ORIGINAL RESEARCH PAPER

Surgery

KEY WORDS: cross-finger flap, fingertip injury, full thickness skin graft, sensory

STUDY OF FINGERTIP RECONSTRUCTION USING CROSS FINGER FLAP AND FTG

Dr Rahul Patel Assistant Professor, Department Of Burns And Plastic Surgery, B. J. Medical College, Ahmedabad

Dr. Pankaj Pandor M.ch Plastic And Reconstructive Surgery

Dr. Kumar Mehta* M.ch Plastic And Reconstructive Surgery *Corresponding Author

ABSTRACT

Objectives: Fingertip injuries are frequent and there are many techniques used for reconstruction fingertip injuries. The authors reviewed the outcomes of fingertip reconstruction, including sensation and shape, using the combined technique of the cross-finger flap and full thickness skin graft and defined the optimal dimensions of fingertip defect that is applicable to this technique. **Methods:** Between 2019 and 2021, 40 cases, aged 3-60 years (mean, 28.1 years), who had undergone fingertip reconstruction using a combination of the cross-finger flap and full thickness skin graft were reviewed. The presence of fingertip and nail deformity and the results of the Semmes-Weinstein (S-W) monofilament and static two-point discrimination tests were analyzed. **Results:** Fingertip deformities were noted in 12 cases where the defect was more than 50% of the Tamai zone I or extended to zone II. Mild nail plate deformity was found in 12 cases with more than 40% of the nail bed defect. 8 out of these 12 cases presented with partial phalangeal tuft defects. 32 fingers were examined using the Semmes-Weinstein test, and their scores were between 2.83 and 4.31 in 20 fingers and 4.56 in 12 fingers. 24 were examined for static two-point discrimination, with 5 mm in 12, 6 mm in 4, and 10 mm in 2. The color and contour of all donor fingers were almost typical. **Conclusions:** The combination of the cross-finger flap and full-thickness full thickness skin graft is applicable to around 50% of fingertip defect within the Tamai zone I, achieving a satisfactory shape and regaining more than protective sensation.

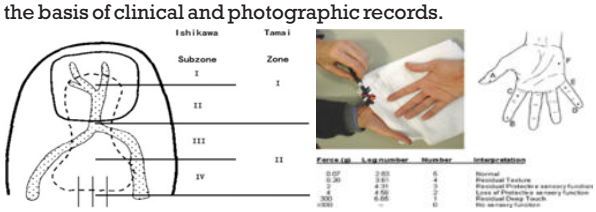
INTRODUCTION

The goal of fingertip reconstruction is to recreate a painless, sensate, and esthetically acceptable finger, which will allow patients to feel comfortable appearing in public view and improved self esteem. Various modes of reconstruction have been reported from a skin graft to free tissue transfer in past[1]. An flap is relatively an adaptable technique due to its various patterns of transfer and its applicability to a variety of defects[2-8]. We uses a combination of the cross-finger (CROSS FINGER) flap and full thickness skin graft for the reconstruction of a fingertip soft tissue defect. This staged procedure is considered simple and consistently provides an aesthetically acceptable appearance. We report our 2-year experience with this technique for the reconstruction of a fingertip with soft tissue defect[9].

METHODS

We retrospectively studied the records of consecutive cases, wherein the combination of the CROSS FINGER flap and full thickness skin graft was used to reconstruct a fingertip soft tissue defect during the period from May 2019 to December 2021. The criteria included cases with a fingertip injury, wherein there was preservation of most of the distal phalangeal tuft and nail matrix, patients expressing the desire to preserve the finger length, patients having normal adjacent donor fingers, and failure to retrieve the amputated tip. Exclusion criteria included patients who had retrieved their amputated fingertip, large defects extending proximal to the distal interphalangeal (DIP) creases, loss of the majority of the phalangeal tuft or nail matrix, and those with adjacent finger injuries.

The extent of fingertip injury was divided into two groups based on the Tamai zone classification: zone I, wherein the wound was located distal to the level of the lunula, and zone II, wherein the wound spanned proximally to the DIP joint. Fingertip defect dimensions were divided into less than 25%, 25% to less than 50%, 50% to less than 75%, and 75% or more within each Tamai zone. Similarly, a nail bed defect was presented as a percentage of its original size. For a partial nail matrix defect, a nail bed defect was estimated based on the residual nail matrix as the original size. The presence of a distal phalangeal tuft defect was recorded. The outcomes measured included the presence or absence of fingertip and nail plate deformity, Semmes-Weinstein monofilament (SW) test using five filaments (2.83, 3.61, 4.31, 4.56, and 6.65), static two-point discrimination (S2PD) test on the reconstructed area, the presence of joint stiffness of both the affected and donor digits, the appearance of the donor site, and any complications. Deformity of a fingertip or nail were judged on the basis of clinical and photographic records.



Surgical technique

The procedure was performed under the brachial plexus block with tourniquet control. Local anesthesia was used for skin graft harvest from the instep. General anesthesia was used for pediatric cases. The adjacent finger was chosen as the donor of the flap similar to the conventional cross-finger flap by considering the ergonomic position of each finger. The dimension of the flap was set as follows: the length was the whole length of a single phalanx, and the width was in between the bilateral mid-lateral lines. The procedure was carried out under a loupe magnification of 2.5-3.5 times. The skin flap, whose base was on the contralateral side of the affected finger, was elevated distally, ensuring not to cut deep into the fat layer as this was needed as a base of the flap. The distal part of the skin flap did not possess any fat tissue, but in the rest of the flap, a very thin layer of fat lobules was retained underneath the skin flap to preserve the subdermal plexus. Skin flap elevation was commenced up to the mid-lateral line. Then, the flap, including the subcutaneous veins, was elevated on the paratenon of the extensor tendon from the base of the elevated skin flap toward the midlateral line of the other side, i.e., the affected finger side. Dissection of the distal part of the tissue beyond the mid-lateral line was not attempted to preserve the neurovascular bundle. The fingertip shape was

recreated by folding or tucking the flap. The skin flap on the donor finger was set back to its original position, with quilting sutures catching the underlying extensor tendon, which was placed in the radioulnar direction in order not to interrupt flap circulation. Next, a piece of full-thickness full thickness skin graft was harvested either from the instep or hypothenar eminence. In some cases, a split-thickness full thickness skin graft or dermal substitute was used instead, according to the surgeon's preference. The size of the skin graft should be designed larger than the fingertip defect to cover the area of the flap spanning both fingers. The skin graft with one or two drainage holes was placed without compression, such as quilting or tie-over sutures. Here the distal edge of the skin flap and edge of the skin graft were sutured together to cover the area of the flap spanning two digits. Both fingers were splinted proximally with a loose 3-0 nylon suture against the unintended force separating the two fingers. A light compressive dressing with petroleum gauze over the skin graft and skin flap was applied and kept unchanged for one week. Epidermolysis over the skin graft and skin flap was often seen and treated conservatively with Vaseline based ointment. The CROSS FINGER flap was divided 2-3 weeks later under the digital block or brachial plexus block. The distal part of the skin flap was elevated first, and the base of the flap was divided as proximally as possible with care not to injure the neurovascular bundle as mentioned above. Reshaping of the fingertip was performed, and the donor site was closed primarily. When a dermal substitute was used, a skin graft was applied after the division and arrangement of the flap.

Clinical Photograph

RESULTS

A total of 40 consecutive patients, aged 3-60 years (mean, 28.1 years), with a single digit injury were included. The median follow-up period was 184.5 days (range, 60-533 days). 8 patients were smokers. 36 cases were caused by trauma, and 4 resulted from the resection of vascular malformation. Cases included the thumb (12), index finger (12), middle finger (12), and small finger (4). The extent of the defect was within the Tamai zone I in 32 fingers, wherein the size of the defect was 25% to less than 50% in 24 digits, 50% to less than 75% in 4, and 75% or more in 4. The defects of 8 digits extended into the Tamai zone II with 25% to less than 50% and 75% or more, respectively. A nail bed defect was noted in 32 cases, wherein their size was less than 50% in 24 digits and more than 50% in 8. A partial distal phalangeal tuft defect was noted in 12 cases.

The full-thickness full thickness skin graft was harvested from the instep in 28 cases and hypothenar eminence in 4. The split-thickness skin graft from the instep was used in 8 cases. A combination of a dermal substitute and fullthickness skin graft from the instep was used in 4 cases . 12 cases showed nail plate deformity. 8 cases, showed the same deformity, i.e., reduced length of the nail bed and nail plate at the affected area. Fingertip deformity was noted in 12 cases. The defect in the lateral oblique direction had a size of 50% to less than 75% and possessed a partial distal phalangeal tuft defect. A flat fingertip deformity was noted on the affected area. The defects of the other 8 cases showed fingertip deformity, which extended into the Tamai zone II (Figure 5). A split-thickness skin graft was used for reconstruction in both cases. The results of the SW test in 32 patients were 2.83 in 4, 3.61 in 12, 4.31 in 4, and 4.56 in 12 fingers. The results of the S2PD in 24 cases were 5 mm in twelve, 6 mm in four, and 10 mm in eight fingers. Both tests were conducted in 20 of the cases, because in the rest of cases, measurement of S2PD could not conducted appropriately due to the small area of reconstruction or inability to discriminate. The donor finger had almost normal color and contour. Joint stiffness of the donor finger proximal interphalangeal joint was noted in four case with a total active motion percentage of 71%. Eight cases experienced dehiscence of the instep wound that healed naturally.

DISCUSSION

The CROSS FINGER flap was first reported by Atasoy in 1982 as a "reversed cross-finger subcutaneous flap" for the reconstruction of the dorsal soft tissue defect of a distal phalanx[10]. As this flap is pliable and the same on both sides, owing to the lack of skin, it can be molded to any shape of the defect. The requirement of a skin graft to close the defect is not a shortcoming but rather an advantage as we have freedom to choose the skin graft to be similar to the defect lost (the full thickness skin in our technique.

We used a laterally based cross-finger pattern for three reasons. First, most of the transferred tissue could be used without waste. Furthermore, the tension over the flap should be minimal compared with a distally- or proximally-based cross-finger pattern. Finally, a laterally based cross-finger pattern[5] has robust circulation. Circulation of the dorsal skin of the phalanges is provided proximally by the dorsal digital branches of the dorsal metacarpal arteries and dorsal cutaneous branches of the palmar digital arteries (PDA) along the phalanges, which are the vascular base of the cross finger flap[11].

Although the combination of the cross finger flap and full thickness skin graft is a staged procedure that requires secondary flap division, the authors prefer this technique to other established single-stage methods, such as V-Y advancement and neurovascular island flaps, because this technique restores optimal finger aesthetic and sensation. The natural appearance of the fingertip is based on its contour, texture, color match, and shape of the nail. Fingertip deformity was noted in 12 cases with a relatively large defect. The dimension of the defect to which this method is suitable is a tissue loss of around 50% within Tamai zone I. This volume is almost equal to the total volume of the flap from a single phalanx and a piece of full-thickness skin graft. Therefore, the volume imbalance of the defect and transferred tissue and the use of a split-thickness skin graft, causing more contracture than a full-thickness skin graft, were the reasons for the deformity in these cases.

Regarding the sensation of the reconstructed fingertip, 20 cases regained more than protective sensation. Three possible reasons can be raised. First, the defect was small and had dense cutaneous innervation. Second, a full thickness full-thickness skin graft possessing many corpuscles (the target of regenerating nerves) was used. Many cutaneous nerve ends were reported to direct the target organs in the grafted skin. Moreover, some studies reported reinnervation of corpuscles in the grafted full thickness full-thickness skin graft. Lastly, age might contribute to better reinnervation. Contrary to the abovementioned target theory, some argued that the

sensation might be mediated by simple nerve endings even in the absence of the encapsulated corpuscles due to cortical adaptation/plasticity, wherein children possess higher potential compared to adults. In 24 cases with SW test of less than 4.56 and/or S2PD of less than 10 mm, 4 small child and 8 teenagers were included, whereas 12 cases with SW test of 4.56 and/or S2PD of 10 mm were all adults. There are many modes to sensate fingertip reconstruction, but they require tedious dissection, tiny neurorrhaphy, or proper digital artery sacrifice, with variable results. Moreover, some use the pigmented dorsal skin[14-18]. Although sensation was suboptimal in some cases, considering simplicity, giving priority to the cosmetic appearance of the fingertip can be excusable.

CONCLUSION

The combination of the CROSS FINGER flap and full-thickness full thickness skin graft is applicable to approximately 50% of the fingertip defect within Tamai zone I, achieving satisfactory fingertip appearance and reasonable reinnervation. Typical nail plate growth was seen in cases with a nail bed loss of less than half with an intact distal phalanx.

REFERENCE

1. Lee WP, Ganchi PA. Plastic surgery. 2nd ed. Philadelphia (USA): Saunders Elsevier; 2006. Chapter 170, Fingertip reconstruction; p. 153□70.
2. Voche P, Merle M. The homodigital subcutaneous flap for cover of dorsal finger defects. Br J Plast Surg. 1994 Sep;47(6):435□9.
3. Al-Qattan MM. Technical modifications and extended applications of the distally based flap for dorsal digital defects. Ann Plast Surg. 2004 Feb;52(2):168□73.
4. Onishi K, Maruyama Y. Dorsal metacarpal flaps for palmar finger and hand reconstruction. Ann Plast Surg. 2006 Aug;57(2):203□5.
5. Al-Qattan MM. The cross-digital dorsal flap. Ann Plast Surg. 2008 Feb;60(2):150□3.
6. Iwasawa M, Yanagida T, Fujita K, et al. Extensor gliding tissue reconstruction with an flap based on a dorsal branch of the digital artery. J Plast Reconstr Aesthet Surg. 2008 Feb;61 (2):221□5.
7. Camporro D, Vidal D, Robla D. Extended applications of distally based axial flaps for hand and digits defects. J Plast Reconstr Aesthet Surg. 2010 Dec;63(12):2117□22.
8. Karamese M, Akatekin A, Abac M, et al. Fingertip reconstruction with reverse homodigital flap. Ann Plast Surg. 2015 Aug;75(2):158□62.
9. Imaizumi A, Ishida K. Fingertip reconstruction using the cross-finger flap. Jpn J Plast Surg. 2014 Nov;57(11):1255□62.
10. Atasoy E. Reversed cross-finger subcutaneous flap. J Hand Surg Am. 1982 Sep;7(5):481□3.
11. Strauch B, de Moura W. Arterial system of the fingers. J Hand Surg Am. 1990 Jan;15(1):148□54.
12. Yang D, Morris SF. Vascular basis of dorsal digital and metacarpal skin flaps. J Hand Surg Am. 2001 Jan;26(1):142□6.
13. Moss SH, Schwartz KS, von Drasek-Ascher G, et al. Digital venous anatomy. J Hand Surg Am. 1985 Jul;10(4):473□82.
14. Borman H, Maral T, Tancer M. Fingertip reconstruction using two variations of direct-flow homodigital neurovascular island flaps. Ann Plast Surg. 2000 Jul;45(1):24□30.
15. Lassner F, Becker M, Berger A, et al. Sensory reconstruction of the fingertip using the bilaterally innervated sensory cross-finger flap. Plast Reconstr Surg. 2002 Mar;109(3):988□93.
16. Ozcanli H, Coskunfirat OK, Bektas G, et al. Innervated digital artery perforator flap. J Hand Surg Am. 2013 Feb;38(2):350□6.
17. Chen C, Tang P, Zhang X. A comparison of the dorsal digital island flap with the dorsal branch of the digital nerve versus the dorsal digital nerve for fingertip and finger pulp reconstruction. Plast Reconstr Surg. 2014 Feb;133(2):165e□73e.
18. Kim J, Lee YH, Kim MB, et al. Innervated reverse digital artery island flap through bilateral neurorrhaphy using direct small branches of the proper digital nerve. Plast Reconstr Surg. 2015 Jun;135(6):1643□50.