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ORIGINAL ARTICLE

Comparative study between Hexagonal and Rectangular Flaps for Web Reconstruction of Simple Syndactyly of the Fingers

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Abstract

Background: ***Syndactyly is a common congenital hand anomaly, affecting one in every 2000 live births, and can be classified as complex, simple, complicated, or syndromic. Syndactyly release is one of the most frequent procedures in congenital hand operation.***

Aim and objectives: ***To review different modalities for the release of simple congenital syndactyly and assess the hexagonal advancement flap and the rectangular flap in web reconstruction in desyndactyly procedures.***

Patients and methods: ***This prospective research involved twenty cases of simple congenital syndactyly admitted to the Department of Plastic & Reconstructive Surgery at Al Azhar University hospitals. Cases were separated into two groups according to the surgical procedure: Group A treated ten cases with rectangular advancement flaps, and Group B treated ten with hexagonal advancement flaps.***

Results: ***The two groups showed insignificant differences in terms of degree of syndactyly, localization, web creep, flexion contracture, and need for a second operation, while there were significant differences in terms of operative time (hours). There were 90% of patients with complete grafts and 10% with partial grafts.***

Conclusion: ***Hexagonal and rectangular advancement flaps are good ways to release simple and complex syntactically. They have benefits like being easy to learn, changing during surgery, and having wide tips that keep flap tips from necrosis.***

Keywords: Syndactyly; Hexagonal Flaps; Rectangular Flaps

1. Introduction

Syndactyly is a congenital hand abnormality that affects approximately one in two thousand live births. It can be categorized as simple, complicated, complex, or syndromic. Traditionally, a condition is considered simple when it only affects soft tissue, complex when it involves bone fusion, and complicated when it involves more complex conditions, such as brachydactyly, polysyndactyly, and clinodactyly. Syndromic conditions include Apert's syndrome, Poland's syndrome, and ring constriction syndrome.[1]

Syndactyly is classified as complete when the fusion spans from the base of the digits to the tip and incomplete when just a shorter portion of the digits is fused. Syndactyly release is a frequently performed operation in congenital hand operation. The objective is to establish a suitable digital space and separate the fingers to enhance functionality. One proposed method for creating a visually pleasing and anatomically correct web is dorsal flaps. In contrast, skin grafts can cover any deficiencies along the sides of the fingers.[2]

Several writers have proposed techniques for correcting syndactyly, including the triangle and rectangular flap methods. Additionally, various altered designs have been employed, including the V-Y advancement flap, pentagonal flap, bilobed flap, hexagonal flap, trilobed flap, hourglass-shaped flap, plane-shaped flap, palmar flap, venous flap, T and Omega flap, three-square flap, M-V flap, dorsal transversely oriented transposition flap, and bellbottom flap.

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The primary distinctions among these approaches lie in the geometric shape of the web flap, the incisions used to separate the fingers, and the quantity and placement of the skin grafts.[3]

Revision surgery is frequently required due to secondary skin graft contracture and distal web creep. After syndactyly release surgery, web creep is a common complication. It often manifests within three years of following the procedure. The documented occurrence of web creep following surgical syndactyly release varies between two percent and twenty-four percent, and in some cases, it can be as high as sixty percent.[4]

Research has shown that the optimal surgical technique for treating uncomplicated syndactyly involves utilizing rectangular flaps interacting with each other. This technique is preferred due to its simplicity and the ability to make modifications throughout the operation.[5]

This work aimed to review different modalities for the release of simple congenital syndactyly and assess the hexagonal advancement flap and the rectangular flap in web reconstruction in desyndactyly procedures.

2. Patients and methods

This prospective research involved twenty cases of simple congenital syndactyly admitted to the Department of Reconstructive and Plastic Operation at Al Azhar University hospitals. Cases were separated into two groups according to the surgical procedure performed: Group A: Ten cases were treated with a rectangular advancement flap, and Group B: Ten cases were treated with a hexagonal advancement flap.

2.1.Inclusion criteria: Participants were involved in cases of congenital syndactyly, specifically simple syndactyly. Simple syndactyly is characterized by an active range of motion in the interphalangeal joints and well-defined flexion and extension creases, indicating normal joint structure. Both males and females aged six to twenty-four months were involved in the study.

2.2.Exclusion criteria: complex and complicated syndactyly, patients associated with other congenital anomalies (syndromes), patients unfit for anesthesia, syndactyly in the feet, and post-traumatic and post-burn patients.

2.3.Ethical Consideration: The research protocol has been submitted to the Institutional Review Board of the Department of Plastic and Reconstructive Operations at Al-Azhar University for approval. Parents provided written informed consent. Confidentiality and personal privacy were maintained throughout all levels of the research.

2.4.Surgical technique:

The following strategies were carried out:

Rectangular flap: The surgical procedure involves developing a rectangular flap that spans from the metacarpal heads to two-thirds of the length of the proximal phalanx. The flap's borders are curved to match the finger's rounded shape. The dorsal zigzag incision originates at the flap's highest point and stretches toward the center of the adjacent finger's proximal interphalangeal joint. The palmar zigzag is configured in a way that is opposite to the proximal zigzag, creating a mirrored pattern. A minor T-shaped incision is made at the end to facilitate the flap's insertion. During surgery, the T incision might be modified to enhance the fit among the flaps. The hand is exsanguinated with blood using a Martin bandage, and the tourniquet is raised to a pressure of 250 millimeters of mercury. The tourniquet is usually inflated to a pressure of 250 millimeters of mercury, although it rarely exceeds three hundred millimeters.[6]

The initial step involves elevating the dorsal triangular flaps using sharp dissection techniques while simultaneously managing any bleeding spots with bipolar cautery. The volar flaps are raised to locate the neurovascular bundles, after which the digits are separated from distal to proximal. This technique maintains the integrity of the neurovascular bundles and venous plexuses. The proximal dissection is restricted by the point where the digital artery splits into two branches, limiting the possible position of the new webspace. Every digit must possess a single functional digital artery. If the opposite side has not had surgery or the other artery remains undamaged, a vein transplant can lengthen the artery and provide a closer web space. If the digital nerve bifurcates distal to the webspace, microdissection separates it.[7]

Next, raise triangle flaps on the upper side, create vertical cuts on the lower side, and make a little T-shaped incision at the first palm incision. The wounds are flushed with a sterile solution, and the bleeding is controlled. The process involves carefully removing excess fat from the finger flaps and securing them at the tips with a 4-0 chromic suture. The tourniquet has been released, the bleeding has been managed, and the remaining flaps have been secured with interrupted 4–0 chromic sutures.[6]

A graft is identified and marked above the anterior superior iliac spine (ASIS), then raised, and hemostasis is accomplished. The area where the tissue is taken from is sealed using separate 4–0 Vicryl and subcuticular 4–0 Monocryl sutures. After dressings are placed over the wound, the graft is prepared by removing excess fat, trimming it, and securing it over the skin defects using interrupted 4–0 chromic sutures.

Hexagonal flap

The hexagon flap is a surgical technique carried out under general anesthesia. Its purpose

is to remodel the region among the proximal interphalangeal (PIP) and metacarpophalangeal (MCP) joints in the dorsal proximal interdigital area. The flap is partitioned into three equal halves by four intersecting lines, each marked with six vertices. The dorsal and volar zigzag lines are drawn from the farthest to closest points, with the dorsal line terminating at one of the two farthest vertices and the volar zigzag line terminating closer to the finger crease. A horizontal line is drawn at the closest end of the zigzag line on the palm side, which has the same length as the opposite horizontal edge of the flap. The triangular flaps formed by reciprocating Z incisions are stitched together, and the donor sites on the dorsal phalanx are closed using a V-Y technique. The flap is moved towards the palm and put into the space between the fingers. The angle of the space is restored using the hexagon flap. All wound suturing is conducted with appropriate tension, although wound closures for cases older than three are often performed with slight stress.

2.5.Postoperative Dressings and Immobilization

Following surgery, dressings have a significant influence on the outcomes of the operation. Grafts necessitate immobilization and compression. Grafts and incisions are covered with gauze and cotton, with fingers abducted to avoid kinking. Soft gauze and sterile cotton padding are used. In young children, a cast prevents slipping off the arm. Postoperative immobilization is crucial; dressings can be changed every 5-7 days. Evaluations of flap viability, skin graft take, web distribution, web creep, flexion contractures, angulation deformity, and functional outcomes are necessary. Following dressing removal, normal hand use is encouraged, and physiotherapy is usually unnecessary.[8]

3. Results

Table 1. Demographics of the studied groups

		GROUP A (N=10)	GROUP B (N=10)	TOTAL (N=20)	X^2/T	P VALUE
AGE (MONTHS)	Mean ± SD	16.8 ± 3.65	15.6 ± 3.86	16.2 ± 3.66		0.484
	Min – Max	13 - 24	12 - 22	12 - 24		
	Median	18.8	16.1	17.5	t=0.17	
SEX	Male	6 (60%)	7 (70%)	13 (65%)		0.639
	Female	4 (40%)	3 (30%)	7 (35%)	X^2=0.22	
WEIGHT (KG)	Mean ± SD	20.1 ± 3.28	19.2 ± 2.66	19.8 ± 2.47		0.509
	Min – Max	16 - 24	16 - 25	16 - 25		
	Median	20.5	19.5	20	t=0.67	
HEIGHT (M)	Mean ± SD	1.6 ± 0.03	1.6 ± 0.04	1.6 ± 0.03		0.610
	Min – Max	1.59 - 1.69	1.56 - 1.7	1.56 - 1.7		
	Median	1.7	1.7	1.7	t=0.01	
BMI (KG/M^2)	Mean ± SD	25.3 ± 3.02	23.8 ± 2.65	24.1 ± 2.91		0.256
	Min – Max	19.72 - 28.88	20.66-27.9	19.72- 28.88		
	Median	26.1	24.3	25.8	t=1.18	

χ2, t, p: χ2 and p values for Chi square test for comparing between the two groups t for t test. BMI: Body mass index

Regarding demographics of the studied groups; age, sex, weight, height and BMI were insignificantly different between both groups.**Error! Reference source not found.**

Table 2. Affected hand, degree of syndactyly

		GROUP A (N=10)	GROUP B (N=10)	TOTAL (N=20)	X^2	P VALUE
DEGREE OF SYNDACTYLY	Complete	7 (70%)	8 (80%)	11(55%)	X^2=0.2	0.653
	Incomplete	3 (30%)	2 (20%)	9(45%)		

The two groups showed insignificant difference regarding degree of syndactyly between both groups. Table 2

Table 3. Classification of syndactyly's and number of affected webs of the studied groups

		GROUP A (N=10)	GROUP B (N=10)	TOTAL (N=20)	X^2	P VALUE
LOCALIZATION	Little/ring	3(30%)	3(30%)	6(60%)		0.85
	Middle/index	3(30%)	2(20%)	5(50%)	0.31	
	Ring/middle	4(40%)	5(50%)	9(90%)		

The two groups showed insignificant difference regarding localization between both groups. Table 3

Table 4. Visual analogue scale of the studied groups

		GROUP A (N=10)	GROUP B (N=10)	TOTAL (N=20)	T	P VALUE
OPERATIVE TIME (HOURS)	Mean±SD	2.13 ± 0.10	1.39 ± 0.08	2.05±0.09		<0.001*
	Range	2.01 – 2:30	1.31 – 1.56	1.31–2.30	18.2	
	Median	2.18	1.41	1.98		

The two groups showed significant difference regarding operative time (hours) between both groups. Table 4

Table 5. Outcomes findings between both groups

	GROUP A (N=10)	GROUP B (N=10)	TOTAL (N=20)	X^2	P VALUE
WEB CREEP	0	0	0	0	1
RANGE OF MOTION	Normal 10(100%)	Normal 10(100%)	20(100%)	0	1
FLEXION CONTRACTURE	3(30%)	2(20%)	5(50%)	0.26	0.6
NEED FOR SECOND OPERATION	2(20%)	1(10%)	3(30%)	0.39	0.53

The two groups showed insignificant difference regarding web creep, flexion contracture and need for second operation between both groups. Table 5

Table 6. Distribution of patients in group A according to graft take.

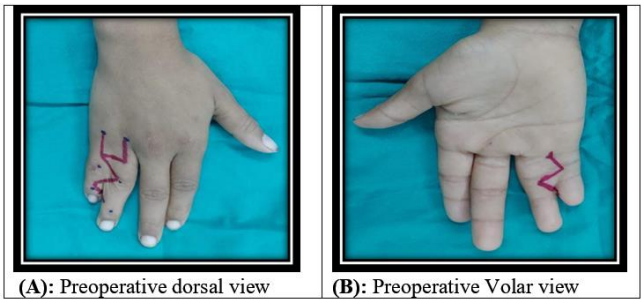
	N=10	NO.	%
GRAFT TAKES	Complete	9	90
	Partial	1	10

There were 90% of patients with Complete Graft and 10 % of patients with Partial Graft takes Table 6

CASES presentation

3.1.Case 1

Incomplete simple syndactyly right small/ring fingers operated on using the rectangular flap with skin graft.



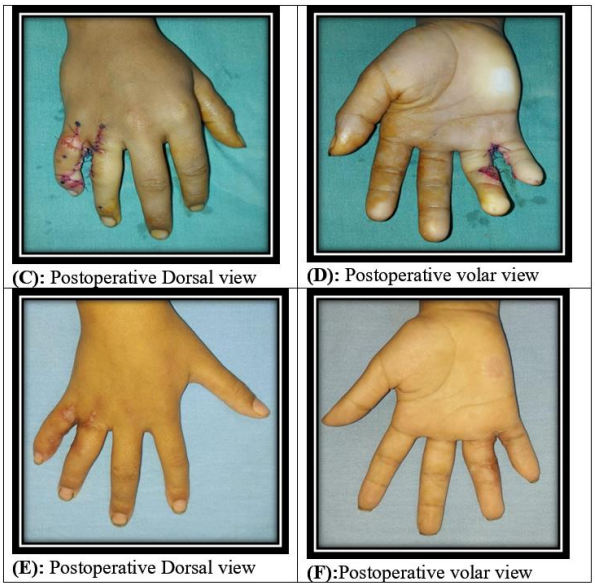


Figure 1. Photos of case 1

3.2.Case 2

Incomplete simple syndactyly lt ring/middle fingers operated on using the hexagonal flap without skin graft

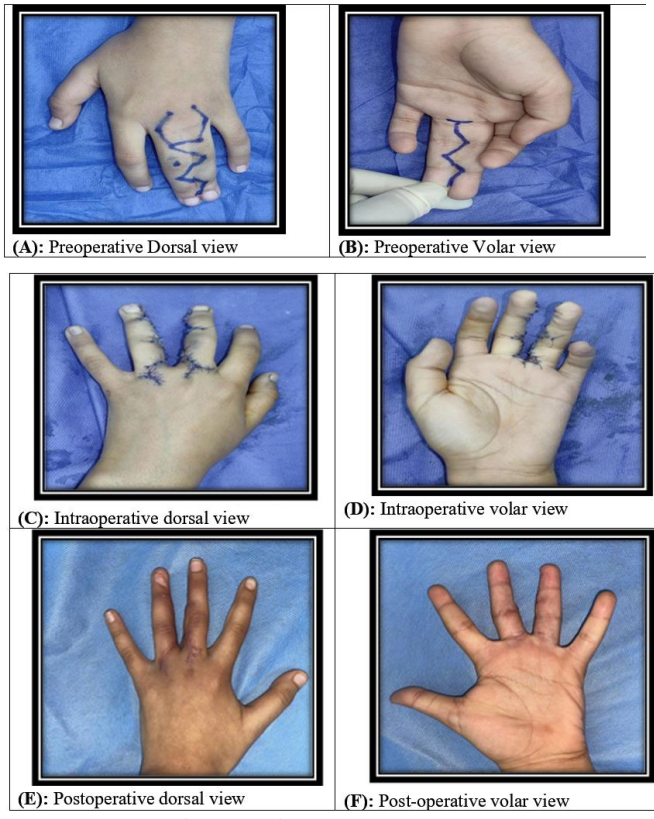


Figure 2. Photos of case 2

4. Discussion

The demographic data of the studied groups, including age, sex, weight, height, and BMI, showed no significant differences ($p > 0.05$). In group A, the mean age was 16.8 ± 3.65 years, 60% were men, the mean weight was 20.1 ± 3.28 kg, and the mean BMI was 25.3 ± 3.02 kg/m2. While in group B, the mean age was 15.6 ± 3.86 years, 70% were male, the mean weight was 19.2 ± 2.66 kg, and the mean BMI was 24.1 ± 2.91 kg/m2.

In a similar previous study, Liu et al.[9] modified the hexagonal advancement flap involving two wings on each side, resulting in a "plane-shaped" flap. The technique was applied to twenty-four cases of syndactyly in twenty youth cases, ranging in age from 1.5 to eight years, with an average age of 2.5 years. The two groups did not significantly differ regarding the degree of syndactyly or whether it was bilateral or unilateral ($p > 0.05$). In group A, there were 5 (50%) bilateral, 5 (50%) unilateral, 7 (70%) complete, and 3 (30%) incomplete syndactyly. In group B, there were 6 (60%) bilateral, 4 (40%) unilateral, 8 (80%) complete, and 2 (20%) incomplete syndactyly.

Liu et al.[9] investigated twenty children with syndactyly who underwent reconstruction using a dorsal hexagonal flap. This included ten cases of complete syndactyly, six cases of incomplete syndactyly in the 3rd web space, and four cases of incomplete syndactyly in the 2nd web area. Out of the total number of cases, syndactyly was present on one side in sixteen cases and on both sides symmetrically in four patients.

The mean operative time was significantly greater in group A compared to group B (2.13 ± 0.10 vs. 1.39 ± 0.08 hours; $p<0.001$).

Furthermore, our findings were consistent with those of Jasim and Naji,[10] who noted that the average operation time was 60 minutes, with an average follow-up period extending to 6–12 months postoperatively.

There were no significant differences among both studied groups regarding web creep, flexion contracture, and the need for a second operation; the p-values were 0.26, 0.60, and 0.56, respectively.

In a previous study conducted by Jasim and Naji,[10] among 10 patients were enrolled in the study. Six patients showed satisfactory results regarding an aesthetically acceptable web space with near-normal inclination and no web creep, flexor contracture, or digital angulations. Three cases out of ten had complications, including superficial sloughing of the flap, hypertrophic scars on the flap donor site, and web space creeping. Applying the traction device to 31 web spaces that had to creep after a burned hand resulted in a remarkable improvement in the cohort. However, 22% had developed creeping due to poor patient adherence to this method.

Additionally, Yoon and Jones,[11] reported ten minor complications, including partial skin graft loss, minor distal interphalangeal joint flexion contractures, skin graft donor site dehiscence, an d a single case of minor web creep.

The average follow-up period was twelve months. All parents reported satisfaction with the functionality and appearance of their child's restored digits without requiring more surgical procedures.

In a study by Jasim and Naji,[10] adding two triangular wings to each side of the hexagonal advancement flap provided adequate defect coverage of both sides of the digits with a near-normal configuration of the webspace. No skin graft.

Farhadieh R et al.[12] noted that, in general, skin grafts are usually needed in all cases of syndactyly (except in minor cases), as even in the simple type of syndactyly, the skin shortage was at least thirty-six percent of the circumference.

Niranjan et al.,[13] suggested that using skin grafts in webspace reconstruction is associated with a high risk of web creep because it reduces intrinsic growth potential, and the skin graft, in contrast to the flap, does not grow with the child.

Due to the complications associated with using skin grafts in webspace reconstruction to repair syndactyly surgically, Tian X et al.,[14] introduced different local flaps for web reconstruction. The basic idea is to rearrange local tissue as a flap to gain more skin and more distally placed tissue for Webspace reconstruction.

In our study, the distribution of patients in group A according to graft take was observed to be 90% of patients with complete graft and 10 % with partial graft.

4. Conclusion

The hexagonal and rectangular advancement flaps are effective techniques for releasing simple and complex syntactically, offering advantages such as easy learning, intraoperative modification, and wide tips to prevent flap tip necrosis. However, these findings require confirmation by a larger, more powerful study with a larger sample size.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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