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The use of a dorsal double-wing flap without skin grafts for congenital syndactyly treatment

A STROBE compliant study

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Abstract

Numerous techniques have been developed that use various flaps to treat syndactyly. Skin grafts have often been used to cover remaining surgical defects. The long-term aim of surgery is to find new methods of separating the digits without using skin grafts. This paper describes a new surgical technique for the correction of simple, incomplete, and complete syndactyly. The technique consists of a dorsal double-wing flap to cover the newly created web space and zigzag incisions in the fingers, thus avoiding the use of skin grafts in this space. Overall, 35 web spaces in 24 patients were treated using this technique. Patient follow-up ranged from 6 months to nearly 5 years. There were no complications such as hematoma, infection or flap necrosis, and no fingers needed skin grafts after separation. The average operative time for each web space was approximately 45 minutes. Ninety-seven percent of patients treated with the dorsal double-wing flap procedure achieved good function, and superior cosmetic results following a single surgery. The technique is simple, rapid, safe, and easily performed and does not require the use of skin grafts.

Keywords: congenital, skin grafts, syndactyly, treatment, web reconstruction

1. Introduction

Congenital syndactyly is the second most common congenital hand anomaly, which results from the failure of developmental separation of adjacent digital rays, and has an incidence of 1:2000 live births.[1] Congenital syndactyly has a strong familial tendency, and is usually bilateral.[2,3] The condition may present as an isolated abnormality, or in association with complex conditions such as Poland syndrome, Apert syndrome, or cleft hand.[4]

The aim of the treatment strategies for syndactyly is to separate the fused digits, create a functional hand, and produce an aesthetically acceptable web with the fewest complications and the fewest surgical corrections.[5] Numerous methods for digit separation and web space reconstruction have been well reported in the literature, and many researchers have attempted to achieve an appropriate wide web space using vascularized flaps with a low incidence of web creep.[6] Although these techniques have been described and widely used for decades, numerous problems still need to be resolved. For instance, full-thickness skin grafting is a time-consuming process, the result of which is often suboptimal, and is associated with complications such as graft necrosis or infection, graft contraction, web creep, partial graft loss, hyperpigmentation, and hypertrophic scarring.

Recently, some authors have started using new techniques to reconstruct the web space and resurface the fingers without skin grafts.[7,8] The main differences of these techniques are the design of the web flap and the type of incisions used to separate the fingers. Although these techniques can obtain good results, these techniques need to be specially designed, as recurrences with more serious scars are common.[9]

The aim of this study was to review the results of our experience of using a double-wing flap to treat simple, incomplete, and complete syndactyly without bone fusion.

2. Methods

This study was approved by the ethics committee of the Third affiliated hospital of Zhengzhou University, Henan Province, China, and written informed consent was obtained from all patients. We conducted a retrospective observational study at our hospital with a new surgical method for congenital syndactyly treatment. Between 2010 and 2016, 24 patients (14 male, 10 female) with 35 webs underwent surgical correction using the double-wing flap technique. At the time of surgery, the patients' ages ranged from 5 to 35 months (mean age, 16.7 months). Syndactyly types were simple, incomplete, and complete without bone fusion. The syndactyly was unilateral in 13 (54%) patients (left in 5 and right in 8) and bilateral in 11 (46%) patients, 6 of which were symmetrical. The third web space (middle-ring finger) was the most frequently affected, with 24 webs out of the 35 involved (68.6%), followed by the ring-little web space (5 of 35,

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Table 1

Demographics of patients operated for primary syndactyly of the hand.

Particulars	Particulars
Patients/webs	24/35
Sex (male:female)	16:8
Age at surgery	16.7 mo (5–35 mo)
Web space involvement	Second 5
	Third 24
	Fourth 6
Complete/incomplete	23/12
Bilateral/unilateral	11/13
Simple/complex	27/8
Follow-up, y	4.6 y (6 mo–5 y)

14.3%) and index-middle web space (6 of 35, 17.1%) (Table 1). The first web space (thumb-index) was not available in our series. Patient details are summarized in Table 2.

In all cases, the web space was reconstructed using a double-wing flap without any skin grafts. This technique also used zigzag incisions for the separation of fingers. These patients were followed up clinically, and photographs were taken before and after the operation. All the patients were assessed at regular intervals for web creep, flexion contractures, range of motion, cosmetic results and function, scars, and need for reoperation.

3. Technique

The flaps were marked as shown in Fig. 1. A separated double-wing flap was designed on the dorsum of the metacarpal heads of the involved fingers, with its base located between the metacarpal heads of the involved fingers and its top at the intermetacarpal line, drawn as a triangle with an angle of 60°. A rhombic flap was then designed on the volar and dorsal sides of the hand with its base at the level of the proximal web space. Oblique markings for the interdigital skin incisions were drawn in a traditional zigzag manner, designed to allow the flaps to interdigitate when reconstructing the fingers.

After drawing these markings, the arm was exsanguinated with a tourniquet under regional anesthesia and intravenous anesthesia. The fingers were separated as in the preoperative design. Care was taken to identify and protect the neurovascular structures when separating the digits.

When the double-wing flap was separated, the adjacent side was sutured to form a flap with a V-shaped end and then the distal end of the double-wing flap was sutured to the volar V-shaped incision of the web space. Finally, the web space was reconstructed with the double-wing flap, which now had an adequate web space floor and was of an appropriate depth (Fig. 2A–D). The small dog ear that formed at the proximal end of the double-wing flap was excised (Fig. 3). The flaps obtained from the zigzag incisions were then wrapped around the newly separated fingers and sutured in place to completely close the skin along the sides of the 2 fingers. Finally, the dorsal wound was sutured directly (Fig. 2E).

At the end of the operation, the involved fingers were positioned in abduction with sterile gauze dressings for 2 weeks. After removal of the dressing and suture, the patient could begin to use the hand.

4. Results

All 35 simple, incomplete, and complete syndactiles in 24 patients were surgically corrected using this technique (Table 2). The average follow-up time was 4.6 years (range, 6 months to 5 years, Table 1). There were no complications such as hematoma, infection, or flap necrosis. No fingers needed skin grafts after

Table 2

Summary of follow-up patients.

No.	Age at operation/sex	Primary/secondary syndactyly	Simple/complex syndactyly	Incomplete/ complete syndactyly	Web space involved	Follow-up period	Complications	Results
1	6 mo/F	Primary	Simple	Incomplete	Bilateral 3rd	4 y	Nil	Good
2	10 mo/M	Primary	Simple	Complete	4th	3 y	Nil	Good
3	11 mo/M	Primary	Simple	Complete	3rd	5 y	Nil	Good
4	6 mo/F	Primary	Simple	Complete	Bilateral 3rd	3.5 y	Nil	Good
5	13 mo /F	Primary	Simple	Incomplete	Bilateral 3rd	5 y	Nil	Good
6	9 mo/M	Primary	Simple	Complete	4th	3.5 y	Nil	Good
7	12 mo/F	Primary	Simple	Complete	Bilateral 4th	4 y	Nil	Good
8	18 mo/M	Primary	Simple	Complete	2ed	1 y	Web creep	Fair
9	18 mo/M	Primary	Simple	Incomplete	3rd	8 mo	Nil	Good
10	19 mo/M	Primary	Simple	Incomplete	Bilateral 3rd	2 y	Nil	Good
11	32 mo/M	Primary	Simple	Complete	2ed	3.5 y	Nil	Good
12	21 mo/F	Primary	Simple	Complete	Bilateral 3rd	6 months	Nil	Good
13	14 mo/M	Primary	Simple	Complete	Bilateral 3rd	3 y	Nil	Good
14	18 mo/M	Primary	Simple	complete	2ed	2.5 y	Web creep	Fair
15	24 mo/M	Primary	Simple	complete	Bilateral 3rd	4 y	Nil	Good
16	22 mo/F	Primary	Simple	complete	3rd	4 y	Nil	Good
17	12 mo/M	Primary	Simple	Incomplete	3rd	5 y	Nil	Good
18	27 mo/M	Primary	Simple	Complete	2ed	3.5 y	Nil	Good
19	13 mo/F	Primary	Simple	Complete	Bilateral 3rd	3.5 y	Nil	Good
20	30 mo/F	Primary	Simple	Complete	2nd	4.5 y	Nil	Good
21	16 mo/M	Primary	Simple	Complete	4th	3.5 y	Nil	Good
22	22 mo/F	Primary	Simple	Incomplete	Bilateral 3rd	5 y	Nil	Good
23	15 mo/M	Primary	Simple	Complete	2nd	4 y	Nil	Good
24	35 mo/F	Primary	Simple	Incomplete	Bilateral 3rd	8 mo	Nil	Good

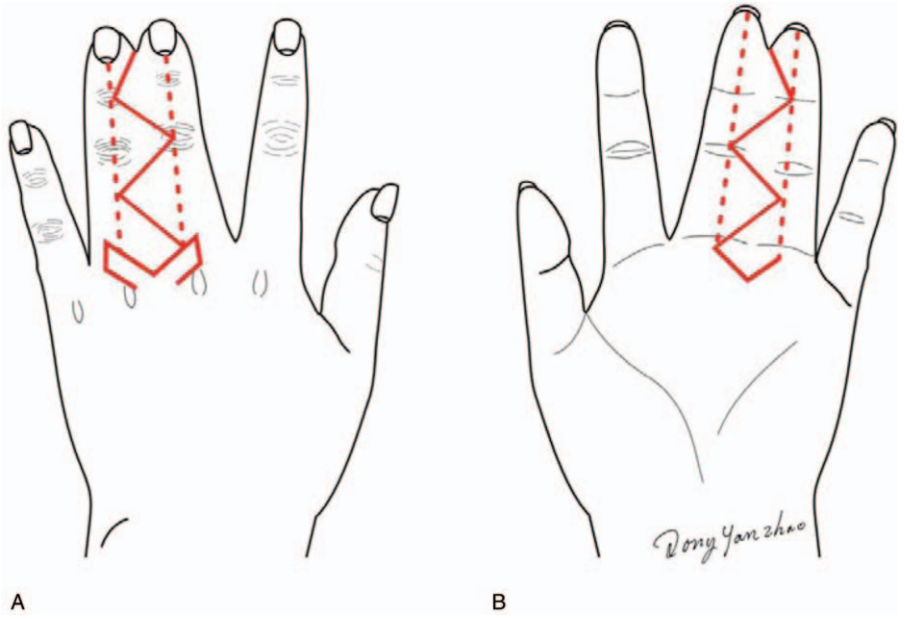

Figure 1. Illustrations depicting the markings for dorsal and palmar incisions.

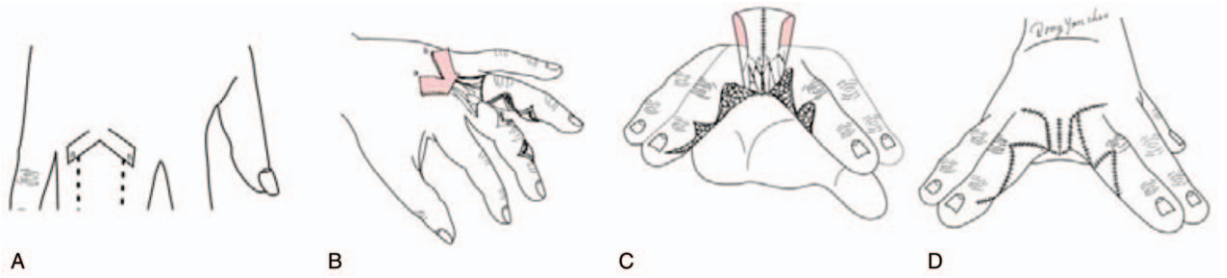

Figure 2. (A) Double-wing flap markings. (B) The double-wing flap is raised, leaving the dorsal on the digits. (C) The adjacent side of the double-wing flap is sutured to form a flap. (D) End-on view of the web space with the dorsal double-wing flap and the zigzag incisions in the digits and without skin grafts.

separation. The average operative time for each web space was approximately 45 minutes. All patients were followed up clinically after surgery (Figs. 4 and 5). Web creep, flexion contractures, range of motion, cosmetic results and function, scars, and need for reoperation were evaluated. One of the 35 webs developed web creep (overall incidence of 3%). No patients developed flexion contractures, and all fingers were able to fulfill the main functions of flexion and abduction movement. The patient who developed web creep underwent revision surgery without skin grafts. An adequate dorsal to volar slope of the web was achieved in all cases with good aesthetic appearance; the scars were not conspicuous, and there was no evidence of hypertrophy or keloid changes.

5. Discussion

Multiple techniques have been developed that use various flap designs with or without skin grafts to treat syndactyly.[7,8] The long-term aims of surgery include reduction in scarring both in the web and in the dorsum of the hand, avoidance of web space narrowing or web creep, and separation of the digits without using skin grafts.[10,11] The trilobed flap technique, or a dorsal triangular flap, or a dorsal rectangular flap, or a combination of interdigitating dorsal and volar triangular flaps may be used to treat syndactyly to reconstruct the web.[12,13] Although these techniques have been described and widely used, numerous problems still need to be resolved. These techniques are complex, result in excessive dorsal scarring, and fail to offer an aesthetic and anatomic correction of the web.[14] Moreover, these standard techniques do not reduce the rate of recurrence and reoperation. Skin grafting procedures are often used to separate syndactyly, and reports indicate that full-thickness skin grafts are superior to split skin grafting, with markedly lower incidence of flexion contracture or web creep. A published investigation of 100 patients found that 42 required at least 1 secondary operation to achieve an acceptable outcome.[15] This is unfortunately typical, and most reports describe high recurrence and reoperation rates, ranging from 5% to 59%.[12]

In this study, we have described a different technique of using dorsal double-wing flaps for the surgical correction of simple, incomplete, and complete syndactyly. We have designed a double-wing flap where the distal end can reach the new web space, and the donor site can be sutured directly. Finally, a large area of the skin flap is saved at the base of the proximal phalanges and can be redistributed to achieve primary closure of the separated fingers without skin grafting.

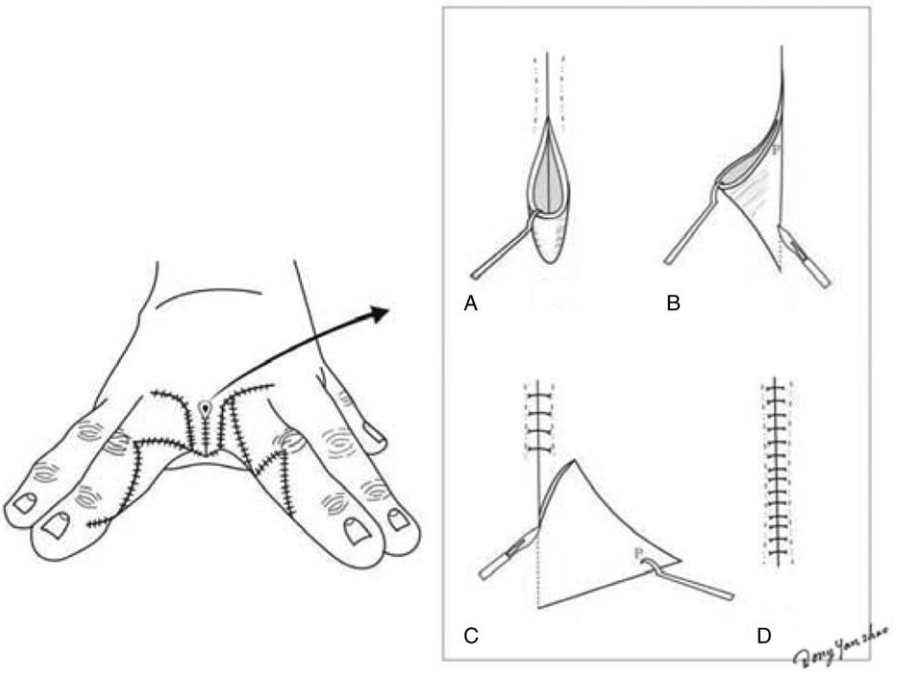

Figure 3. The small "dog ear" is excised.

Figure 4. Case No. 1 (A) Plan of dorsal incision of the syndactyly separation. (B) Plan of Palmar incision of the syndactyly separation. (C) Immediate postoperative view of the hand. (D) Twelve months after operation. The height and width of the reconstructed web space is close to normal.

Figure 5. Case No. 2. Poland syndrome (A) Plan of dorsal incision of the syndactyly separation. (B) Plan of Palmar incision of the syndactyly separation. (C) Immediate postoperative view of the hand. (D) Thirty-six months after operation. The height and width of the reconstructed web space is close to normal.

The dorsal skin of the hand near the web space where the double-wing flap is located is the best material to reconstruct the web space. It has a good elastic structure similar to the normal web space and can offer a more aesthetic and anatomic correction of the web. As a local flap, it also offers an excellent color, thickness, and texture match to the adjacent fingers. In addition, the flap is a pedicle flap, with a very rich blood supply, making it less prone to necrosis. Furthermore, there is minimal scarring after primary closure of the donor site on the dorsum of the hand.

In our short-term follow-up group of 24 patients with 35 webs, no flexion contractures developed. The incidence of web creep in the operated webs, without the use of skin grafts, was lower (3%). Revision surgery, when required, can be performed using Z-plasties without the use of skin grafts. The use of skin grafts is associated with numerous problems, including web creep, graft loss, skin of different color, hyperpigmentation, hair growth, and hypertrophic scarring.[16] In addition, skin grafting takes more time and has a high incidence of secondary graft contraction, which can be avoided by using the technique described in this paper.

Recently, numerous studies have reported that multiple general anesthetics impair neurologic development in infants and young children.[17–19] The current literature indicates that general anesthetics have a dose-dependent neurodegenerative effect.[18] Minimized anesthetic exposure is very important in young children whenever possible. Another advantage of the double-wing flap technique is that it can shorten the operative time without skin grafting, as evidenced by our average operative time for each web space of approximately 45 minutes, which is much less than before.[11,20]

Overall, 97% of patients treated with the dorsal double-wing flap procedure achieved good function, and superior cosmetic results following a single surgery. The technique is simple, rapid, safe, and easily performed and without skin grafts.

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