

New Simple Technique for Syndactyly Release

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Background: Can good functional and cosmetic result be achieved in syndactyly separation using a straight midline incision with a hexagonal dorsal skin flap?

Methods: We performed 39 web reconstructions at a median of 20 months of age (11–43 months) to 26 consecutive children (21 male) with 30 simple, 4 complex, and 5 complicated syndactylies. Eighteen of the simple syndactylies were incomplete, ending at the proximal interphalangeal joint in 15 and at the distal interphalangeal joint in 3. Inguinal skin grafts were used in 2 children with either complex or complicated syndactyly. Operation time was recorded. Complications were registered. Height of the new web spaces was calculated. Parents' satisfaction on both functional and cosmetic outcome was assessed using a Visual Analog Scale from 0 to 100.

Results: Duration of one web reconstruction ranged from 50 to 95 minutes in simple incomplete, 56 to 135 in simple complete, 116 to 151 in complex, and 72 to 123 in complicated syndactylies. One child had a self-induced bilateral postoperative infection that led to web creep. Two patients developed hypertrophic scars, which responded well to silicone treatment. Mean cosmetic and functional Visual Analog Scale scores were 87 (45–100) and 92 (63–100), respectively, at a mean follow-up of 1.3 years (range, 0.5–3.7).

Conclusion: Web reconstruction using a hexagonal dorsal skin flap and straight midline incisions with closure at mid-lateral lines is safe, with good cosmetic and functional outcome in our short-term follow-up. (*Plast Reconstr Surg Glob Open* 2020;8:e2842; doi: 10.1097/GOX.0000000000002842; Published online 14 May 2020.)

INTRODUCTION

Syndactyly is one of the most common congenital hand anomalies with a reported incidence of 2:10,000, and it is classified as incomplete or complete, simple, complex, or complicated. In simple incomplete (SI) or simple complete (SC) syndactyly, only soft tissue connects the digits. Complex (C) syndactyly involves bony connections of adjacent phalanges. Syndactyly is complicated in cases with accessory phalanges or abnormal soft tissues. Complicated syndactyly (CC) is usually associated with other congenital anomalies or different syndromes.^{1–6}

The main goal of treatment in syndactyly is to separate fused digits, create a normal web space, and improve both

function and esthetics of the hand.⁷ The recommended timing of syndactyly separation is from 3 to 24 months depending on the web space(s) involved and the type of syndactyly. Children with multiple syndactylies affecting adjacent webs need at least 2 surgeries ≥ 3 months apart according to most authors.² Numerous surgical options have been described with graftless techniques gaining popularity, which may lead to fewer complications than procedures using skin grafts. These techniques most commonly utilize a zigzag incision for finger separation with different types of metacarpal advancement flaps to reconstruct the web.^{8–16}

We developed a new simple technique for web reconstruction with a hexagonal metacarpal advancement flap combined with straight midline incisions for syndactyly separation. Short-term results of the first 39 web space reconstructions are presented.

PATIENTS AND METHODS

This is a prospective intervention study including all nonsyndromic and syndromic syndactyly patients referred to our institution. Since 2015, 39 web spaces

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Table 1. Patient Demographics and Outcome

Patient	Web Space Affected	Type	Associated Condition	Follow-up (y)	Web Space Separated	Results			
						Use of Skin Graft and Harvest Site	Cosmetic VAS	Functional VAS	Web Grade by Withey et al ¹⁸
1	2	SI PIP	Poland	3.7	2		80	78	1
2	3	SI PIP		3.4	3		NA	NA	0
3	3L (3R)	SC (SI PIP)		1.7	3		95	94	1
4	2	SI PIP	Poland	2.1	2		94	93	0
	3	SI PIP		1.5	3				1
	4	SI PIP		2.1	4				0
5	3	SC		1.0	3		82	100	0
	4	SC		1.5	4				0
6	2	SI PIP	Symbrachydactyly	1.8	2		95	96	1
7	3	SI PIP		1.5	3		100	100	0
8	3	C		2.0	3		87	100	2
9	2	SI DIP		1.2	2		96	86	0
	3	SC		0.6	3				1
	4	SC		1.2	4				1
10	3	SI PIP		1.5	3		100	100	0
11	3	SC	VSD	0.9	3		52	85	0
12	3R	C		1.8	3 R	Local	63	82	2
	3L	C		1.8	3 L	Inguinal	80	90	1
13	3 (4)*	SI PIP	Moebius	0.8	3		100	90	1
14	2L (3R)	SC (SI PIP)	Ulnar aplasia	1.1	2	Local	90	90	0
15	3	SI DIP		1.1	3		90	100	1
16	4	SI DIP		1.0	4		90	100	0
17	2	SI PIP	Poland	1.1	2		89	89	1
18	3R (2,4)*	CC (CC)	Constriction band	1.2	3 R	Local	72	63	1
	3L (2,4)*	SI PIP (SI PIP)		1.2	3 L		94	94	1
19†	3R	SC		1.7 (0.5)	3 R		-(80)	-(90)	2 (0)
	3L	C		1.7 (0.5)	3 L	Local	-(80)	-(90)	4 (0)
20	2	SI PIP		1.0	2 R		87	100	0
21	3R	SI PIP		1.0	3 R		100	100	1
	3L	SI PIP		1.0	3 L		100	100	1
22	4R	SC	Hereditary	0.8	4 R		100	100	0
	4L	CC		0.8	4 L	Inguinal	89	100	1
23	4	SC		0.5	4		100	100	0
24	4R	SC	VSD, bilateral ulnar polydactyly	0.5	4 R		100	100	0
	4L	SC		0.5	4 L		100	100	0
25	2R (3)	CC (CC)	Constriction band	0.5	2 R	Local	56	64	1
	4R	CC		0.5	4 R		56	64	0
	2L (3)	SI PIP (SI PIP)		0.5	2 L		83	96	0
26	4	CC	Foot anomaly	0.5	4		79	92	0

() Not separated.

() * Separated earlier using a different technique.

† Reoperation of web creep following postoperative infection. Follow-up time and Withey grade from reoperation in brackets. L, left; NA, not answered; PIP, proximal interphalangeal joint; R, right; S, simple; VSD, ventricular septal defect.

(5 CC, 4 C, 12 SC, and 18 SI) in 26 consecutive patients (24 white, 1 brown, 1 black, 21 male, 10 left, and 9 bilateral) have been reconstructed using a hexagonal metacarpal advancement flap and straight midline incisions (Table 1). Our former technique used the same flap for web reconstruction, but finger separation was done with zigzag incisions.

Of the 18 patients with SI syndactyly, 15 ended at the proximal interphalangeal joint and 3 at the distal interphalangeal joint (DIP). Twelve of the 26 patients had an associated condition or syndrome (Table 1). Syndactyly separation was performed at a mean age of 20 months (range, 11–43 months). The more complicated, the earlier the separation was done; CC mean: 13 months (range, 11–14), C mean: 14 months (range, 11–16), SC mean: 18 months (range, 11–43), SI DIP mean: 18 months (range, 15–22), and SI PIP: mean 25 months (range, 11–42). Patient 22 underwent Qube-fix distraction¹⁷ of the left side before web reconstruction. Five patients with syndactyly affecting adjacent webs had 2 surgeries at a mean of 7 months (range, 7–50 months) apart. Two of these 5 patients had their first

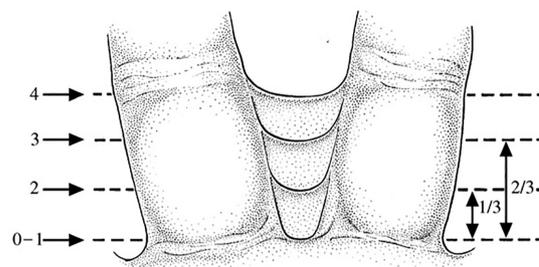


Fig. 1. Grading of web creep according to Withey et al.¹⁸ Grade 0: soft web, abduction mirrors the adjacent web or equivalent web on the other hand. Grade 1: no web advancement, but thickening of the web with reduced span. Grade 2: creep of web to 1/3 of the distance between base of the web and PIPJ crease. Grade 3: creep of web to 2/3 of the distance between base of the web and PIPJ crease. Grade 4: creep of web to the PIPJ crease. PIPJ indicates proximal interphalangeal joint.

web reconstructions performed with a hexagonal metacarpal advancement flap and zigzag incisions (Table 1).

The length of the operation (incision to closure) was registered in minutes. Minor and major complications

were recorded. Follow-up (FU) was scheduled at 6 months and 1, 3, 5, 10, and 20 years after surgery to be performed by an occupational therapists. Photographs were taken preoperatively and during FU. Web space was calculated from photographs by an independent observer using a method created by Withey et al¹⁸ (Fig. 1). Parent's satisfaction regarding both cosmetic and functional outcome was registered using a 0–100 Visual Analog Scale (VAS). Parents' consent was obtained to use pre- and postoperative photographs of their children's hands for research purposes.

SURGICAL TECHNIQUE

Incisions are marked on the skin with metacarpophalangeal (MP) and interphalangeal (IP) joints in extension (Fig. 2). (See Video [online], which displays the surgical technique and postoperative care.) Tourniquet is inflated. The dorsal midline is incised, and the hexagonal flap is elevated (Fig. 3). Buck-Gramcko¹⁹ plasty is used if necessary. In C syndactylies, synostosis is separated with a chisel or a knife. Volar incisions are made. Meticulous defatting is performed protecting the neurovascular bundles (Fig. 3). The interdigital nerve is split if necessary. Wounds are closed at mid-lateral lines using 6-0 absorbable sutures attaching the distal edge of the dorsal hexagonal flap to the palm first (Fig. 3). Excess skin from the flap or the edges of the palmar incision can be used as a free skin graft if necessary. Tourniquet is deflated either before or after closing the wounds according to the surgeons' preference. A silicone mesh is placed on the wounds, and a soft hand dressing is applied. Dressings are removed by the surgeon at 10–14 days after surgery. Wound therapy is started at 3 weeks from surgery by an occupational therapist and ended when there is no further activity in the scarring process.

RESULTS

None of the patients were lost to FU, with a mean FU of 1.3 years (range, 0.5–3.7). Surgery time per web space

and level of syndactyly was as follows: in CC, mean 96 minutes (range, 72–123); in C, 129 minutes (range, 116–151); in SC, 91 minutes (range, 56–135); and in SI, 76 minutes (range, 50–95). There were no differences in the time between SI proximal interphalangeal joint and DIP level releases. Inguinal skin grafts were needed in 2 patients, and excess skin from the web reconstruction site was used to cover small distal defects in 5 patients. One bilateral postoperative infection occurred 7 days after surgery (patient 19) due to patient-related reasons (contaminated his dressings in a toilet bowl). The infection was treated with oral cephalexin for 5 days. The same patient later developed excessive scarring and web creep on the right side. Two separate patients developed scar hypertrophy and received treatment with silicone sleeves for the fingers and silicone sheets for the web spaces (patients 8 and 11). Mean web space height using the grade by Withey et al¹⁸ was 0.5 (range, 0–2). At last FU, one patient reported slight feeling of dryness in the web space area (patient 1). Twenty-five of 26 patients' parents answered the VAS questionnaire. Mean cosmetic and functional VAS scores were 87 (52–100) and 92 (63–100), respectively, at last FU (Table 1 and Figs. 4–7).

DISCUSSION

In the early 1800s, webbed digits were separated with scissors in the nursery, which created 2 raw surfaces on the opposing fingers that healed by epithelialization and apparently lead to flexion contractures.¹ In the mid 1800s, Didot popularized his technique of separating fingers with straight flaps with alternating midline incision on the dorsal and palmar side without grafting, which also lead to flexion contractures.²⁰ In the mid 1900s, Cronin²¹ and Webster²² reported that flexion contractures did not develop if webbed fingers were separated with zigzag incisions and skin grafts. This principle has been adopted by most surgeons, and many modifications of the technique have been reported. Pigmentation and scarring of the

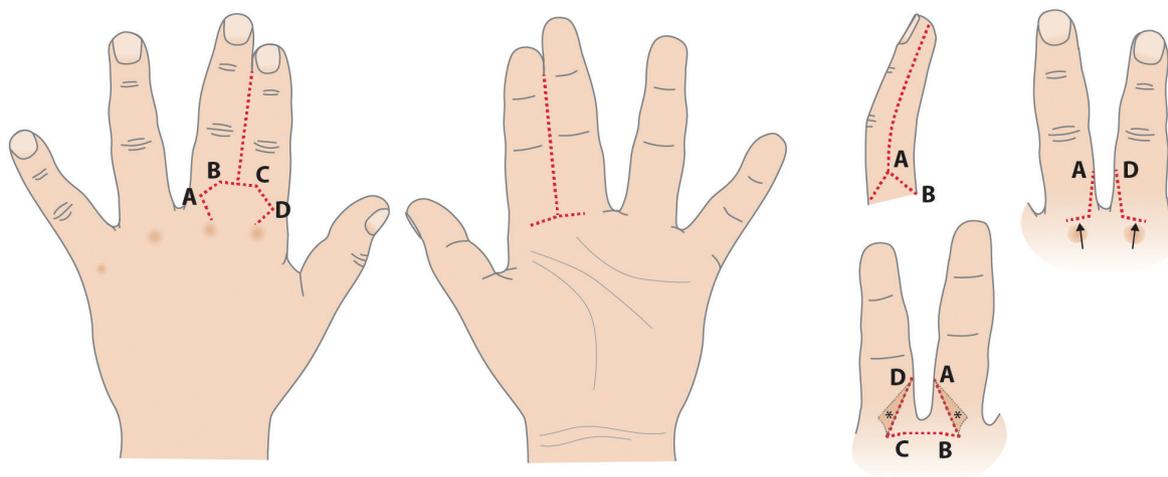


Fig. 2. Surgical incisions and site for skin graft. The specific geometric measures for the dorsal hexagonal skin flap are based on the interspace of the knuckles of the fingers to be separated: the distance measured between the midpoints of the knuckles is the same as the height of the flap as well as the distal width (BC). $AD = 2 \times BC$. *Can be used as a skin graft.

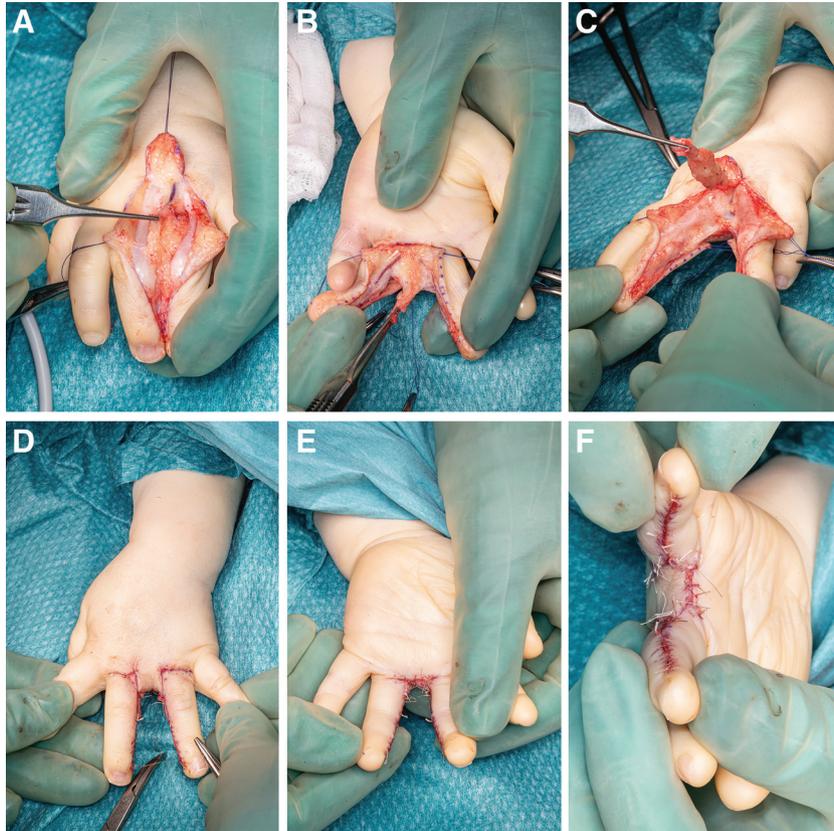


Fig. 3. Defatting and skin closure. A, Hexagonal flap raised and dorsal defatting. B and C, Defatting from volar side and removal of the excess fat in one piece dorsally. D–F, Wound closure with absorbable sutures.

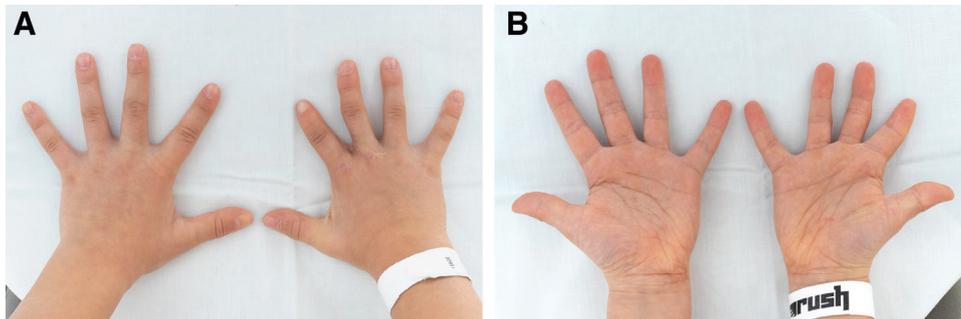


Fig. 4. Patient 1: simple incomplete syndactyly 3 years after surgery. A, View from dorsal side. B, View from palmar side.

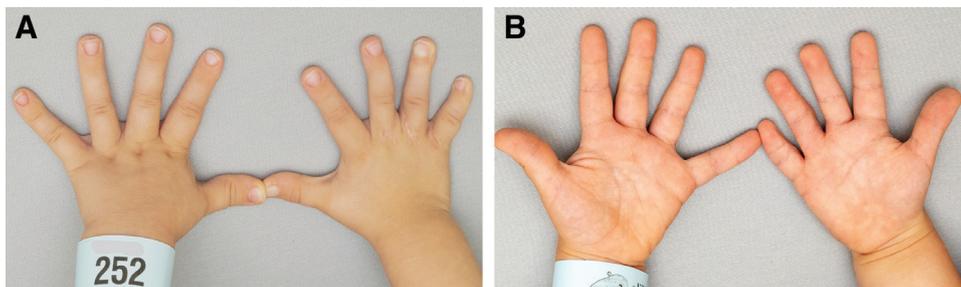


Fig. 5. Patient 5: simple complete syndactyly 2 years after surgery. A, View from dorsal side. B, View from palmar side.

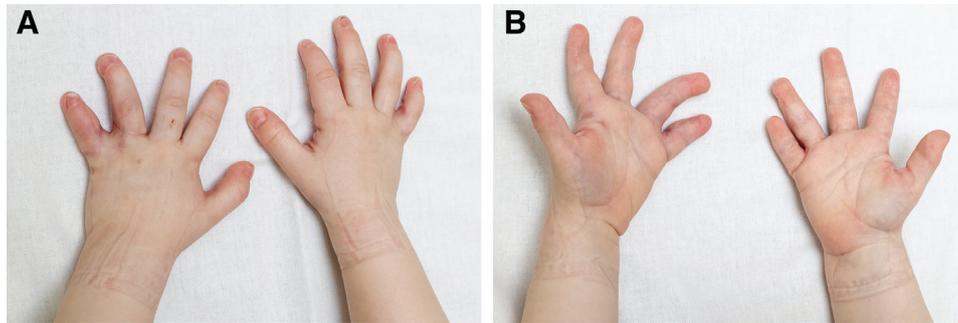


Fig. 6. Patient 22: complex (right hand) and complicated (left hand) syndactyly 6 months after surgery. A, View from dorsal side. B, View from palmar side.

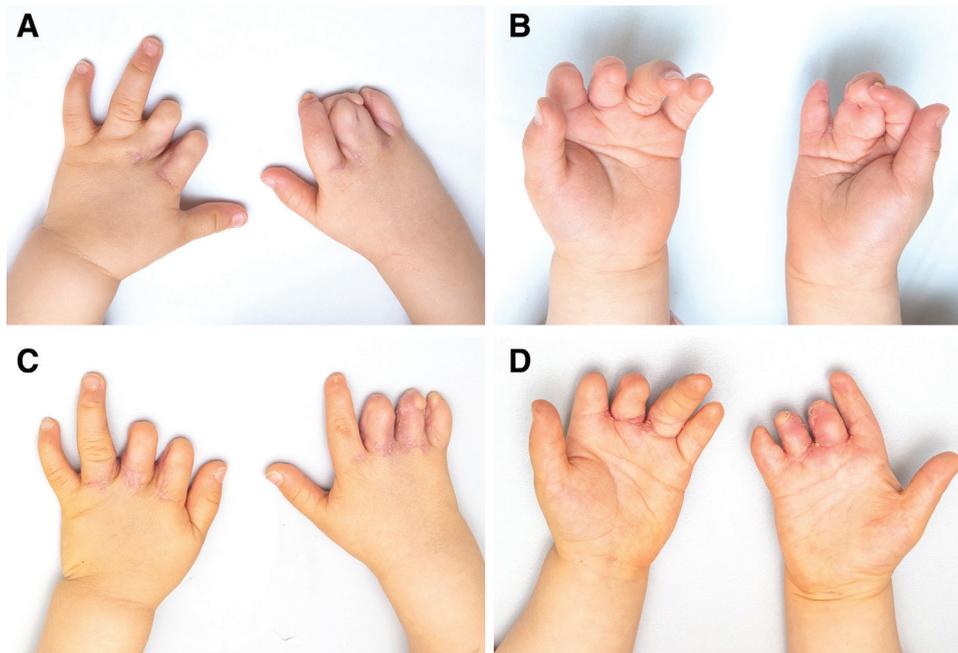


Fig. 7. Patient 25, complicated (right hand) and SI PIP (left hand) syndactyly six months after first surgery (A and B). Same patient three weeks after second surgery (C and D). The last separation is not included in our results as the follow-up is too short.

grafts lead to development of defatting techniques and metacarpal advancement flaps to facilitate closing the wounds without grafts.^{9,22,23} The most commonly used technique with interdigitating zigzag flaps often leaves a cosmetically unpleasing prominent scar due to mismatch between palmar and dorsal skin texture and color. Fearon²⁴ separated syndactylies in 43 Apert hands and feet by straight-line incisions without the development of flexion contractures. What role the lack of proximal interphalangeal joint plays in these results is unclear; however, Fearon²⁴ reported no scar contractures in non-Apert syndactylies treated with the same technique. Sharma et al¹¹ separated 14 fingers in 7 patients (2 syndromic) using longitudinal incisions and a triangular metacarpal advancement flap with functionally and esthetically pleasing results, but they failed to report the level of separated webs in nonsyndromic hands. Wang et al¹⁶ have recently reported a series of 16 web reconstructions using a

hexagonal metacarpal advancement flap with zigzag incisions, yielding satisfactory results in 12- to 34-month FU. We used the same technique since 2003 but developed it further to straight incisions that leave the scars in the mid-lateral line in combination with the hexagonal metacarpal advancement flap to reconstruct the web.

The operative time of syndactyly separation depends on the extent and type of syndactyly, as well as on the surgical technique. The length of surgery using zigzag incisions and full-thickness skin grafts combined with web reconstruction with commissural dorsal flap varied from 40 to 120 minutes in a series of 39 patients, with mean operative times of 68 minutes in SI, 95 minutes in SC, and 98 minutes in C syndactyly.²⁵ The reported length of simple syndactyly separation without skin grafts with metacarpal advancement flaps and zigzag incisions is shorter ranging between 44 and 86 minutes.^{8,16,26} In our series, separation of SI syndactyly lasted for just over an hour, in most SC and

CC syndactylies, it lasted for <2 hours and in C syndactyly, slightly longer, which is quite close to the reported operation times with other graftless techniques.

Postoperative infections after syndactyly release with full-thickness skin grafts occurred in 3% of the 144 syndactyly webs treated by Barabás and Pickford.²⁷ The risk of a postoperative infection was reported to be higher in 2 series using graftless techniques where 1/16 and 4/19 patients developed an infection.^{10,13} No reoperations were performed in patients with skin grafts, whereas all 5 patients who developed an infection after syndactyly release without skin grafts were operated on again. On the contrary from this, Ekerot²⁶ found there to be more reoperations due to complications when comparing a procedure using full-thickness skin grafts (12/32 webs reoperated) to a graftless technique (2/28 webs reoperated). One of our 20 patients developed a bilateral self-induced infection that healed with oral antibiotics but later developed bilateral web creep that was successfully treated with a reoperation.

Web creep is the most common complication after syndactyly release usually appearing within 3 years after surgery, with a reported incidence of up to 60%.^{3,14,28} Postoperative infections and partial skin graft loss can lead to web creep, in which risk appears to vary also between different web reconstruction techniques.^{25,27,28} Age at the time of surgery does not seem to correlate with the risk of web creep,^{25,27} which seems to be similar in patients treated with (4%–30%) or without (3%–24%) skin grafts.^{7,8,25,26,28–32} Reliable comparison is, however, difficult because the number of patient types of syndactyly, FU rates and grading systems vary. Web height has been assessed by comparing it to the adjacent normal web, using the palmar crease as a reference point^{30,33} and with the 5-point grading system developed by Withey et al.¹⁸ The reported mean web height using the classification by Withey et al.¹⁸ after syndactyly surgery has varied from 1 to 1.4^{12,13}. Our results are better than those in the earlier reports, but our FU time might still be too short.

Cronin²⁰ reported in 1956 in 11 patients that longitudinal incisions crossing flexor creases to separate webbed fingers lead to flexion contractures in all cases. The reported risk of scar contractures is 0%–26% and of scar hypertrophy is 3.5% with techniques using zigzag incisions and skin grafts.^{27,28,31} It has, however, been suggested that zigzag incisions and skin grafts lead to conspicuous scars.³⁵ The risk of scar contractures (0%–6%) or hypertrophy seem to be lower with graftless techniques,^{7,8,10,16} which is in accordance to our findings so far with no scar contractures and 2/30 hypertrophic scars that responded well to silicone treatment.

Subjective functional and esthetic results of syndactyly surgery are unfortunately often reported without using any specific outcome measurements.^{8,10,11,25} Furthermore, long-term outcome of syndactyly separation is also poorly documented usually with low FU rates (14%–32%) and small number of patients (24 webs).^{13,29} Hair growth from full-thickness skin grafts appears to be the most common problem, and minor cold intolerance is experienced by some patients. Mean functional VAS scores

of 91–98 (range, 7–100) and mean cosmetic VAS scores of 79 (range, 38–100) have been reported. Discoloring and abnormal hair growth can be avoided with our new technique because skin grafts from the groin or forearm are rarely needed. Our subjective findings, representing parents' opinion, are similar to the earlier findings that functional outcome is perceived better than the cosmetic.

Due to excellent short-term results, we chose to publish our technique earlier than anticipated. We will, however, continue with the study according to protocol and aim to measure the web space also using the method by Tonkin et al.³⁴ at last FU and report results of all aspects of the assessment method by Withey et al.¹⁸

CONCLUSION

Web reconstruction using a hexagonal dorsal skin flap and finger separation using straight midline incisions that close at the mid-lateral line is safe with good cosmetic and functional outcome in short-term FU.

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