

The role of skin grafts in the treatment of hand syndactyly in childhood

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ABSTRACT

Syndactyly of the hand is a frequent congenital anomaly with remarkable diversity. Medical community has been concerned about its treatment since the 19th century and many skin graft repair techniques have been proposed. There is, however, a strong reflection on their value. Between 2007 and 2016, 38 cases of hand syndactyly were treated in our clinic, in 25 children with an average age of 2.4 years. Twelve of these deformities were unilateral and 13 were bilateral. All cases were surgically repaired. Finger separation was done at the 3rd interdigital web space in 24 hands and at the 4th interdigital web space in 14 hands. In thirty-two cases syndactyly was simple and in 6 complex, while in 26 cases syndactyly was complete and in 12 incomplete. After finger separation, a free skin graft from the flexor surface of the wrist joint was used to cover the skin defects of one complex and 12 simple deformities. The abdominal area was preferred as a skin graft donor area in 14 simple and 5 complex deformity cases. In 6 cases of simple incomplete syndactyly, free skin graft repair was not required. In the follow-up which ranged from 6 months to 4 years, the results were generally considered satisfactory and all hands had excellent functionality. However, in 4 patients (15.8%), a slight extension of the newly formed interdigital web creep was noted, regardless of the graft donor area and the result was considered fair. In 4 hands (10.5%), where superficial inflammation of soft tissue developed, the end result was good. In conclusion, full thickness skin grafts are considered necessary to cover finger separation defects. The selection of the donor area is left to the surgeon's wish, as no significant correlation has been found with the final functional and cosmetic result. However, the use of a future technique where the use of skin grafts will not be required is under consideration.

Keywords: syndactyly; skin grafts; surgical plan

Introduction

Hand syndactyly is one of the most common congenital deformities. Medical community has been concerned about its treatment since the 19th century. It may appear as an individual condition or as part of

a syndrome, such as those of Poland or Apert [1-4]. Syndactyly exhibits great diversity, whereas the phenotype may involve one or both of the hands, or even the lower extremities. It may also be symmetrical or asymmetric, simple, complex or complicated, com-

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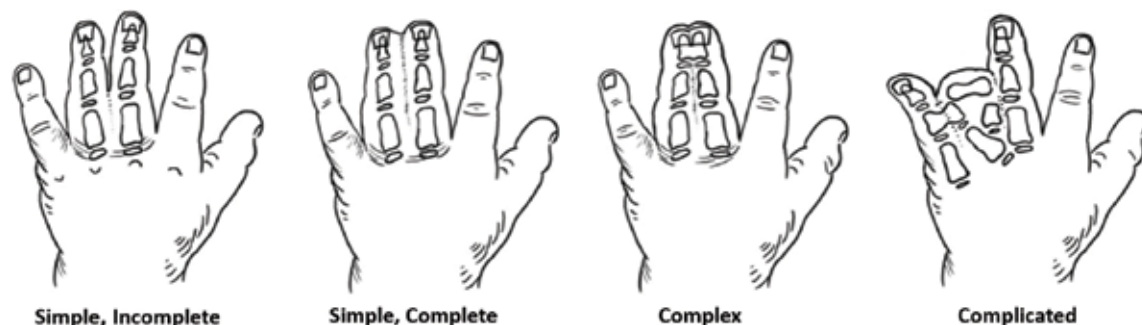


Fig. 1: Types of hand syndactyly, depending on the size (incomplete, complete) and the participation or not of bony structures (simple, complex, complicated)

plete or incomplete (**Figure 1**) [5, 6].

Most cases are inherited in an autosomal dominant pattern, although cases of autosomal or X-linked recessive inheritance have rarely been observed [7]. Despite the great progress in understanding the clinical and molecular identity of this deformity, little is known about its true pathogenesis [8]. Thus, the research interest in syndactyly for the coming years is obviously great.

The purpose of surgical treatment is to separate the joined fingers and ensure the skin flaps. From the early 19th century to date, there has been great progress. Since the beginning of the 20th century, the simple straight incision of the fingers with simultaneous mobilization of the local flaps was quickly replaced by the use of free skin grafts. In recent decades, using the zig-zag method and creating triangular flaps, along with wider use of grafts, many of the problems of the first period have finally found their solution [9, 10].

Creating of a sufficient size and correct shape flap for the formation of the interdigital web creep, can have a prominent role in obtaining two independent and functional fingers. This should not cause stiffness, bending or rotational deformities. Various techniques have been developed for this purpose [11]. However, for optimal cosmetic and functional results, in addition to familiarizing with the correct surgical technique, it is necessary to select the appropriate graft to cover skin defects [12].

The graft may be taken from the proximal or a remote body region, with the prospect of being directly incorporated with the skin of the recipient region,

without forming shrinkage scars and impeding the functionality of the hand. The ulnar side of the wrist offers the best graft [13]. Other areas that have the potential to give an optimal full thickness graft are the femoroinguinal area [14-16], the forearm, the inner surface of the arm or the anterior surface of the thigh [14], and the foreskin in infants who are subjected to circumcision at the same time [17].

However, there is a tendency on the part of researchers to avoid using grafts, making sure to save as much skin as possible from the already existing [18-26]. Sometimes they resort to the use of an external device for soft tissue dilation before the programmed separation of the fingers [27, 28]. In cases of syndactyly that accompanies polydactyly, the excess skin from the supernumerary finger that is going to be excluded, is sufficient to cover any defect [29]. Full thickness free skin grafts are preferred, as compared to the split thickness skin grafts, as they are responsible for 7.5% of failures compared to 60% of failures respectively [30].

On the following lines, we review our ten-year clinical experience, looking for ways to better repair these deformities, especially the most difficult ones, and discuss the prospect of improving our technique.

Patients and Methods

Between January 2007 and December 2016, thirty-eight hand syndactyly cases in 25 children (14 boys and 11 girls) with an average age of 2.4 years (ranging from 9 months to 7 years) underwent surgical treatment in our department. Twelve unilateral (6 right



Fig. 2: A 1-year-old female infant with a simple-incomplete syndactyly at the 3rd in-terdigital web space of the left hand (patient 8).

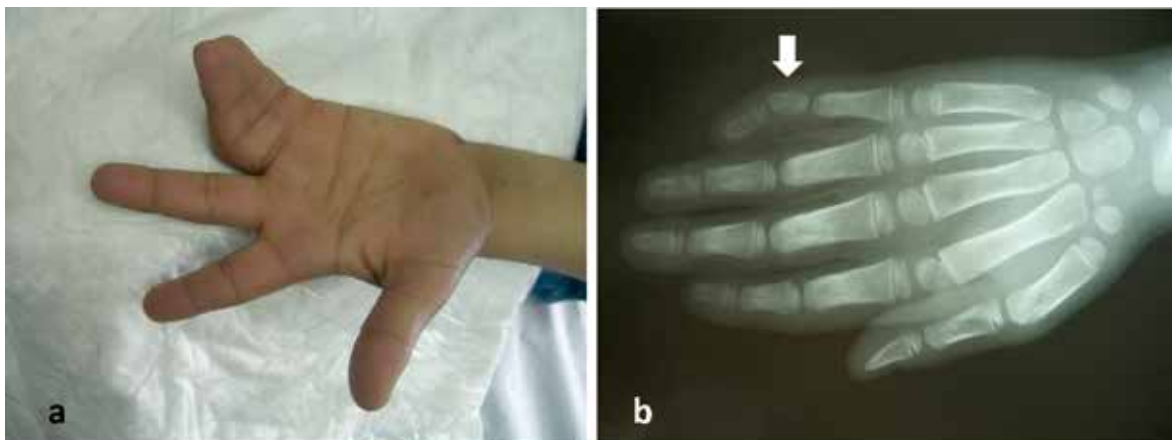


Fig. 3: A 2.5-year-old male toddler with a simple-complete syndactyly at the 4th inter-digital web space of the left hand (patient 19). a) Preoperative clinical picture b) A hand x-ray where the presence of a deltoid middle phalanx of the small finger is indicated (arrow).

and 6 left hands) and 13 bilateral deformities were repaired. Finger separation was done at the 3rd interdigital web space in 24 hands (**Figure 2**) and at the 4th interdigital web space in 14 hands (**Figure 3**). From our study were excluded children who suffered from Apert syndrome and syndactyly cases in patients with polydactyly. Thirty-two deformities were simple and 6 complex. Twenty-six of them were complete and 12 incomplete (**Table 1**). After finger separation, a free skin graft from the flexor surface of the wrist joint was used to cover the skin defects of one complex and 12 simple deformities (13 complete syndactyly cases).

The abdominal area was preferred as a skin graft donor area in the case of 14 simple and 5 complex deformities (13 complete and 6 incomplete syndactyly cases). In 6 cases of simple incomplete syndactyly, free skin graft repair was not required.

Surgical technique

Under general anesthesia and the application of a pneumatic tourniquet, the hand is properly cleaned with an antiseptic solution and the skin incisions are designed, both on the dorsal and palmar surface. Resection of sufficient dorsal skin flap is of great impor-

No	Age/Sex	Donor site	Simple Complex	Incomplete Complete	Web space	Follow-up period	Complications	Results
1	5 years/M	Abdomen	Simple	Incomplete	Bilateral/3rd	6 months	Nil	Good
2	1 year/F	Wrist	Simple	Complete	Left/3rd	24 months	Web creep	Fair
3	0.9 years/F	Wrist	Simple	Complete	Right/3rd	36 months	Nil	Good
4	6 years/M	Abdomen	Simple	Incomplete	Bilateral/3rd	6 months	Nil	Good
5	2 years/M	Wrist	Complex	Complete	Right/3rd	48 months	Nil	Good
6	4 years/M	Abdomen	Simple	Complete	Left/3rd	36 months	Nil	Good
7	1.5 years/F	Abdomen	Simple	Complete	Right/3rd	24 months	Web creep	Fair
8	1 year/F	Abdomen	Simple	Incomplete	Bilateral/3rd	6 months	Nil	Good
9	1.5 years/M	Wrist	Simple	Complete	Left/4th	48 months	Infection	Good
10	2.5 years/M	Abdomen	Complex	Complete	Bilateral/4th	12 months	Nil	Good
11	1 year/F	Wrist	Simple	Complete	Right/3rd	36 months	Nil	Good
12	0.9 years/F	No graft	Simple	Incomplete	Bilateral/4th	24 months	Web creep	Fair
13	7 years/M	Abdomen	Simple	Complete	Bilateral/3rd	9 months	Nil	Good
14	1 year/F	Wrist	Simple	Complete	Bilateral/3rd	48 months	Infection	Good
15	1 year/F	No graft	Simple	Incomplete	Bilateral/4th	12 months	Nil	Good
16	1.5 years/F	Wrist	Simple	Complete	Left/4th	6 months	Nil	Good
17	2 years/M	Abdomen	Simple	Complete	Bilateral/4th	48 months	Nil	Good
18	3 years/M	Abdomen	Complex	Complete	Bilateral/3rd	48 months	Nil	Good
19	2.5 years/M	Wrist	Simple	Complete	Bilateral/4th	9 months	Nil	Good
20	1.5 years/F	No graft	Simple	Incomplete	Left/3rd	48 months	Nil	Good
21	1 year/F	Wrist	Simple	Complete	Bilateral/3rd	6 months	Nil	Good
22	4.5 years/M	Abdomen	Complex	Complete	Left/3rd	24 months	Nil	Good
23	2 years/M	Abdomen	Simple	Complete	Bilateral/3rd	12 months	Web creep	Fair
24	1.5 years/M	Wrist	Simple	Complete	Right/4th	48 months	Nil	Good
25	3.5 years/M	No graft	Simple	Incomplete	Right/4th	9 months	Infection	Good

Table 1 Patients' data of the study

tance in creating the interdigital web creep. Zig-zag incisions are used in order to form triangular flaps and cover the adjacent surfaces of separated fingers (Figure 4). During finger separation, great care is also taken to ensure the integrity of the neurovascular bundles. Magnifying surgical loupes are required for this reason. In complex deformity cases, thin metal osteotomes are used to separate the bones.

In order to obtain full thickness skin grafts and cover the skin deficits before surgery begins, we select as donor area either the flexor surface of the wrist joint or the abdominal area over the femoroinguinal crease.

Skin incision is spindle-shaped and during grafting we take care to remove subcutaneous fat (Figure 5). We also recommend making the graft discontinuous, with thin parallel incisions, made with a No.15 scalpel blade. Suturing of skin flaps and grafts in the recipient regions is performed according to the principles of Plastic Surgery using non-absorbable sutures, preferably 4-0 or 5-0 nylon (Figure 6). We do the same for repairing the donor area.

Bleeding is checked, the pneumatic tourniquet is removed and the hand is covered with gauze dressings. Then it is immobilized using cotton and elastic band-

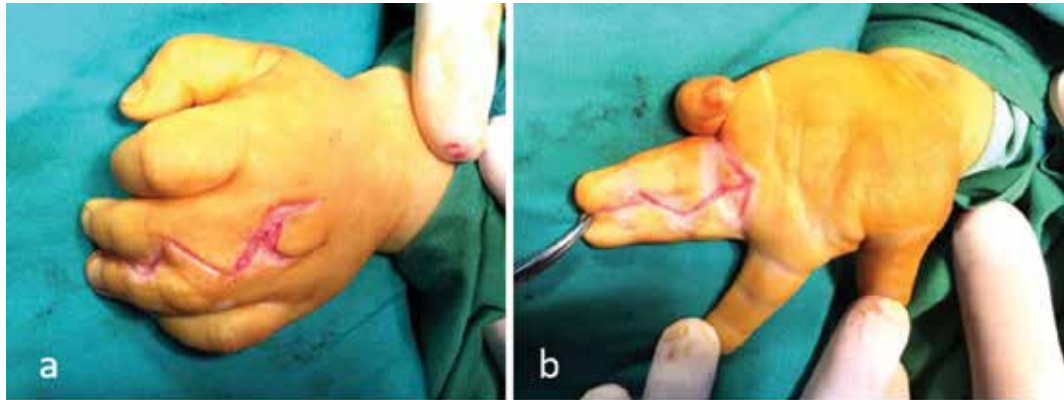


Fig. 4: Creation of triangular flaps using zig-zag incisions a) on the dorsal surface and b) the palmar surface.

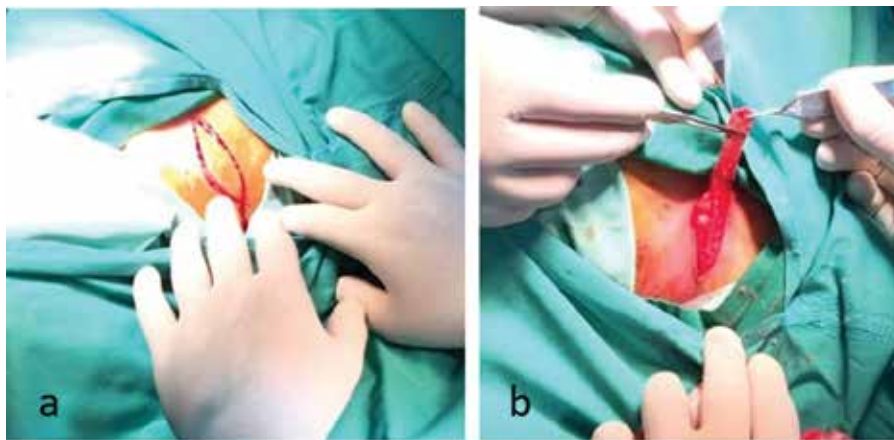


Fig. 5: A full-thickness skin graft from the abdominal area over the femoroinguinal crease. a) A spindle-shaped skin incision b) Removal of the subcutaneous fat from the graft before it is separated from the donor area.



Fig. 6: Middle finger-ring finger separation in a patient with a simple-complete syndactyly of the left hand (patient 21). a) Triangular flaps and taking of full-thickness graft from the flexor surface of the wrist joint b) Suturing of the triangular flaps and grafts for covering skin deficits according to the principles of Plastic Surgery.

	Pigmentation
0	Close to normal
1	Hypopigmented
2	Mixed
3	Hyperpigmented
	Pliability
0	Close to normal
1	Supple
2	Yielding
3	Firm
4	Banding
5	Contracture
	Height
0	Flat
1	<2 mm
2	2-5 mm
3	>5 mm
	Vascularity
0	Normal
1	Pink
2	Red
3	Purple

Table 2 Vancouver Scar Scale

ages in the shape of a boxing glove. Wound dressings are changed after 7 and 10 days, while the sutures are removed after 2 weeks. Complete return of the patient to normal activities is allowed after 4 weeks.



Fig. 7: Grading of the length of a newly formed interdigital web creep according to the Withey grading system (2001) on the left hand of the patient 21, six months after finger separation. On the basis of the above system's criteria, the result was excellent.

0	Soft web, abduction mirrors the adjacent web or equivalent web on the other hand
1	Thickening of the web without advancement
2	1/3 web creep recurrence of distance from palmar MCP to PIP joint crease
3	2/3 web creep recurrence of distance from palmar MCP to PIP joint crease
4	Web creep recurrence of the full extent from the palmar MCP crease to PIP joint crease

Table 3 Grading of web creep modified according to Withey et al (2001)

Results

During patient follow-up which ranged from 6 months to 4 years, the results were generally considered satisfactory. According to the clinical criteria of the Vancouver Scar Scale (**Table 2**), which takes into account the possibility of skin pigmentation, the pres-

ervation of its elasticity, the length of the interdigital web creep and the vascularity of the separated fingers, no serious changes were found.

According to the Withey modified grading system, regarding the size of the newly formed interdigital web creep, four patients were found to have a small degree of elongation (**Figure 7, Table 3**). One of them was a 12-month-old female infant with a simple-complete syndactyly at the third interdigital web space of left hand. Another patient was an 18-month-old female infant with a simple-complete syndactyly at the third interdigital web space of right hand. A third patient case was about a 9-month-old female infant with a simple-incomplete syndactyly at the fourth interdigital web space of both hands. In the first case, a free skin graft from the area of the wrist joint was used, in the second case the donor area was the abdomen, while in the third case no skin grafts were needed. Finally in a 2-year-old boy with a simple-complete syndactyly of his both hands at the third interdigital web space, where a skin graft from the abdominal area was used, a slight interdigital web creep elongation was also observed. In all these cases (15.8%), the results were found to be fair.

Four hands (10.5%) developed superficial soft tissue inflammation and were successfully treated with frequent wound changes and antibiotics. In these cases, the end result was considered good.

Discussion

Our study did not include syndactyly cases accompanied by polydactyly due to the need to compare similar deformities. We also did not include cases belonging to syndromes (Apert or Poland) because they were few in number and could not be statistically evaluated. In this study were included cases of incomplete or complete, simple or complex syndactyly. Patients with complicated syndactyly were transferred to a special center where they could be treated by a medical team of Plastic Surgery.

The average age of our patients was 2.4 years, while all of them were older than 9 months old. For the reconstruction of simple syndactyly, patients aged over 6 months old are preferred, although many authors prefer ages over 18 months old [31]. We believe that

choosing the right timing is of vital importance because it prejudices the good result. In Greek reality, it is common for parents to put pressure on doctors for early reconstruction of the deformity, if possible in the first few weeks after birth. Such cases must be handled wisely.

We have established our technique for the past 15 years and we are very satisfied with the results. However, we would gladly accept any new technique that could facilitate finger separation or avoid the use of skin grafts. We consider the careful removal of fat from the graft as important as its discontinuous modification with thin parallel incisions. We prefer the use of nylon sutures because they are monofilament and leave smaller scars, although general anesthesia is often required in order to be removed. After completion of skin suturing, we release the tourniquet band. If we detect poor blood flow, we cut the sutures that are considered responsible. In cases of synonychia, we proceed to a detailed separation of the distal phalanges, making sure to cover the created skin deficit by graft, according to the literature guidelines [32].

In order to select a full thickness skin graft instead of a split thickness, we did not have the slightest hesitation, as we are convinced that the chances of failure of the technique are more with the second option [30]. A split thickness skin graft was not used in any of the study patients. Regarding the color of graft, we did not notice any problems, although grafts from the ulnar surface of the wrist are considered the safest [33].

The goals of the proper management of syndactyly are: a) to create an interdigital web creep without shrinking, bending or rotational deformities of the separated fingers and b) to cover skin deficits with the appropriate grafts. Some authors consider the second goal to be of prime importance [34]. However, complications of inability to achieve the first goal are not uncommon [35].


In childhood syndactyly cases, techniques that give excellent results to adults, such as the use of bilobed flaps from the dorsal surface, as described by Sahin et al. [36], have not yet been used. However, we must bear in mind that the right choice of the donor area may limit the possibility of other complications. The inguinal region is selected to refer to a region away

from the mons pubis in order to avoid unacceptable hair growth [14]. The inner surface of the arm has been almost abandoned because it is implicated in the formation of an ugly scar in the donor area. In the literature, there are many articles suggesting different donor areas for skin grafts [13,33] and others with areas to be avoided [37-39]. In an attempt to replace flaps with the V-Y technique that is quite popular in finger separation [21,40], Aydin and Ozden [18] suggest a pedicle vascular flap to create a secure interdigital web creep.

The short patient follow-up (6 months to 4 years) is perhaps the weak point of our work, but we intend to reassess these cases along with the registration of new patients after a reasonable period of time. Dao et al.

suggest that patients should be screened on a regular basis until completion of skeletal maturation in order to prevent or treat any further complications [31].

Conclusion

Syndactyly can be combined with other complex abnormalities that affect the end result. Careful preoperative study is required with regard to indications, correct timing, flap design, and donor area selection for skin graft use. Orthopedic surgeon must be fully aware of the anatomical structure and the various and varied variants. 

Conflict of interest:

The authors declared no conflicts of interest.

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