LONG-TERM RESULTS OF SYNDACTYLY CORRECTION: FULL-THICKNESS VERSUS SPLIT-THICKNESS SKIN GRAFTS

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In order to compare the long-term results of full-thickness and split-thickness skin grafts after the correction of congenital syndactyly, 27 patients have been investigated after an average follow-up of 21 years. Post-operative functional and cosmetic results have been assessed by patient records, questionnaires and physical examination. The webs that had received split-thickness grafts showed more flexion and extension lags and the overall spreading of the operated fingers was significantly decreased compared to the control fingers. On the other hand, more re-operations because of web creep had to be performed after full-thickness grafts. Hyperpigmentation and hair growth in the grafts was found in most of the full-thickness grafts, while breakdown of the graft was found in some of the split-thickness grafts. Therefore, based on the results of this study, either full- or split-thickness skin grafts can be used when treating of congenital syndactyly.

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INTRODUCTION

Syndactyly is the second most common congenital deformity of the hand. It occurs in 1 per 2000 to 1 per 3000 living births. It is believed to be a failure of differentiation of the mesenchymal structures, resulting in fingers that remain fused together, causing finger "webbing" (Toledo and Ger, 1979). It may present as an isolated deformity or in association with syndromes or other congenital deformities. Syndactyly can be classified into complete, if the web involves the full length of the fingers, or incomplete if the web does not. It is called simple when the web is formed only by skin, and complex when other tissues like bone, nails, tendons, nerves and vessels are involved as well.

Since syndactyly can cause major functional and cosmetic problems, surgical correction is usually indicated. In most cases, the use of a skin graft is inevitable because of the skin deficit arising after separating the fingers. Grafts may consist of full-thickness or split-thickness (i.e. partial thickness) skin. Although many authors advocate a certain type of skin graft, the results of split-thickness versus full-thickness skin grafts in the correction of syndactyly have rarely been compared. Full-thickness skin grafts are believed to cause less recurrence of the webbing and less contracture of the digits. On the other hand, split-thickness skin grafts are easier to harvest and supposedly have less tendency to give hypertrophic scars in the donor site, produce a better colour match and cause no hair growth (Brown, 1977; Schulstad and Skoglund, 1977; Toledo and Ger, 1979).

Since the final operative results can only be determined when the patients and their hands have grown up, post-operative results can only be judged after a long time. To our knowledge, no very long-term studies of full-thickness versus split-thickness skin grafts have been conducted. This study compares the very long-term results of split-thickness skin grafts with those of full-thickness skin grafts after correction of congenital syndactyly.

PATIENTS AND METHODS

Since the result of syndactyly correction can be negatively influenced by the presence of other hand deformities (Percival and Sykes, 1989), complex forms of syndactyly and syndactyly associated with deformities like brachydactyly, clinodactyly, longitudinal reduction defects and other reduction defects were excluded in this study. Only patients with simple syndactyly and patients with syndactyly in combination with minor abnormalities, not interfering with the operated fingers or web, were included in this study. Of the patients operated in the period 1968 to 1990, 27 patients (19 boys and 8 girls) could be traced for follow-up. From their records information was collected about the type of syndactyly, the operation technique, post-operative check-up and any re-operations. Long-term post-operative results were assessed by a questionnaire which enquired about functional problems and cosmetic satisfaction and by examination of the operated fingers and hands. Maximal active flexion and extension of the operated fingers were determined by asking the patient to make a fist and then to extend the fingers maximally. When abnormal, the defect in degrees was measured at the metacarpo-phalangeal or interphalangeal joints. The angle of the maximal active spreading of the fingers was also measured. This was done by tracing the maximally spread fingers on a blank sheet and comparing it with the contralateral web. When the contralateral web was also affected with syndactyly, the adjacent web was chosen as the control web. Web creep and thickening was evaluated as proposed by Withey et al. (2001)

Table 1—Assessment of the grade of web creep, as proposed by Withey et al. (2001)

Web creep	0 = normal and soft web 1 = no web creep, but thickening of the web due to scarring 2 = creep of the web to 1/3 of the distance between the base of the web and the PIPJ crease 3 = creep of the web to 2/3 of the distance between the base of the web and the PIPJ crease 4 = creep of the web to the PIPJ crease

PIPJ = proximal interphalangeal joint.

(Table 1). Other examined parameters were rotation and deviation deformity, scar quality, hyperpigmentation, hair growth, instability and shrinkage of the graft. Scar quality of the donor sites was also evaluated. All physical examinations were performed by the first author. The Mann–Whitney *U* test was used to compare the results of the finger spreading. Fisher's exact test was used for the other data.

RESULTS

In this study 27 patients, all Caucasian, were operated on for syndactyly in 34 webs affecting 68 fingers. The post-operative follow-up averaged 21 years, ranging from 12 to 34 years. The median age at operation was 3.5 (range, 1–16) years. Fifteen patients received full-thickness skin grafts and 12 patients split-thickness skin grafts. Full-thickness grafts were taken either from the groin (17 webs) or from the medial side of the upper arm (three webs). Split-thickness grafts were taken either from the forearm (ten webs) or from the thighs (four webs). The types of syndactyly and the localisation of the 34 webs are shown in Table 2. All digits were separated using zigzag incisions and the base of each web was constructed either with dorsal flaps, or with palmar and dorsal triangular flaps. A positive family history for syndactyly was found in 14 patients.

Flexion and extension

Normal flexion was found in all but two fingers. In both fingers the decrease in flexion was 25° at the proximal interphalangeal joint and 30° in the distal interphalangeal joint. Because of normal function of the metacarpo-phalangeal joint, this did not cause many functional problems. Both fingers were adjacent to the same web. This patient had received split-thickness grafts.

Normal extension was found in all but five fingers. In four fingers the extension lag was located in the distal interphalangeal joint, with a maximum loss of extension of less than 25°. All of these four fingers had been part of a complete syndactyly. Two of them had received full-thickness skin grafts and two split-thickness grafts. In one finger there was a small extension lag of 5° at the proximal interphalangeal joint. This finger had received split-thickness grafts. A Z-plasty had already been performed in two patients to release a flexion contracture. One of them had received a full-thickness skin graft and a split-thickness graft. The difference in presence of flexion and extension lags between full-thickness and split-thickness grafts was not statistically significant ($P = 0.19$ and $P = 0.64$, respectively) (Fig 1).

Spreading

In the webs that had received full-thickness grafts, the average angle in maximal active spreading was 24°, compared with 28° in the control webs. This was not a statistically significant difference ($P = 0.17$).

In the webs that had received split-thickness skin grafts, the average angle in maximal active spreading was 20° compared to 28° for the control webs. This was a statistically significant difference ($P = 0.012$) (Fig 2). The difference between the webs that had received full-thickness grafts (24°) and those that had received split-thickness grafts (20°) was not statistically significant ($P = 0.25$).

Web creep

During examination, no web creep was actually found. However, six webs in four patients who had received full-thickness grafts, had already undergone re-operation for web creep (Fig 1). In all six webs a Z-plasty was performed and in four of them additional full-thickness skin grafts were needed. In one web that had received split-thickness grafts, a Z-plasty had already been performed because for web creep.

Thickening of the web (grade 1; Table 1) was found in one web that had received split-thickness grafts and in three webs that had received full-thickness grafts. The

Table 2—Number of webs affected and types and localization of syndactyly

	Type of syndactyly		*Hand*		*Web space*		
	Complete	*Incomplete*	*Left*	*Right*	*Index/Middle*	*Middle/Ring*	*Ring/Little*
Full-thickness	10	10	12	8	2	16	2
Split-thickness	11	3	13	1	4	9	1
Total	21	13	25	9	6	25	3

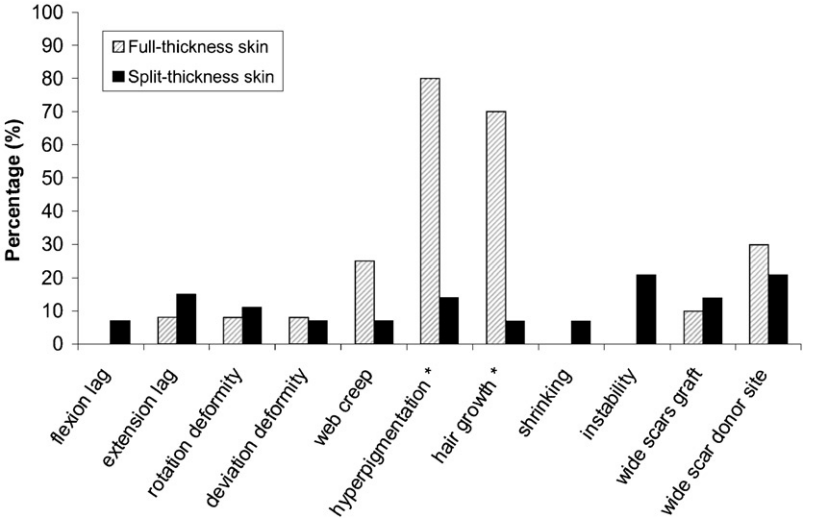

Fig 1 Percentage of complications in full-thickness and split-thickness skin grafts. * indicates a statistically significant difference between full-thickness and split-thickness skin grafts.

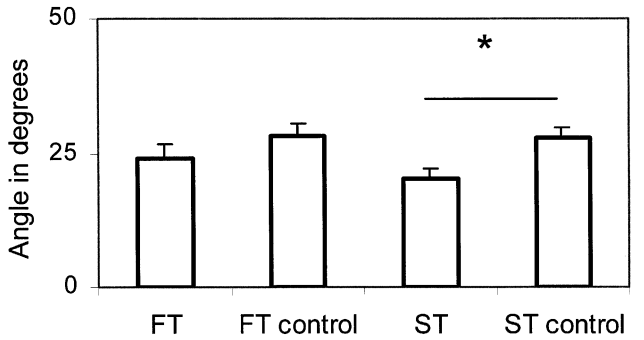

Fig 2 The angle between the spreading fingers. Webs that received full-thickness grafts (FT) and split-thickness grafts (ST) are compared to their control webs. (Error bars = standard error of the mean.) * indicates a significant difference between the webs that received split-thickness grafts and their control webs.

differences in web creep ($P = 0.23$) and thickening of the web ($P = 0.64$) were not statistically significant.

Rotation and deviation deformities

Rotation deformities were found in three fingers with full-thickness grafts and in three fingers with split-thickness grafts. Deviation deformities were found in three fingers with full-thickness grafts and in two fingers with split-thickness grafts (Fig 1). It was not clearly documented whether these deformities were already present pre-operatively.

Colour and hair growth of grafts

Hyperpigmentation (Fig 3) of the graft was found in 16 webs that had received full-thickness grafts. This was a reason for dissatisfaction in eight of the 15 patients. In three of the five webs that had not become hyperpigmented, the grafts had been taken from the medial side of the upper arm. Hyperpigmentation of split-thickness grafts was found in two webs. This was no reason for dissatisfaction. Hair growth (Fig 3) was found in 14 full-thickness grafts, and most patients had to depilate their skin once in a while. This was a reason for dissatisfaction in four of the 15 patients. Two patients had seen a skin therapist for electric depilation. Hair growth of the graft was found in only one of the split-thickness grafts (Fig 1). The differences in hyperpigmentation ($P = 0.03$) and hair growth ($P = 0.02$) between full-thickness and split-thickness were both statistically significant.

Shrinking and instability

Slight shrinking (Fig 4) was found in two webs and instability (easy splitting) was found in three webs that had received split-thickness grafts. Three patients complained about easy splitting and rough skin in cold and wet weather. No shrinking and instability was found in webs that had received full-thickness grafts (Fig 1). The difference in instability between full-thickness and split-thickness skin grafts was not statistically significant ($P = 0.09$).

Scar quality of grafts and donor sites

Wide but flat scars were found in two webs that had received full-thickness and another two that had received split-thickness grafts. Wide and raised scars at the donor site were found in one patient with full-thickness and one patient with split-thickness grafts. Wide but flat scars of the donor site were found in four

Fig 3 Hyperpigmentation and hair growth of the full-thickness graft on the ulnar side of the middle finger, 18 years after correction of complete syndactyly between index and middle fingers.

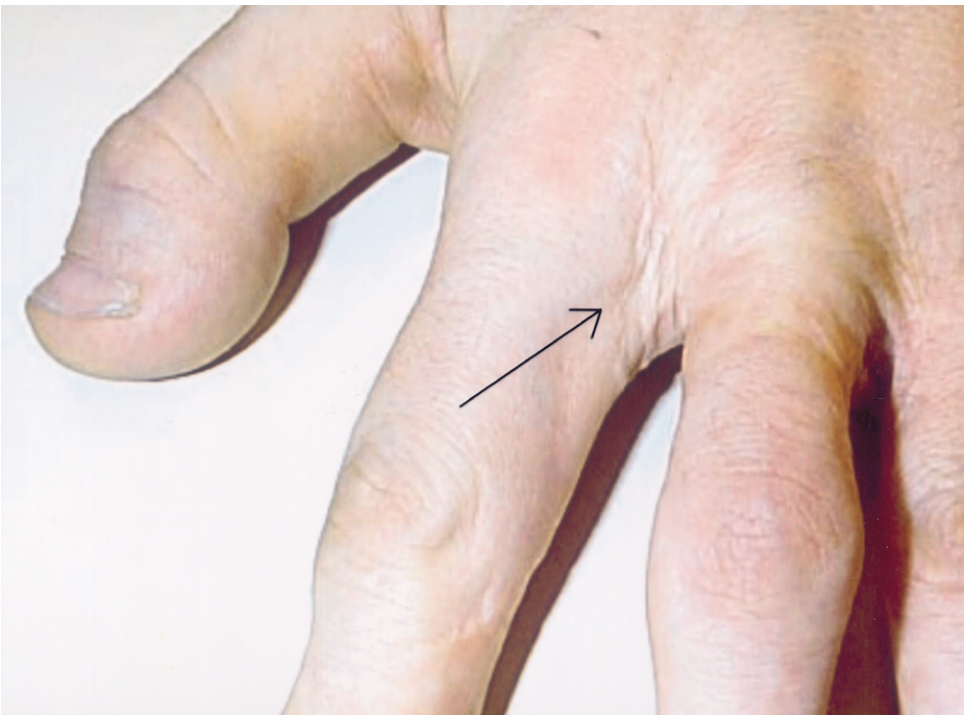

Fig 4 The arrow indicates shrinkage of the split-thickness graft at the ulnar side of the index finger, 27 years after correction of complete syndactyly between index and middle fingers.

patients with full-thickness grafts and two patients with split-thickness grafts (Fig 1). In most cases the donor sites for the split-thickness grafts were hardly visible, only showing some pitting of the skin (peau d'orange) (Fig 5). In most cases of full-thickness grafts, the scars of the donor site were narrow but still plainly visible.

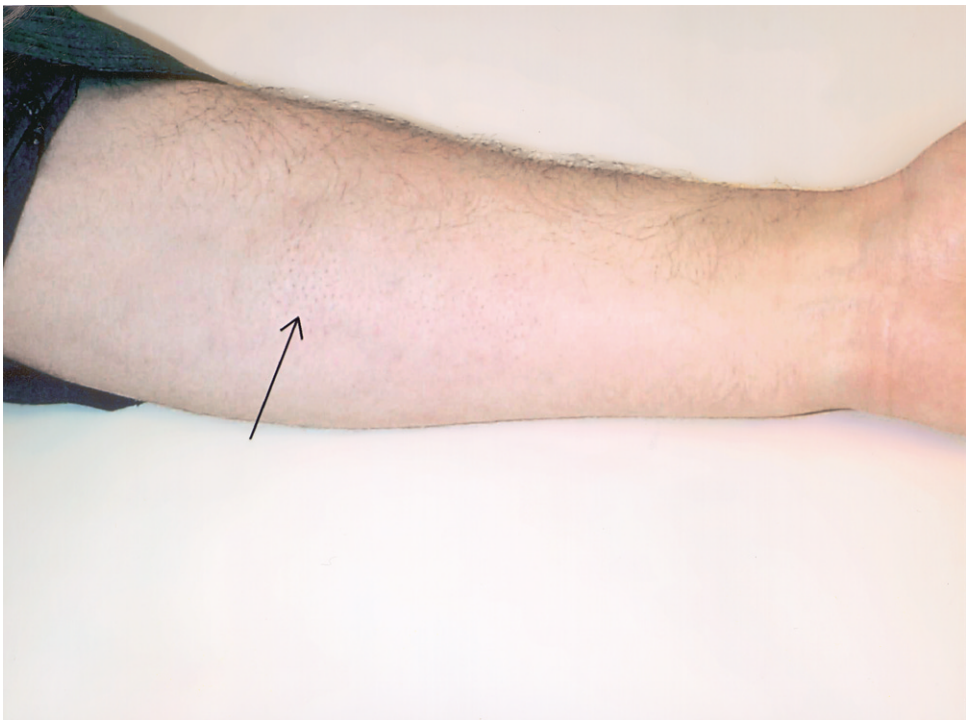

Fig 5 The arrow indicates pitting of the skin (“peau d’orange”) at the hardly visible donor site on the forearm, 28 years after harvest of a split-thickness graft with a dermatome.

DISCUSSION

In this study, 27 patients were investigated in a standardised manner to determine the results of their syndactyly correction. Only cases of syndactyly that were not influenced by other deformities were included and a standard protocol was used for the examination. In this way, we have produced as accurate as possible a comparison of full-thickness and split-thickness skin grafts in a nearly equal numbers of patients. The patients were examined after a minimum follow-up of 12 years, with an average of 21 years, and thus all patients were adult and the assessed results could be considered as final. So far, only a few studies (Brown, 1977; Deutinger et al., 1989; Percival and Sykes, 1989; Toledo and Ger, 1979) have compared full-thickness with split-thickness skin grafts. In these studies, preference was given to full-thickness grafts which were associated with fewer flexion and extension contractures and less web creep. One study showed good results with split-thickness grafts, with negligible graft contractures (Schulstad and Skoglund, 1977). However, these studies did not assess the outcome in the very long term, and not every patient was an adult. Therefore, it is hard to draw conclusions from these studies, especially as some did not exclude cases with co-existing hand deformities and others did not have equal proportions of full-thickness and split-thickness grafts (Table 3).

The present study found more flexion and extension lags and decreased spreading of the operated fingers in the split-thickness group. However, it is doubtful whether the difference between spreading of 24° in the full-thickness and 20° in the split-thickness groups is clinically significant, as a decrease of 4° is not likely to cause any more functional impairment. Moreover, none of the patients complained of decreased function due to decreased spreading of the fingers.

While slightly better functional results were seen, more re-operations had to be performed in the full-thickness group because of web creep. The latter is remarkable, since other studies comparing full-thickness with split-thickness skin grafts found more web creep with split-thickness grafts (Brown, 1977; Deutinger et al., 1989; Percival and Sykes, 1989; Toledo and Ger, 1979). This difference might be coincidental, since it was not statistically significant. However, we do not have a satisfactory explanation for this clinical difference.

Most of the full-thickness skin grafts had become hyperpigmented and hair bearing, leading to dissatisfaction in a large number of patients. On the other hand, some split-thickness grafts exhibited with shrinkage or instability, which was also a reason for complaints by some of the patients. Hyperpigmentation and hair growth is a significant disadvantage of the full-thickness graft. As hair growth in the graft depends on the donor site, full-thickness skin grafts from the groin should not be taken too medially, from the future pubic area.

Table 3—Studies comparing full-thickness and split-thickness skin grafts in syndactyly surgery

	Number of patients examined	*Split/full-thickness ratio*	*Follow-up (years)*			*Co-existing deformities*[1]
			Minimum	*Maximum*	*Average*	
Brown (1977)	32	20/12[2]	8[3]	18[3]	Unknown	No
Toledo and Ger (1979)	35[4]	5/28[5]	2	38	14 years	Yes
Percival and Sykes (1989)	[6]	50/19	5[3]	14[3]	Unknown	Yes
Deutinger et al. (1989)	29	10/19[7]	1	18[3]	Unknown	Yes
Schulstad and Skoglund (1977)	20	19/1	<1	11	Unknown	No
Present study	27	12/15	12	34	21 years	No

[1] Deformities like brachydactyly, clinodactyly, longitudinal reduction defects and other reduction defects.
[2] Estimate of the ratio, based on 80 sides of fingers with split-thickness skin grafts and 46 sides with full-thickness skin grafts, in a total of 32 patients.
[3] Estimate of the minimal and maximum follow-up duration, based on the time between the given date of operation and the year of acceptation (or publication) of the article.
[4] 35 of 61 patients were examined.
[5] Estimate of the ratio, based on 80% split-thickness grafts and 14% full-thickness skin grafts, in a total of 35 patients and 2 patients receiving no skin grafts at all.
[6] Patients not examined: a review of 69 records.
[7] Estimate of the ratio, based on 22 skin defects with split-thickness and 40 skin defects with full-thickness skin grafts, in a total of 29 patients.

Hyperpigmentation also probably depends on the location of the donor site, since only grafts taken from the groin had developed troublesome of hyperpigmentation. However, the use of full-thickness grafts from the upper arm is not recommended, since all cases developed large wide scars at the donor site. Other donor sites have been proposed by other authors (Park et al., 1999; Zoltie et al., 1989) and some authors have even proposed techniques in which skin grafts are not used at all (Ekerot, 1996; Greuse and Coessens, 2001; Withey et al., 2001). However, more studies of the very long term results for these and other alternative techniques are required.

Based on the results of this study, it can be concluded that in the correction of syndactyly both full-thickness and split-thickness skin grafts give acceptable functional results in the very long term. However, both types of skin grafts have their own disadvantages. While slightly better functional results were seen with full-thickness grafts, more re-operations had to be performed because of web creep with full-thickness grafts. Most full-thickness skin grafts were hyperpigmented and hair bearing, while a relevant percentage of the split-thickness skin grafts exhibited instability of the skin.

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