

Combined Subdermal Pocket Procedure and Abdominal Flap for Distal Finger Amputations in a Toddler

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Summary: A girl (aged 1 year and 9 months) sustained traumatic amputation to her middle and ring fingers (zone 1C) by a cup-sealing machine. Full-thickness dorsal skin burn over amputated fingertips was also noted. Emergent finger replantation was performed. Following bone fixation, bilateral digital arteries and nerves were repaired. After complete debridement of the necrotic dorsal skin, the extensor tendon and joint were exposed. Moreover, all dorsal veins were destroyed. The pulps (middle and ring fingers) were de-epithelialized and inserted into the subdermal pocket over her left abdomen. The 2 raised skin flaps were transferred to reconstruct the dorsal skin defects. Division of the replanted finger from abdomen was performed at the 14th postoperative day. The fingers survived completely. Good functional and aesthetic outcomes were achieved. (*Plast Reconstr Surg Glob Open* 2015;3:e386; doi: 10.1097/GOX.0000000000000349; Published online 4 May 2015.)

Replantation of pediatric fingers after amputation is challenging in reconstructive microsurgery. Finger amputation in children not only affects the long-term functional performance of the hand but also destroys children's body image identification, which may cause difficulty in social interactions at school age.

In Taiwan, due to the prevalence of drinking shops, cup-sealing machine usage is common. Therefore, the curiosity of children and inattention of a caregiver can often result in serious damage if the children's fingers inappropriately interact with the cup-sealing machine. The cup-sealing machine operates under high compression

pressure and high temperature conditions. Therefore, finger injuries caused by the cup-sealing machine have 2 main characteristics: (1) amputation by the pressure sealing applier and (2) severe contact thermal injury from the high temperature. A combination of these 2 injury mechanisms makes the reconstruction more complicated than other types of injury.

In the following case, we present a valuable option characterized by the use of a combination of the subdermal pocket procedure and abdominal flap to rescue 2 fingers with guillotine amputation and full-thickness dorsal skin burn in a toddler.

CASE REPORT

A girl (aged 1 year and 9 months) suffered from traumatic amputation of her index, middle, and ring fingers by a cup-sealing machine. The index finger was amputated at the distal pulp area (zone 1A); the middle and ring fingers were amputated at the distal interphalangeal joint (zone 1C). Severe contact burn injuries with full-thickness skin damage of the amputees of the middle and ring fingers were also noted (Fig. 1A).

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Emergency replantation was performed. The right index fingertip was sutured back as a composite graft. The replantation of the middle and ring fingers was started by distal interphalangeal joint arthrodesis using a percutaneous k wire. The extensor tendons were fixed to the base of the distal phalanx. The flexor digitorum profundus tendons were repaired by 4-0 polydioxanone. Under a microscope, bilateral digital arteries and nerves of the middle and ring fingers were identified and anastomosed using 10-0 and 11-0 nylon.

The extensor tendons and joint capsules were exposed, which was followed by complete debridement of the necrotic dorsal skin. Moreover, no dorsal veins were available for anastomosis.

The subdermal pocket procedure was planned on her left abdomen and was performed as described by Lin et al^{1,2} (Fig. 1B). Two skin flaps were elevated based on the subdermal plexus, with part of the deep dermis remaining on the base. The pulps of the middle and ring fingers were de-epithelialized and inserted into the pocket.

The dorsal finger defects were reconstructed using 2 skin flaps (Fig. 1C).

At the beginning of the third postoperative day, puncturing of the nail fold with a 25-gauge needle was performed to confirm circulation. Finger circulation was adequate, and further intervention was not required. Two weeks after replantation, the division procedure was performed in the operation room under general anesthesia. The skin flaps covering the dorsal fingers were divided from the abdomen, and the fingers were detached (Fig. 1D). The donor site was closed primarily. The patient was hospitalized for 15 days. At the 6-month follow-up, the replanted fingers were confirmed to have survived well with a good aesthetic outcome. Static 2-point discrimination was 6 mm and 5 mm for the index finger and middle finger, respectively. Range of motion of distal interphalangeal joint was 30 degrees and 45 degrees for the index finger and middle finger, respectively. The appearance of replanted fingers at 4 years and 8 months after operation is shown in Figure 2.

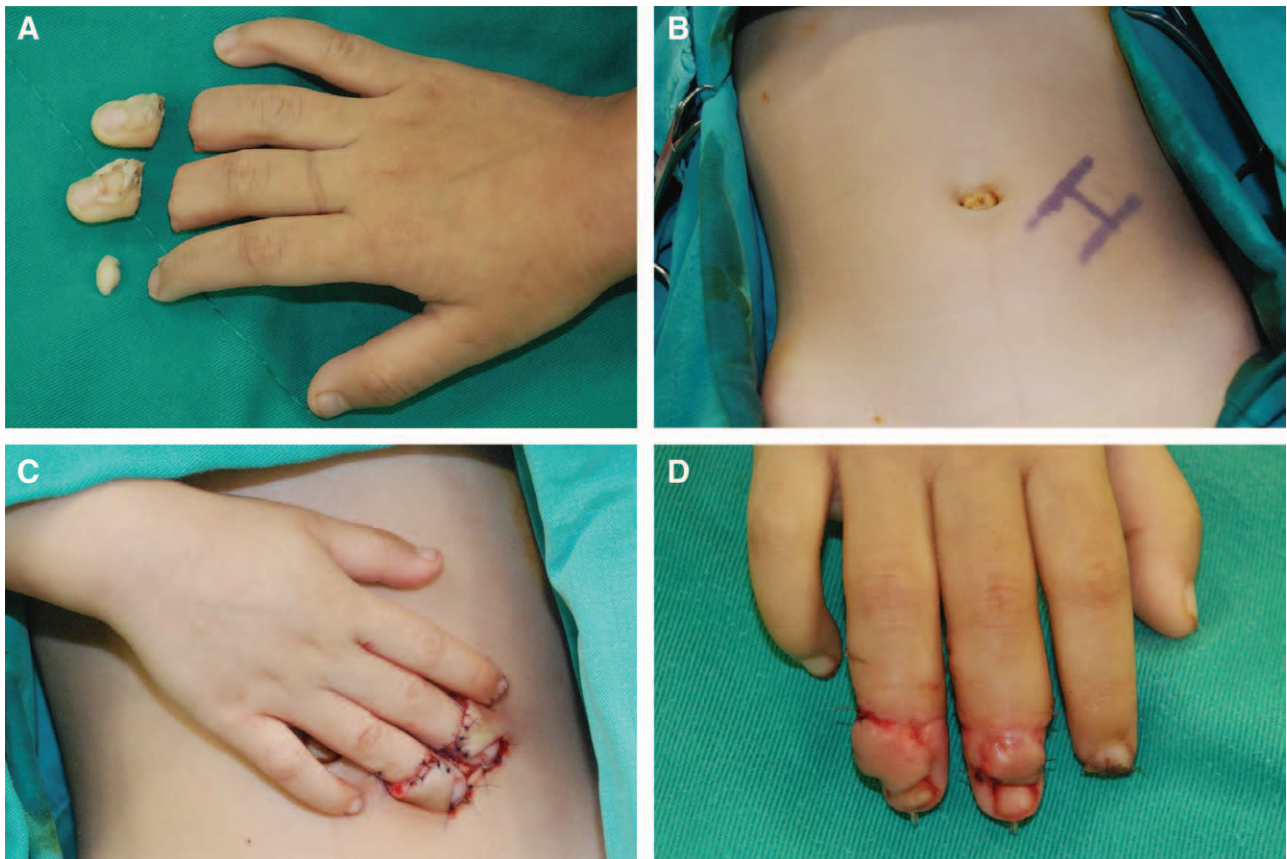


Fig. 1. Traumatic amputation of middle and ring fingers (zone 1C). A, Note the full-thickness contact thermal burn over dorsal skin. B, Subdermal pocket procedure with 2 skin flaps was designed over left abdomen. C, After replantation, pulps of replanted middle and ring fingers were de-epithelialized and inserted into the pocket. Two skin flaps were used to reconstruct dorsal skin defect. D, Division procedure was performed 10 days after operation.

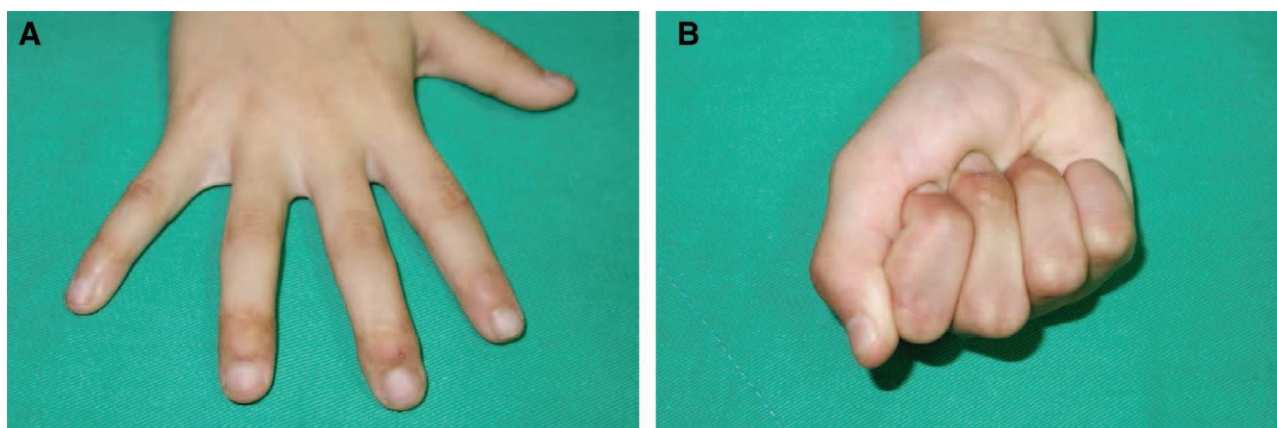


Fig. 2. Appearance of replanted fingers 4 years and 8 months after operation with good aesthetic (A) and functional (B) results.

DISCUSSION

The goals of finger replantation are to restore function and preserve the natural contour. The anatomic, aesthetic, and functional proprieties of the fingers should be restored, especially for children. A successful replantation is very important for both hand function and psychosocial development. Therefore, replantation of the amputated fingers should be attempted in all cases to obtain maximum functional and aesthetic outcomes.³

Sebastin and Chung⁴ performed a comprehensive systematic review of distal digital amputations and proposed a new classification system that divided the amputations into zones 1A (distal to the lunula), 1B (between the root of the nail bed and the lunula), 1C (between the neck of the middle phalanx and the flexor digitorum profundus insertion), and 1D (between the flexor digitorum superficialis insertion and the neck of the middle phalanx). In zone 1B, the superficial dorsal veins are first available. From zone 1B to 1D, venous anastomosis significantly improves the survival of the replant.³⁻⁷

When no dorsal veins are available, several techniques have been proposed, such as an arterial venous shunt,⁸⁻¹¹ external bleeding,^{12,13} chemical or medicinal leeches,^{14,15} subcutaneous pocket,¹⁶ and subdermal pocket procedures.^{1,2} However, each method has its own set of disadvantages. The use of a contralateral digital artery of the amputated finger for venous drainage and its connection, with or without vein graft, to the proximal vein stump as an arterial venous shunt has been reported.⁹ However, it might be time-consuming and requires advanced microsurgical skills. The external bleeding method and leech therapy might cause inevitable blood loss and the consequent need for blood transfusion. Moreover, it has been reported in the literature that leech therapy could result in arterial compromise, pulp atrophy, and *Aeromonas hydrophila* infections.¹⁷

Lin et al¹ reported on the use of a subdermal pocket; the authors used the highly vascularized subdermal plexus to enhance early neovascularization and provide venous drainage of the replanted finger. Compared with the subcutaneous pocket procedure,¹⁶ the subdermal pocket procedure provided better vascularization of the wound bed, feasible finger monitoring, easy wound care, and a shorter pocket time.

In our case, the patient had zone 1C amputation of the middle and ring fingers with concomitant full-thickness burn damage of the dorsal skin. Venous drainage was indicated to improve the finger survival, but the dorsal veins were destroyed by the burn injury. The use of an arterial venous shunt, external bleeding method, and leech therapy are difficult for such a child. The external bleeding method is too risky for children due to the chance of profound blood loss. Moreover, none of the above methods could concurrently reconstruct the dorsal skin defects. Local flaps from the homodigit or heterodigit, distant flaps, or even free flaps are required to cover the dorsal finger defects.

Therefore, we applied the subdermal pocket procedure for venous drainage and simultaneously used the raised skin flaps to reconstruct the dorsal skin defects. The procedure has the following advantages: (1) no additional venous microvascular anastomosis is required; (2) the operation time is not long; (3) this method serves as an option with 2-stage reconstruction (including the division procedure); and (4) no second donor site is needed.

CONCLUSIONS

Distal finger amputation with concomitant full-thickness dorsal skin burn injury is a difficult situation for replantation. We successfully used a combination of the subdermal pocket procedure and abdominal flap to salvage the fingers of a child (aged 1 year and

9 months). This simple method provides a solution simultaneously to reconstruct venous drainage and the dorsal skin defect.

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REFERENCES

1. Lin TS, Jeng SF, Chiang YC. Fingertip replantation using the subdermal pocket procedure. *Plast Reconstr Surg.* 2004;113:247–253.
2. Lin TS, Yang JC. Secondary subdermal pocket procedure for venous insufficiency after digital replantation/revascularization. *Ann Plast Surg.* 2014;73:662–667.
3. Chaivanichsiri P, Rattanasrithong P. Type of injury and number of anastomosed vessels: impact on digital replantation. *Microsurgery* 2006;26:151–154.
4. Sebastin SJ, Chung KC. A systematic review of the outcomes of replantation of distal digital amputation. *Plast Reconstr Surg.* 2011;128:723–737.
5. Jazayeri L, Klausner JQ, Chang J. Distal digital replantation. *Plast Reconstr Surg.* 2013;132:1207–1217.
6. Li J, Guo Z, Zhu Q, et al. Fingertip replantation: determinants of survival. *Plast Reconstr Surg.* 2008;122:833–839.
7. Hattori Y, Doi K, Ikeda K, et al. Significance of venous anastomosis in fingertip replantation. *Plast Reconstr Surg.* 2003;111:1151–1158.
8. Hsu CC, Lin YT, Moran SL, et al. Arterial and venous revascularization with bifurcation of a single central artery: a reliable strategy for Tamai Zone I replantation. *Plast Reconstr Surg.* 2010;126:2043–2051.
9. Koshima I, Soeda S, Moriguchi T, et al. The use of arteriovenous anastomosis for replantation of the distal phalanx of the fingers. *Plast Reconstr Surg.* 1992;89:710–714.
10. Koshima I, Yamashita S, Sugiyama N, et al. Successful delayed venous drainage in 16 consecutive distal phalangeal replantations. *Plast Reconstr Surg.* 2005;115:149–154.
11. Yan H, Jackson WD, Songcharoen S, et al. Vein grafting in fingertip replantations. *Microsurgery* 2009;29:275–281.
12. Kamei K, Sinokawa Y, Kishibe M. The venocutaneous fistula: a new technique for reducing venous congestion in replanted fingertips. *Plast Reconstr Surg.* 1997;99:1771–1774.
13. Chen YC, Chan FC, Hsu CC, et al. Fingertip replantation without venous anastomosis. *Ann Plast Surg.* 2013;70:284–288.
14. Barnett GR, Taylor GI, Mutimer KL. The “chemical leech”: intra-replant subcutaneous heparin as an alternative to venous anastomosis. Report of three cases. *Br J Plast Surg.* 1989;42:556–558.
15. Baudet J. The use of leeches in distal digital replantation. *Blood Coagul Fibrinolysis* 1991;2:193–196.
16. Lee PK, Ahn ST, Lim P. Replantation of fingertip amputation by using the pocket principle in adults. *Plast Reconstr Surg.* 1999;103:1428–1435.
17. Lineaweaver WC, Hill MK, Buncke GM, et al. *Aeromonas hydrophila* infections following use of medicinal leeches in replantation and flap surgery. *Ann Plast Surg.* 1992;29:238–244.