)

Surgical technique – Axillary block or regional anesthesia and arm tourniquet are preferred, based on the patient's condition. After routine preparation and draping of the upper extremity, a properly located, sized, and designed flap is marked. An adipocutaneous flap is harvested from the dorsum of the finger to the midlateral line, while preserving the paratenon of the donor phalanx. The flap is transferred to the defect of the neighboring finger while the donor site is covered by split-thickness skin graft.

1.6 Reverse (dorsal) cross finger flap

Indicated for soft-tissue defects in the dorsal proximal or middle phalanges not suitable for skin grafting.[9]

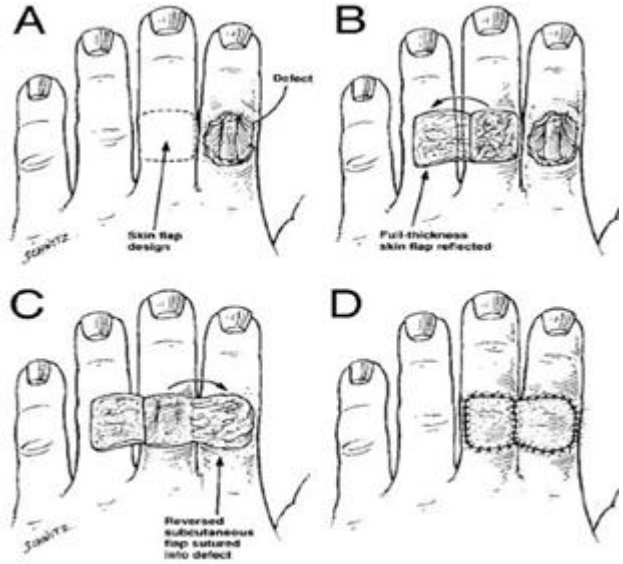


Figure 2: Reverse cross finger flap (schematic representation)

Surgical technique – similar to classic cross finger flap procedure, a properly located, sized, and designed flap is marked. Under loupe magnification, a thin full-thickness skin flap with intact subdermal vascular plexus is elevated based on the opposite side of the uninjured finger. After reversing the subcutaneous flap with this intact oblique skin island, the skin island will form the inner surface of the eponychium. This elevated subcutaneous flap with intact skin island is now sutured to the defect. The flap is elevated at the level of the extensor paratenon and dorsal veins and blood supply are preserved in the flap. The originally elevated, thin, full-thickness skin flap is then sutured back to cover the donor defect and a tie-over dressing is applied. After obtaining good hemostasis, the reverse surface of the thin subcutaneous flap on the injured finger is covered with a skin graft without a tie-over dressing.



(a)



(b)

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(c)

Figure 3: Reverse cross-finger flap

1.7 Dorsal flag flap

Indicated for covering soft-tissue defects on the dorsal aspect of fingers between the metacarpophalangeal and the distal interphalangeal joint as well as on the tip of the thumb.[10]

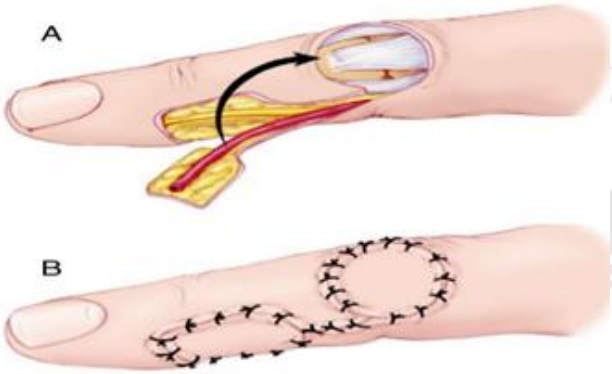


Figure 4: Dorsal flag flap (schematic representation)

Surgical technique – the flap is marked at the middle phalanx along with its flagpole pedicle, which contains the dorsal digital artery. The breadth should reach to the middle of the finger and the proximal pole should not cross the middle of the proximal phalanx. With tourniquet, dissection of the flap is done above the peritendineum with respect of the dorsal digital artery and subcutaneous veins in the pedicle. Following release of the tourniquet, flap perfusion is checked and then transposed into the defect. The donor site is covered by skin graft.



Figure 5: Dorsal flag flap

1.8 Distally based cross finger flap

Suited for coverage of near-circumferential defect at the tip of the finger in the form of crush amputation with element of degloving, where replantation is not possible.[11]

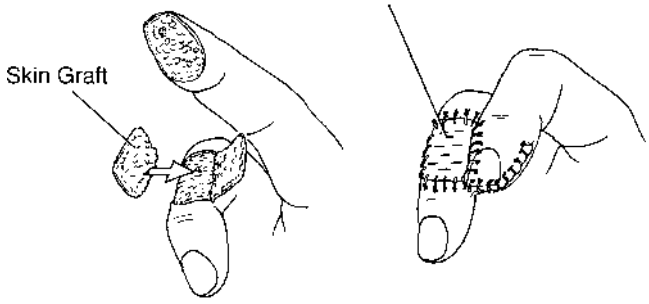


Figure 6: Distally based cross finger flap (Schematic representation)

Surgical technique – Performed under local anaesthesia and tourniquet control, skin over the dorsum of the finger between the mid-lateral lines is elevated as flap, with the base planned just distal to the extent of defect over the injured finger. The base of the flap constitutes the communication between the volar and the dorsal digital arterial systems around the joints. The flap is elevated as the usual cross finger flap just above the paratenon over the extensor tendons carefully controlling the dorsal veins and transposed to cover the defect over the injured finger. The donor site is then covered with split thickness skin graft with a tie over dressing.



(a)



(b)

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(c)



(d)



(e)

Figure 7: Distally based cross finger flap (Surgical procedure) (A – Injury status; B – Flap raised; C – Inset; D – Recipient site post-transection; E – donor site post-transection)

1.9 Post-operative management

Volar functional slab was applied to immobilize the fingers for one week and later discontinued to start active and passive physiotherapy. Regular dressings were done with Coban pressure wrap was done. Transection of the pedicle was done after 21 days and started with active and passive mobilization exercises.

2. Results

All patients showed a survival of the flap and a good wound healing without complications. Two patients developed a flexion contracture at the donor finger due to noncompliance following immobilization. Three patients complained about intermittent cold intolerance. The functional and aesthetic results were satisfactory in all patients, the average DASH Score ("Disabilities of the Arm, Shoulder and Hand") was 16.2, after an average follow-up of 10 months.

3. Discussion

The first article that dealt with cross-finger flap was published in the year 1950 by Micheal Gurdin and John W. Pangman, who termed the procedure as “trans-digital flap”, which was carved more on the lateral and volar surface if the donor digit.[12]

Almost 10 years after the first publication, Hoskins DH, published an article where he described the design of the classic cross finger flap.[13] With the passage of time, various modifications were brought into light regarding cross finger flaps. In 1969, Gaul SJ published an article that dealt with innervated cross finger flap for thumb innervations, where he named the flap as a “radial-innervated cross-finger flap from index”.[14]

In 1976, Joshi BB described the classic cross-finger flap that encompasses the dorsal sensory branch in the reconstruction of the index finger pulp by using the long finger donor sites. Following the division of the flap, he dissected that branch out from the digital nerve, isolated it and transposed it onto the index finger.[15]

In 1980, Atosay E published an article about another modification where a cross-finger flap was used to cover a pulp loss of an index finger.[16] In 1985, Robbins TH published another modification wherein a de-epithelialized cross-finger flap was used for dorsal finger defects.[17] He also published an article on “jam roll” cross finger flap in 1988, wherein a de-epithelialized cross-finger flap was rolled and made like a cylinder-like soft tissue mass and used it to replace the lost distal finger part covering the donor area and the flap with skin graft.[18]

Atasoy E, in 1989, described a reverse cross finger subcutaneous flap in order to cover nail bed, nail fold and dorsal tissue defects.[19] Mutaf M et al developed another modification called C-ring flap, used to cover amputated stumps and larger digital defects. Here, both the flaps receive a blood supply as axial flaps from ante- or retrograde blood supply from digital arteries and concomitant veins.[20]

Gupta A, in 1997, described another modification of innervated classic cross finger flap along with a portion of subcuticular tissues from distal or proximal finger areas to enhance the amount of subcutaneous tissues in finger pulp reconstruction, or to use these extra tissues to cover nail bed defects.[21]

The cross finger flaps and its modifications used in our study were planned in such a way based on the level of injury and the condition of adjacent fingers.

The cross-finger flap has been a reliable and efficient procedure in providing sensibility, preserving the finger length, and also coverage of exposed tendons and bones. It can be primarily used to replace an avulsed finger pad or

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secondarily in order to release a scar or to replace a hyperaesthetic scar or an inadequate skin graft. Other indications include the need for tactile gnostic ability, length preservation and bulk restoration with cosmetic appearance.[3] The cross finger flap also provides a source for resilient and stable hand skin.

Reverse cross finger flaps have been successfully indicated in various situations like reconstruction of an eponychial skinfold and coverage of an exposed extensor tendon near the IP joint, reconstruction of large, full-thickness, sterile matrix nailbed defects with exposed distal phalanx, coverage of a contused, repaired, or grafted extensor tendon denuded of paratenon, boutonniere deformity with poor-quality skin over the proximal interphalangeal (PIP) joint after burn or avulsion injury and full-thickness coverage of complete avulsion of the nailbed, germinal matrix, and surrounding skin of digits.[22]

Dorsal flag flap is indicated for covering soft-tissue defects on the dorsal aspect of fingers between the metacarpophalangeal and the distal interphalangeal joint as well as on the tip of the thumb.[10]

Distally based cross finger flap is well-suited for coverage of near-circumferential defect at the tip of the finger in the form of crush amputation with element of degloving, where replantation is not possible. This flap can easily cover dorsal digital defects if the adjacent finger is sufficiently long. They can be transposed without de-epithelialisation, and thus would reduce the operative time. The flap provides durable cover, with good quality, soft and supple local tissue.[11]

In this series, all flaps were divided as an outpatient after 3 weeks, followed by continuation of physiotherapy and scar care.
All patients showed a survival of the flap and a good wound healing without complications. The functional and aesthetic results were satisfactory in all patients, the average DASH score was 16.2, after an average follow-up of 10 months.

4. Conclusion

The technique of cross-finger flap and its various modifications used in our study, i.e., reverse cross-finger flap, dorsal flag flap and distally based cross-finger flap, provide durable cover of suitable dimensions at the most appropriate area, enabling coverage of the exposed vital structures, without undue morbidity.

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