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Original Research Article

Management of syndactyly: a clinical study

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ABSTRACT

Background: Syndactyly is a congenital anomaly, basic principles of surgical release of syndactyly have been well established, each patient requires a thorough assessment of the soft-tissue and bony components in the syndactylized region. Reconstruction must be planned carefully when more than two digits are involved or when the syndactyly is a component of a systemic congenital syndrome. The aim of the treatment strategies for syndactyly is to separate the fused digits, create a functional hand, and produce an aesthetically acceptable web.
Methods: The prospective clinical study is conducted in the Department of Plastic & Reconstructive surgery, between October 2016 to October 2018. Twenty six patients with congenital syndactyly and post burn syndactyly of fingers were included in this study.
Results: There were no intra operative complications and no cases had any neurovascular compromise**.** Integrity of Dorsal and volar flaps, quality of scars, aesthetical aspects of fingers are reasonably good in almost all the cases that are operated in this study. Overall 97% of patients treated achieved good function and superior results following single surgery.
Conclusions: Primary syndactyly is more common than secondary syndactyly. In this study the primary goal is separation of fused digits/toes and covering the web space with dorsal flap, and covering the separated digits/ toes with a graft and create a functional hand and produce an aesthetically web with fewest complications and fewest surgical corrections.

Keywords: Primary syndactyly, Reconstruction, Dorsal rectangular flap

INTRODUCTION

The human hand is a miraculous instrument that serves us extremely well in a multitude of ways. We successfully use our hands to identify objects and to extract a wealth of information about them, such as their surface texture, compliance, weight, shape, size, orientation, and thermal properties. We demonstrate impressive manual dexterity when reaching for, grasping, and subsequently manipulating objects within arm's reach. Manual gestures, such as those used in sign language and finger spelling, collectively offer valuable forms of communication to those who are deaf or hearing impaired. Finally, the human hand serves as a formidable creative tool in a variety of aesthetic milieus that include dance, sculpture, playing music.

Syndactyly is a congenital anomaly that may be the most common or second most common hand malformation.[1] The incidence of syndactyly is uncertain, but estimates range from 1 in 2,000 to 1 in 3,000 live births.[2] In normal development, the fingers are webbed until apoptosis and skin recession allow for formation of the digital interspaces. Full interdigital spaces are usually present by the end of the 6th week of gestation. It may hinder hand function if not corrected appropriately during infancy. Although the basic principles of surgical release of syndactyly have been well established, each patient

requires a thorough assessment of the soft-tissue and bony components in the syndactylized region. Reconstruction must be planned carefully when more than two digits are involved or when the syndactyly is a component of a systemic congenital syndrome.

Congenital syndactyly has a strong familial tendency, and is usually bilateral more commonly in males, and is most often seen in the third web space. It can be either primary or secondary, the former being due to a failure of differentiation or separation. Secondary syndactyly is a result of antecedent events and is produced by refusion abnormality. Syndactyly may present as the sole abnormality or may be associated with other syndromes like Poland's, Cleft hand or Apert's. Separated digits, however, have a greater surface area than syndactylized digits and generally skin grafts are used to cover the raw areas, with some morbidity. The treatment strategies for syndactyly is to separate the fused digits, provide cutaneous cover and create a normal web space with a functional hand, and produce an aesthetically acceptable web with the fewest complications and the fewest surgical corrections.[3] The trilobed flap technique, or a dorsal triangular flap, or a dorsal rectangular flap, or a combination of interdigitating dorsal and volar triangular flaps may be used to treat syndactyly to reconstruct the web, although these techniques can obtain good results, these techniques need to be specially designed, as recurrences with more serious scars are common.[4] Recently, some authors have started using new techniques to reconstruct the web space and resurface the fingers without skin grafts. In our study we presented different types of syndactyly managed by different flap techniques and their surgical outcome.

METHODS

The prospective clinical study is conducted in the Department of Plastic and Reconstructive surgery, Osmania general hospital, Hyderabad in the period between October 2016 to October 2018. Twenty six patients with congenital syndactyly and post burn syndactyly of fingers were included in this study.

Inclusion criteria

All cases from age group 1 to 60 years of congenital syndactyly and syndactyly due to burns (post burn syndactyly).

Exclusion criteria

Patients unfit for anesthesia, patients not willing to participate in the study.

Syndactyly repair has no gold standard operation. However, all methods employ a common set of techniques such as dividing the fingers, commissure reconstruction and resurfacing borders of the separated digits that any surgeon must be comfortable with before attempting a repair. The study was approved by the Institutional ethical committee of our institution.

Once the patients come to the Outpatient department – clinical assessment done, work up and thorough analysis for other anomalies were ruled out, pre anesthetic evaluation for surgery done, patient parents are counseled in detail regarding the operative procedure, complications, prognosis and further management.

Patients' demographic information, including age and sex, and the clinical features of syndactyly were evaluated, including features such as partial or complete, simple or complex, and unilateral or bilateral involvement. In nonsyndromic cases, the involved web distribution was analyzed. Functional outcome and postoperative complications such as web creep, scar quality, flexion contractures, angulation deformity and functional outcomes were assessed.

Preclinical assessment for syndactyly surgery

Clinical examination provides an overview of the extent of involved fingers. Closer clinical examination will make it possible to distinguish between simple, complex and complicated syndactyly. The presence of an active range of motion in the interphalangeal joints with well-defined flexion and extension creases indicates normal joint anatomy and simple syndactyly.

Plain X-ray examination of the affected hand is done in the primary assessment to reveal any synostoses, hidden polydactylies or other skeletal deformities, and is particularly important in complex syndactylies. Complete blood picture and necessary investigations needed for anaesthesia are done for surgery.

Syndactyly surgical steps are as commissure is designed dorsally to have its medial and lateral base borders at the mid sagittal line of the contiguous digits, starting at the metacarpophalangeal joints. Distally, the bases of the flap are tapered slightly toward each other to accommodate the width of the proximal phalanges on either side after the flap is inset. Making the flap length approximately two thirds the length of the proximal phalanx provides a palmar commissure edge approximately. One third the length of the proximal phalanx, once the flap is inset. The distal border of the flap is marked like a rectangle or with slightly inverted v-shaped like a projection to minimize scarring at the commissure border between the dorsal and palmar skin. A reciprocal V-shaped incision is then marked on the palmar surface of the proposed new web space to accommodate this flap. It is important that the created commissure slope in the proximal-dorsal to distal-palmar direction. Starting at the distal tip of the dart, the dorsal incision is extended in a zigzag fashion from the mid sagittal line of one digit to that of the adjacent digit. If two separate nails are present, the dorsal incision is extended distally, bisecting the two fingertips. In a complex syndactyly, the nail matrix and nail bed is

divided in line with the division of the distal phalanges. The nail bed, matrix, and nail may be narrowed in preparation for coverage with a double flap. The palmar incision for the syndactyly release is drawn by visually projecting the apices of the dorsal zigzag flaps to the palmar mid sagittal line of each digit. These marks become the geometric center of the bases of the corresponding flaps to be designed on the palmar side. The palmar zigzag incision is then drawn. Proximally, this line meets the center of the previously drawn V-shaped palmar anchor line, which is located approximately at the junction between the proximal and middle third of the proximal phalanges. The incision is first taken distally between the nails, then palmary. The interdigital soft tissue is carefully divided to protect the neurovascular structures. If the common digital nerves and arteries bifurcate proximal to the new commissure, as is commonly the case, they are not separated and will not impede in setting the dorsal commissure flap. The digital nerves are carefully separated from distal to proximal. the digital arteries bifurcate distally, the smaller of the two arteries can be ligated if there is only a simple web space syndactyly, because both digits still will have an arterial supply based on the opposite side of the finger.

When a central digit has syndactyly on each side (e.g., index-middle ring finger syndactyly), the digital artery supplying the side digits bordering the middle finger may be ligated because they also will have one remaining digital arterial supply ulnarly or radially. Syndactyly of the central digit is less an issue when both sides of the digit are not operated on simultaneously. Alternatively, clamp a vessel, deflate the tourniquet, the resultant blood flow is evaluated before ligating the artery in question. Vascular complications are rare when only one side of a digit is operated on at a time. Before securing the flaps, excess subcutaneous fat is trimmed until only approximately 1 to 1.5 mm of thickness remains. This decreases postoperative edema and the risk of a tight closure. Tight closure is avoided to minimize flap necrosis. Usually one finger may be closed completely with skin flaps, whereas the other requires an FTSG. Harvesting the FTSG lateral to the femoral artery prevents future pubic hair growth on the flaps. Other donor sites include the antecubital fossa and the medial aspect (i.e., instep) of the foot.

Care must be taken to obtain an accurate template of the total area of skin defect to be covered. This template is transferred to the proposed donor site before harvesting the FTSG. The skin graft also requires defatting before being applied to the digits to prevent fat necrosis and graft loss. The dressing consists of paraffin gauze, flavine wool soaked cotton wool, gauze, soft undercast padding, an above elbow soft club cast with the elbow flexed past 110° should be used to protect the fingers from excessive motion while the skin graft is consolidating and crepe bandage. A sleeve made of elasticated tubular bandage is used to secure the arm to the chest in children under 3 years old. As a final check, the vascularity of the digits must be evaluated before casting to ensure that the gauze placed between them will not constrict arterial flow.

Postoperative care to allow the wound to be examined, the cast can be changed at 10 days and then reapplied for 1 week or more. Examination of the wounds can be delayed for 3 weeks if no signs of infection are present. Other than careful attention to the postoperative dressing and immobilization, most children do not require extensive therapy after the 2 to 4 weeks of immobilization required for wound healing. This is also true for aftercare of complex syndactyly reconstruction.

Postoperative complications

The most common acute postoperative complications of syndactyly repair are related to skin infection and necrosis, graft failure, and scar contracture related to a child's activity or lack of immobilization. These often require resurfacing with another graft and debridement. Long-term complications include web creeping, skin graft dysmaturation, keloid formation, and joint instability/deformity. "Web creeping" is the recurrence of abnormal webbing between digits that occurs because of scar contracture at the base of attachment or along incision lines.

Statistical analysis

Data were entered into excel spreadsheets and then managed with SPSS using descriptive methods: Mean, standard deviation for numerical variables, percentages, frequencies for all categorical variables.

RESULTS

There were 37 patients in this study; all patients having syndactyly were operated. The analysis of study of 37 Patients as follows:

Table 1: Demographic distribution in present study.

Variable	Number of patients	Percentage (%)
Sex		
Male	18	48.64
Female	19	51.35
Total	37	100
Age in years		
1 to 20	30	81
21-40	5	13.5
41-60	2	5.5
Type of syndactyly		
Primary/congenital	28	75.6
Post burn	7	18.9
Post traumatic	2	5.4
Form		
Simple syndactyly	32	86.48
Complex syndactyly	5	13.5

Of 37 cases of this study 18 were men while 19 were women. The ratio of male:female was 1:1.

Majority of the patients belong to age group 1 to 20 years, as most of the patients presented to us are congenital syndactyly and they are operated at an early age. Majority (75.67%) of them presented as congenital syndactyly.

Of 37 patients in this study, 32 (86.48%) patients have simple syndactyly and 5 (13.5%) have complex syndactyly.

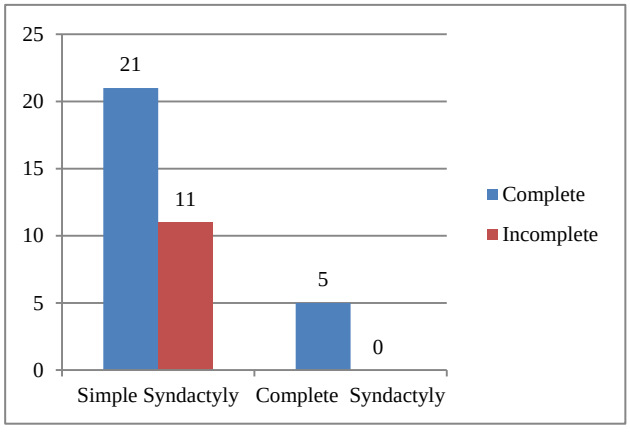

Figure 1: Complete and incomplete syndactyly distribution.

Table 2: Distribution of syndactyly in hand.

Distribution	Number of patients	Percentage (%)
Affected hands		
Right hand	15	40.54
Left hand	9	24.32
Both hands	8	21.62
No hand syndactyly	5	13.51
Affected foot		
Right foot	3	8.1
Left foot	1	2.7
Both foot	1	2.7
B/L foot & hand	2	5.4
Total	7	18.91

Of the 37 patients treated in this study, 15 (40.54%) patients presented with isolated right hand syndactyly. Of the 37 patients treated in this study, 7 (18.91%) patients presented with syndactyly of foot.

Of the 37 patients there are 63 webs that are affected with syndactyly. Of the 63 webs effected both right hand (27 webs) and left hand (26 webs) almost have equal distribution. And also right foot (6 webs) and left foot (4 webs) have also similar in distribution. In foot syndactyly first and second web spaces are most commonly involved.

Table 3: Various surgical procedures for syndactyly finger/toe correction.

Type of procedure	Number of syndactyly webs operated (n= 51)	Percentage (%)
Dorsal rectangular flap	26	50.98
Dorsal double wing flap	8	15.68
Dorsal flap with a slit	7	13.72
Dorsal bilobed flap	8	15.68
Four flap z plasty	**2**	3.92

Of all the various surgical procedures performed for syndactyly finger release and web correction, most commonly done in this study is dorsal rectangular flap method.

Table 4: Postoperative complications- syndactyly surgery.

Postoperative complications	Number of webs involved N (%)
Skin infection	Nil
Necrosis of flap	Nil
Graft loss(partial/total)	4 (6.34)
Web creep	2 (3.17)
Hypertrophic scar	3 (4.76)
Hyper pigmentation of graft	3 (4.76)
Contracture	6 (9.52)

All the patients followed up to 6 months, 9 patients followed up to 3 months.

Postoperative complications such as skin infection, necrosis of flap, graft loss, web creep, contracture, hypertrophic scar, hyper pigmentation of skin graft, recurrence were assessed over period of 3 to 6 months. Partial graft loss is seen in three web spaces, for which would left alone and healed by secondary intention. Total graft loss seen in one web space for which regrafting is done.

There were no intra operative complications and no cases had any neurovascular compromise**.** The overall results are considered good, except few webs with complications. The integrity of dorsal and volar flaps, quality of scars, aesthetical aspects of fingers are reasonably good in almost all the cases that are operated in this study.

DISCUSSION

The overall goal of syndactyly release is to produce a hand with as many independent and functional digits as possible with the fewest number of surgical corrections

and complications. Many techniques have been described to accomplish this goal. The methods have differed in respect of separation of the digits and reconstruction of the web space. It is accepted that long-term stability of the newly created web space is best achieved when the web space is reconstructed using a flap. Traditional surgical approaches to syndactyly repair have used flaps from the dorsum of the involved fingers and dorsal and palmar interdigitating flaps.

Sex distribution

Among 37 cases of this study 18 patients (48.64%) were men while 19 patients (51.35%) were women. The ratio of male: female is 1:1. Dong et al reported the sex distribution in their study conducted on 24 patients with 35 web repairs as male : female ratio is 2:1.[5] Tuma et al reported the sex distribution in their study conducted on 30 patients with 37 webs space repair, 12 patients were male and ten patients were female, so male to female ratio is 1:1.[6] Jose et al reported that 221 web spaces were operated on 102 patients and the male to female ratio in their study was 1:1.7.[7] Lida et al reported in their study for reconstruction of toe syndactyly the male to female distribution is 1:1.[8] Overall there so no significant gender predominance in syndactyly among the case series reported by various authors in different studies when compared to this study.

Age distribution

In this study the youngest patient who was treated is 1 year old and the oldest patient was 55 years old. Average age of patient who was treated is 12.7 years of age. Majority of the patients belong to age group 1 to 20 years (30 patients out of 37 patients), as most of the patients presented to us are congenital syndactyly and they are operated at an early age. In age groups 21-40 (5 patients out of 37 patients), 41-60 years (2 patients out of 37 patients). Dong et al reported in their study conducted on 24 patients with 35 web repairs, the youngest patient is of 5 months of age and the oldest of 35 months of age with a mean age 16.7 months presentation.[5] Tuma et al reported in their study conducted on 30 patients with 37 webs space repair, age varied from 8 months to 21 years old, with a median of 4.8 years.[6] Jose et al reported that 221 web spaces were operated on 102 patients, age of the patients at the time of operation ranged from 6 months to13 years old with an average of 2.7 years.[7]

Lida et al reported in their study for reconstruction of toe syndactyly, age of the patients at the time of patients ranged from 8 months to 11 months, with an average of 10 months.[5] The reason for diversity in the age distribution depends on various factors like age of presentation of the patient to the hospital, etiology of the syndactyly, as congenital syndactyly are presented at the earlier age where as majority of the patients with post burn /post traumatic syndactyly presented at later age.

Type, classification of syndcatyly in hand

In this study out of 37 patients who are treated, 28 patients (75.67%) presented with congenital syndactyly, 7 patients (18.91%) presented with post burn syndactyly, 2 patients (5.4%) presented with post traumatic syndactyly. Of 37 patients in our study, 32 (86.48%) patients have simple syndactyly and 5 (13.5%) have complex syndactyly. Of 32 patients with simple syndactyly, 21 (56.75%) patients have complete syndactyly and 11 (29.72%) have incomplete syndactyly of their fingers. Of 5 patients with complex syndactyly, all the 5 (13.51%) patients have complete syndactyly and none have incomplete syndactyly of their fingers. Dong et al in their study conducted on 24 patients with 35 web repairs, all the patients were presented with congenital simple syndactyly, 12 patients presented with incomplete syndactyly and 23 patients presented with complete syndactyly.[5] Tuma et al in their study conducted on 30 patients with 37 webs space repair reported that all were primary congenital syndactyly patients, 8 patients (36.4%) presented with simple syndactyly of them 6 patients (27.3%) presented with complete syndactyly and 2 patients (9.1%) presented with partial syndactyly.[6] 14 patients (63.6%) presented with complex syndactyly of them 14 patients (63.6%) presented with complete syndactyly.

Jose et al reported that 221 web spaces were operated on 102 patients.[7] Of them 15 patients presented with simple incomplete syndactyly, 39 patients presented with simple complete syndactyly, 25 patients presented with complicated syndactyly. Syndactyly is heterogenous in presentation so there is a wide variation in presentation of syndactyly to the clinician and its etiology primary/ secondary differentiates various modes of presentation at different intervals od time to clinician.

Distribution of syndcatyly in hand

Of the 37 patients treated in this study, 15 (40.54%) patients presented with isolated right hand syndactyly. 9 (24.32%) patients presented with isolated left hand syndactyly, 8 (21.62%) patients presented with syndactyly of both hands. 5 (13.51%) patients out of 37 presented without involvement of hands. Of the 37 patients there are 63 webs that are affected with syndactyly. Of the 63 webs effected both right hand (27 webs) and left hand (26 webs) almost have equal distribution.

Dong et al in their study conducted on 24 patients with 35 web repairs reported 11 patients with syndactyly involving both hands and 13 patients with syndactyly of unilateral hands.[5] Tuma et al in their study conducted on 30 patients with 37 webs space repair reported that 5 patients (22.7%) with right hand syndactyly, 8 patients (36.4%) with left hand syndactyly and 9 patients (40.9%) presented with bilateral syndactyly of both hands.[6] Jose et al reported that 221 web spaces were operated on 102

patients reported that right hand involved in 114 web spaces, left hand involved in 107 web spaces.[7] Syndactyly is heterogenous in presentation so there is a wide variation in presentation of syndactyly to the clinician. Most of the primary cases that present are bilateral in distribution and secondary syndactyly (post trauma/ post burns) usually are unilateral in presentation.

Distribution of syndcatyly in foot

Of the 37 patients treated in this study, 7 (18.91%) patients presented with syndactyly of foot. Of the 7 patients presented with foot syndactyly, 2 (5.40%) patients presented with associated hand syndactyly. 5 (13.51%) patients presented with isolated foot syndactyly. Of the 5 patients presented with isolated foot syndactyly, 3 (8.10%) patients presented with right foot syndactyly, 1 (2.70%) patient presented with left foot syndactyly and 1 (2.70%) patient presented with bilateral foot syndactyly. Lida et al in their study for reconstruction of toe syndactyly reported that 8 out of 4 patients (50%) presented with right foot syndactyly, 8 out of 2 patients (25%) presented with left foot syndactyly, 8 out of 2 patients (50%) with bilateral foot syndactyly.[8] Presentation of isolated foot syndactyly is very rare in primary syndactyly, majority of our cases of primary foot syndactyly are in association with hand syndactyly. Secondary foot syndactyly are isolated in presentation.

Distribution of syndactyly in affected webs of hands & foot:

Of the 37 patients there are 63 webs that are affected with syndactyly. Of the 63 webs effected both right hand (27 webs) and left hand (26 webs) almost have equal distribution. And also right foot (6 webs) and left foot (4 webs) have also similar in distribution. Most commonly involved web space in the right hand syndactyly is middle & ring finger syndactyly, followed by index & middle finger syndactyly. Most commonly involved web space in the left hand syndactyly is middle and ring finger syndactyly, followed by index, middle and ring finger syndactyly. In foot syndactyly first and second web spaces are most commonly involved.

Lida et al in their study for reconstruction of toe syndactyly reported that 7 out of 8 patients (87.5%) presented with second web toe syndactyly, 1 out of 8 patients (12.5%) presented with first web toe syndactyly.[8] The results of this study are in similar to our study. Jose et al reported that 221 web spaces were operated on 102 patients reported that most commonly involved web spaces in their study are middle and ring finger followed by index and middle finger.[7] The results of this study are similar to the results of our study. Dong et al in their study conducted on 24 patients with 35 web repairs reported that 24 web repairs are involving third web space, 6 web repairs are involving fourth web space and 5 web repairs are involving second web space.[5] Tuma et al in their study conducted on 30 patients with 37 webs space repair reported 12 webs (32.4%) involved third web space, 11 webs (29.7%) involved second web space, 7 webs (18.9%) involved first and fourth web spaces.[6]

Treatment of syndactyly with various procedures

Of the 37 patients in this study there are 63 webs involving both hands and foot. Of the 63 webs, 51 syndactyly web spaces operated involving both hands and feet. of all the various surgical procedures performed for syndactyly finger release and web correction, most commonly done in our study is dorsal rectangular flap method 26 (50.98%), dorsal double wing flap 8 (15.68%), dorsal flap with a slit 7 (13.72%), dorsal bilobed flap 8 (15.68%), four flap z plasty 2 (3.92%). Jose et al reported that 221 web spaces were operated on 102 patients, their results are based on combination technique of various flap procedures (palmar and dorsal flaps with zig zag incisions).[7]

Tuma et al in their study conducted on 30 patients with 37 webs space repairs reported use of rectangular flap techniques for simple syndactyly.[6] Dong et al in their study conducted on 24 patients with 35 web repairs reported the use of dorsal double wing flap.[5]

Upton reported 46 different methods used over the past two centuries.[1] The intent with each is to produce a web space commissure that is both deep and wide to cover the remaining sides of the digits with as much local soft tissue as possible and to cover any remaining skin deficits with skin grafts.

Postoperative complications and results

Of the 51 webs operated among 37 patients postoperative follow up done, 28 patients followed up to 6 months, 9 patients followed up to 3 months. Postoperative complications such as skin infection, necrosis of flap, graft loss, web creep, contracture, hypertrophic scar, hyper pigmentation of skin graft, recurrence were assessed over period of 3 to 6 months. Partial graft loss is seen in three web spaces, for which would left alone and healed by secondary intention. Total graft loss seen in one web space for which regrafting is done. Hypertrophic scar is seen in three web spaces (4.76%). Post burn syndactyly cases that were operated developed contractures in 6 web spaces (9.52%), these patients were sent for counseling and physiotherapy of limbs. Hyper pigmentation of graft is seen in three web spaces (4.76%). None of the flaps got necrosed.

Dong et al in their study conducted on 24 patients with 35 web repairs reported that the average follow up period was 4.6 years (range 6 months to 5 years).[5] There were no complications such as hematoma, infection or flap necrosis. One of the 35 webs developed web creep (overall incidence of 3%). My study has similar results with this study except in the follow period, where my follow up period is 3 months to 9 months. Jose et al

reported that 221 web spaces were operated on 102 patients, the follow up period ranged from 6 months to 4 years with a mean follow up of 2 years.[7] Web space creep was noted in 12 web spaces (5%). Lida et al in their study for reconstruction of toe syndactyly reported no complications in the 8 cases they operated.[8] Tuma et al in their study conducted on 30 patients with 37 webs space repair reported skin graft loss in 2 web spaces (9.1%), recurrence in 1 web space (4.5%) with overall good results in 19 web spaces (87%).[6]

CONCLUSION

This study concludes that primary syndactyly is more common than secondary syndactyly. The most common causes of secondary syndactyly are post burn and post trauma. Complication rate was relatively less and minimal in this study. Functional restoration is achieved to the maximum and its aesthetic appearance was good. The use of no graft is more common, but this appears only to be of use in mild cases of simple syndactyly. Overall 97% of patients treated achieved good function and superior results following single surgery.

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