

The Modified 3-square Flap Method for Reconstruction of Toe Syndactyly

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Bandoh reported the 3-square-flap method as a procedure for interdigital space reconstruction in patients with minor syndactyly. We recently modified this flap design so that it could be used in the treatment of toe syndactyly involving fusion of the areas distal to the proximal interphalangeal joint. With our method, the reconstructed interdigital space consists of 4 oblong flaps (A through D). Flaps A and D are designed on the dorsal side, flap B is designed on the frontal plane of the interdigital space, and flap C is designed on the plantar side. Flaps A, B, and C are raised immediately below the dermis in a manner that allowed slight fat tissue to adhere to each flap. Flap D is freed to a degree minimally needed for dislocation, while leaving a thick subcutaneous pedicle. Flaps A, B, and C are each folded in 90 degrees; flap D is dislocated to the proximal plane of the reconstructed digit, followed by skin suturing. In this process, suturing is avoided between flaps A and C, between flaps A and D, and between flaps B and D. During the period of 2011 to 2015, we treated 8 patients of toe syndactyly involving fusion distal to the proximal interphalangeal joint. Cases of congenital syndactyly received surgery between the ages of 8 and 11 months. Using this technique, flap ischemia/necrosis was not observed. During the postoperative follow-up period, the interdigital space retained sufficient depth without developing any scar contracture. No case required additional surgery. (*Plast Reconstr Surg Glob Open* 2016;4:e793; doi: 10.1097/GOX.0000000000000735; Published online 11 July 2016.)

There are 2 variations of the cause of syndactyly of toes: one is acquired and results after a burn or trauma and the other is congenital. The use of skin grafts is a major issue in the treatment of syndactyly. Bandoh et al¹ reported the 3-square-flap method as a procedure for interdigital space reconstruction in patients with minor syndactyly. We re-

cently modified the design used for the 3-square-flap method so that it could be used in the treatment of syndactyly involving fusion of the areas distal to the proximal interphalangeal (PIP) joint. This modified method was applied to 8 patients with severe toe syndactyly, resulting in favorable outcomes in all cases.

SURGICAL METHODS

The 3-square-flap method involves designing 3 square flaps of the same size (Fig. 1).¹ Each flap is folded in 90 degrees and sutured to create interdigital space. This method is applicable only to minor syndactyly involving fusion confined to the area proximal to the PIP joint.¹ With the modified 3-square-flap method, the interdigital space of the area affected by syndactyly involving fusion distal to the PIP joint was designed in a rectangular form. The reconstructed

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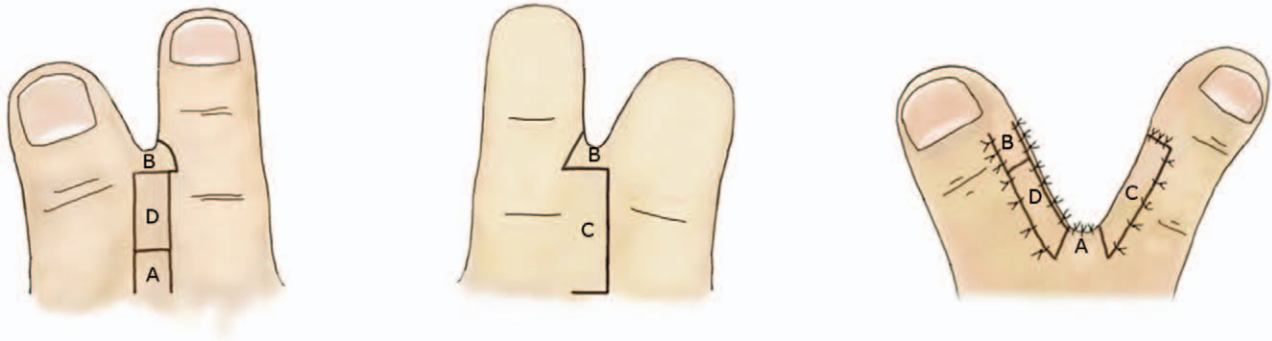


Fig. 1. Diagram of the surgical methods.

Table 1. Characteristics of Parents

No	Age	Sex	Diagnosis	Cause	Postoperative Period	Complication
1	11 months	Male	Bilateral second web toe syndactylies	Anomaly	4 years 9 months	None
2	9 months	Female	Right second web toe syndactyly	Anomaly	3 years 10 months	None
3	10 months	Male	Right second web toe syndactyly	Anomaly	2 years 8 months	None
4	9 months	Female	Bilateral second web toe syndactylies	Anomaly	2 years 5 months	None
5	11 months	Male	Left second web toe syndactyly	Anomaly	2 years	None
6	11 years	Female	Right first web toe syndactyly	Burn injury	2 years	None
7	11 months	Female	Right second web toe syndactyly	Anomaly	1 year 7 months	None
8	8 months	Male	Left second web toe syndactyly	Anomaly	1 year 6 months	None

interdigital space consists of 4 oblong flaps (A through D). Flap D is raised as a subcutaneous pedicle flap and is dislocated to the proximal plane of the reconstructed digit. Flaps A and D are designed on the dorsal side of the interdigital space, flap B is designed on the frontal plane of the interdigital space, and flap C is designed on the plantar side. Flap D is designed as large as possible to obtain adequate vascular supply from the subcutaneous tissue. If there is laterality difference between medial and lateral sides in the length of the fused digits, the base of flap B is allocated for the shorter digit and the greater length of the flap is taken from the lateral side of the longer digit. By this design, the lateral aspect of the reconstructed digit can be closed with sufficient margin by flaps B and D at the time of skin suturing. Flaps A, B, and C were raised immediately below the dermis in a manner that allowed slight fat tissue to adhere to each flap. Flap D was freed to a degree minimally needed for dislocation, while leaving a thick subcutaneous pedicle. Flaps A, B, and C were each folded in 90 degrees; flap D was dislocated to the proximal plane of the reconstructed digit, followed by skin suturing. In this process, suturing was avoided between flaps A and C, between flaps A and D, and between flaps B and D.

RESULTS

During the period of 2011 to 2015, we treated 8 patients of toe syndactyly involving fusion distal

to the PIP joint (Table 1). Cases of congenital syndactyly received surgery between the ages of 8 and 11 months. In cases of bilateral syndactyly, operation was performed on both sides at a time. Postoperatively, all cases remained free of disturbed blood flow through the flaps, with flaps surviving successfully in all cases. During the postoperative follow-up period, the interdigital space retained sufficient depth without developing any scar contracture. No case required additional surgery.

CASE REPORT

Case 1

An 11-year-old girl with right first web toe syndactyly resulting from burn injury underwent interdigital space reconstruction with this method (Fig. 2A and B). The flaps survived successfully without any postoperative complication. Currently, 2 years postoperatively, the interdigital space retains sufficient depth, showing no sign of scar contracture (Fig. 2C).

DISCUSSION

Toe syndactyly is a congenital anomaly with a relatively high incidence. In Japan, many people remain barefoot throughout their daily routine; therefore, patients often desire surgery for children with toe anomalies for aesthetic reason.²

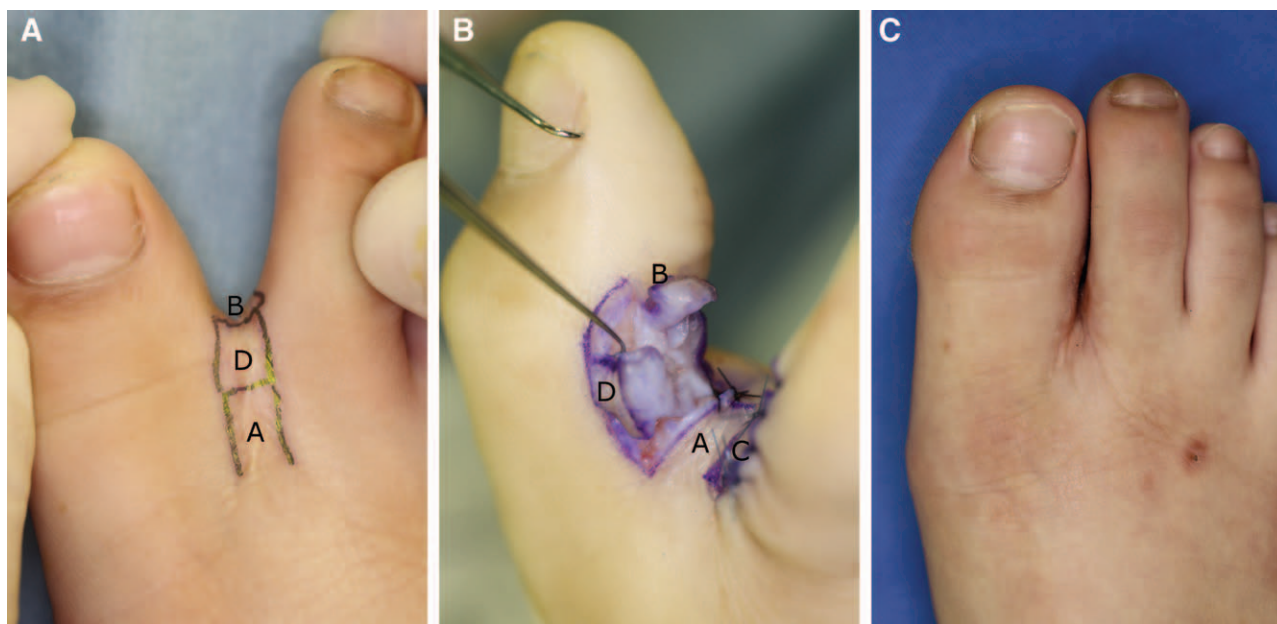


Fig. 2. A 12-year-old girl with right first web toe syndactyly resulting from burn injury underwent interdigital space reconstruction with this method. A, Flaps A and D were designed on the dorsal side, and flap B was designed on the frontal plane of the interdigital space. B, Flaps A, B, and C were folded in 90 degrees, and flap D was freed to a degree minimally needed for dislocation, while leaving a thick subcutaneous pedicle. C, Postoperative condition after 2 years, the interdigital space retains sufficient depth, showing no sign of scar contracture.

Although syndactyly is usually treated surgically with a combination of skin graft and local flap, this approach has shortcomings of inconsistency in color and texture between the skin grafted area and the surrounding skin. In addition, there is likelihood for postoperative scar contracture due to shrinkage of the grafted area.

Several investigators have reported surgical techniques for syndactyly without the need for skin grafting.³⁻⁷ However, all of these techniques are only applicable to minor syndactyly. For cases of severe syndactyly involving fusion up to the distal interphalangeal joint, an operative procedure using an expander has been reported.⁸ However, such a procedure needs to be applied multiple times and requires a long period of treatment, thus limiting its indications.

The 3-square-flap method was reported in 1996 by Bando et al¹ as an operative procedure for minor syndactyly. Hayashi et al⁹ applied surgery with a combination of this method and a subcutaneous pedicle flap to 10 patients of toe polysyndactyly, resulting in partial necrosis of the subcutaneous flap in 3 cases. Hayashi et al⁹ regarded that such results occurred because the subcutaneous flap was delicate and hence prone to necrosis.

To resolve such problems, we modified the 3-square-flap method in the following aspects: (1) designing flaps A, B, C, and D in oblong form, (2) designing a large subcutaneous pedicle flap

to reduce the distance needed for dislocation to the defective area, (3) freeing the subcutaneous pedicle flap to a minimum necessary extent, while leaving a thick pedicle, (4) designing flap B longer, and (5) avoiding suturing between flaps A and C, between flaps A and D, and between flaps B and D. Using this technique, flap ischemia/necrosis was not observed. Furthermore, the reconstructed interdigital space retained sufficient depth for a long period of time, requiring no additional surgery.

CONCLUSION

We devised the modified 3-square-flap method for syndactyly involving fusion distal to the PIP joint. This modified method was applied to 8 patients with severe toe syndactyly, resulting in favorable outcomes in all cases.

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PATIENT CONSENT

The patient provided written consent for the use of the images.

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