End-of-Skin Grafts in Syndactyly Release: Description of a New Flap for Web Space Resurfacing and Primary Closure of Finger Defects

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Abstract Treatment of syndactyly necessitates creation of neo-web space and separation of fingers. Traditionally, this has been done by use of flaps taken from the dorsum; the resultant raw areas thus created have been managed by use of skin grafts. The classical teaching has been that the separated fingers will need skin graft as primary closure is not possible. The skin grafts have a tendency to contract and lead to finger flexion contractures and “creep” of the web space. We describe a flap based upon subcutaneous tissue in the web that is moved in a V–Y fashion to resurface the neo-web. The flap donor site can easily be closed primarily. The fingers are then separated; the subcutaneous fat is carefully removed from the finger flaps under magnification to allow primary closure of the finger defects. It has been possible to primarily close the donor site and fingers in all the patients. The procedure has been used in seven patients with 14 web releases. The age varied between 10 months to 3 years. The V–Y advancement flap based upon the subcutaneous pedicle in the region of the web allows adequate creation of a new web space. The careful de-fattening of skin flaps allows the separated fingers to be closed primarily.

Keywords Syndactyly release · V–Y advancement flap · Subcutaneously based · De-fattening skin flap · Primary closure donor site and fingers

Introduction

Syndactyly is one of the most common congenital deformities of the hand. The separated fingers have a greater surface area than the syndactylized digits, so additional skin coverage is almost always needed in majority of cases [7]. Various reconstructive options like split-skin grafting, full-thickness graft, and local flaps have been described by various authors [1, 4, 8, 10, 11, 14, 15]. Traditionally, web creation has been done by use of flaps taken from the dorsum of the hand and proximal phalanx; the resultant donor defects have been managed by use of skin grafts. Moreover, the raw area of fingers upon separation needs split-skin grafting in a classical release operation. The skin grafts have a tendency to contract and lead to web creep and flexion contracture of fingers in the post-operative period, so we had been searching for a procedure in which the donor site of the flap for web space can be closed primarily. It has also been our endeavor to be able to close the defects in the fingers primarily without need for any skin graft. We describe a technique in which both of these objectives can be met.

Materials and Methods

During the period of 2004–2007, a total of 14 syndactyly release operations were performed on seven patients. The age varied from 10 months to 3 years. Two patients had complex syndactyly and associated Poland and Apert’s syndromes (Table 1).

Follow-up period ranged from 1 to 3 years. Web creep, flexion contractures, function, and cosmetic results were assessed clinically and documented. Web creep was

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Table 1 Syndactyly release operations performed on seven patients.

Serial number	Name	Age at the time of first surgery	Diagnosis	Follow-up	Number of digits involved	Type of syndactyly
1	HA	10 months	Apert's syndrome	3 years	All 5 digits both hands	Complex
2	PR	2 years	Poland syndrome	2 years		Simple
3	GS	11 months	Syndactyly hands feet Bilateral	3.5 years	All digits both hands except thumbs	Simple
4	MK	3 years	Syndactyly one hand	1 year	3 digits	complex
5	PR	2 years	Syndactyly one hand	1 year	4 digits	Simple
6	RR	3 years	Syndactyly one hand	1.5 years	2 digits	Simple
7	RD	3 years	Syndactyly both hands	1 year	2 digits both hands	Simple

objectively and serially assessed using the volar base of web as the baseline.

Surgical Technique

The surgery was done under tourniquet control. Complete exsanguination was avoided for better visualization of the

neurovascular bundle and pedicle of the flap. Fingers were separated by a straight line incision placed directly over the fused area. A V-shaped flap was designed over the dorsum of the hand starting proximally at the level of metacarpal heads and extending distally up to proximal half to the distal two thirds of the proximal phalanx. The flap was mobilized on the subcutaneous pedicle until it could reach the neo-web space without any tension. The attention was

Figure 1 Line drawings of the operative steps. **a** “V”-shaped flap has been marked; incision for separation of fingers is also outlined. **b** The limit of web space on volar side has been marked. **c, d** The flap has

been dissected based on the subcutaneous tissue in the web. **e, f** Final suture line.

Figure 2 Marking of the flap and incisions for separation of fingers. The metacarpal heads have also been marked.

now focused on the skin flaps of the separated fingers. The extra pouting fat was carefully trimmed under magnification avoiding injury to the underlying neurovascular bundles. This allowed primary closure of the separated

fingers in all the cases. If there was tension in primary closure of the separated fingers, small areas of 3–4 mm were left to heal by epithelialization. These healed very rapidly in 4–5 days. The mobilized flap was sutured into

Figure 3 The flap has been inset and the donor site and fingers have been closed primarily.

Figure 4 Anatomical basis of flap. *DCA* Dorsal carpal arch, *DPA* deep palmar arch, *SPA* superficial palmar arch, *DMA* dorsal metacarpal artery, *CDA* common digital artery, *DA* digital artery.

the newly created web space. This flap is based upon the minute vessels that are present in the underlying fat (vide infra). The donor areas could also be closed primarily in all the patients. A usual hand dressing is done with plaster of Paris splint and arm-pouch sling.

The operative details have been depicted through line diagrams in Fig. 1 and on a patient in Figs. 2 and 3.

Blood Supply of the Flap

The first dorsal metacarpal artery arises as a direct branch of radial artery and the remaining dorsal metacarpal arteries arise from dorsal carpal arcade. As these run distally, these are either supplemented or replaced by the perforators from the deep palmar arch or palmar metacarpal arteries [2, 3, 13]. Additional perforator links between palmar and dorsal system are known to exist in the web spaces [3].

Figure 5 Healed flaps in patient shown in Figs. 2 and 3.

Anatomically, three types of anastomosis have been described on the arterial system of fingers [3, 13, 16]:

- Direct anastomosis between the dorsal metacarpal artery and the palmar metacarpal artery by a perforator at the distal margin of the interosseous muscle
- Indirect anastomosis between the terminal branch of the dorsal metacarpal artery and dorsal cutaneous branches of digital artery at proximal phalanx level
- Deep anastomosis—the ring of vessels around the neck of metacarpals contributed by the dorsal metacarpal artery and the palmar metacarpal artery

Thus, in the web space and around the proximal part of the proximal phalanx, many consistent perforating vessels are present on which this flap is based [3, 13, 16] (Fig. 4).

Results

This flap was used to reconstruct 14 web spaces after primary syndactyly release. The flap survived in all cases and the post-operative course was uneventful. All web spaces remained adequate. All patients had normal finger sensation, although the reliability of sensor/functional testing in this group of patients is limited. The scar over the dorsum of the hand settled well in all the cases (Figs. 5 and 6).

Figure 6 Two-year follow-up of an Apert's syndrome syndactyly.

Discussion

Reconstruction of the normal neo-web space is perhaps the most challenging and the key point in the syndactyly treatment. High incidence of contractures and distal web creep after the use of skin graft in the web areas where the tissue is invariably deficient has led to the evolution of many operative procedures and dorsal local flaps of different designs to suit the requirements [1, 4, 8, 10, 11, 14, 15]. Zeller, in the year 1810, first described a dorsal 'V' flap to form the commissure, and Differbach, in 1834, used a quadrilateral flap for the same purpose [5]. Norton, in 1881, used palmar and dorsal triangular flaps to form the web [12] and Cronin described an improved technique where zigzag incision was made on both palmar and dorsal

surfaces [4]. Killiam et al., in 1985, further modified this method by placing the flap slightly ulnar and proximal to the volar flap [9]. In the last few decades, many authors have described perforator-based dorsal flaps of various designs for the web reconstruction [1, 6, 10, 14, 15].

The normal anatomy of the interdigital web space demonstrates a configuration like that of a 'V' which is wider distally and tapers off proximally and slopes at a 35–45° angle from the proximo-dorsal to disto-palmar (Fig. 7). The base of the web commissure is normally located at the mid-portion of the proximal phalanx [7]. Therefore, design of the web flap should be such that it should reach up to half or proximal two thirds of the proximal phalanx for tension-free inset in the web.

Although many types of V–Y advancement flaps based on the perforator of dorsal metacarpal artery and other designs have been described in the literature, a V–Y advancement flap based on distal vasculature, i.e., in the web space like ours, has not been reported. Our flap template has many advantages. The design is simple and uses thin hairless skin, and the advancement achieved is sufficient for tension-free closure. Neither extensive dissection nor pre-operative localization of perforator is needed. Operation time is 20 min and web space can be recreated without any graft and web creep. The flap is reliable and can be done by trainee residents.

Many dorsal flaps based on reverse flow or perforator of the dorsal metacarpal artery have been described but these need more advancement because of their more proximal designs. Our flap design is more distal and the required V–

Figure 7 Anatomy of normal web space.

Y advancement is easily achieved. Donor site scar which seems to be the downside of all dorsal hand flaps is known to settle well in time [16].

Conclusion

A new flap for the correction of syndactyly is described. It is based on a well-vascularized skin supplied by perforators from the anastomosis between branches of dorsal metacarpal artery and digital artery. The flap is based distally over the proximal phalanx so that adequate advancement in a V-to-Y fashion is achieved to reconstruct the web without excessive stretch on the flap. The separated fingers can be closed primarily after careful de-fattening of the flaps. Operation is time saving and does not need any pre-operative localization of perforator. Neither flap necrosis nor a web contracture was seen in our series, though a longer follow-up is needed to assess long-term results. Finally, dressing is simple and results are functionally and aesthetically pleasing.

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