Syndactyly Repair with Dorsal Island Metacarpal Advancement Flap and Multiple Z Flaps

Hussein Mohammad Ali Baqer

Department of Plastic Surgery, Kirkuk General Hospital, Kirkuk, Iraq

Abstract:

Background: Skin grafting for syndactyly repair is time-consuming, and has high potential risks of scar contracture and web creep. The dorsal island metacarpal advancement flap for web space reconstruction in syndactyly with multiple Z flaps repair eliminates the need for skin grafts.
Methods: Between October 2014 to October 2017, dorsal island metacarpal advancement flap was used for web reconstruction in 26 syndactylies of 21 patients, their ages ranged from eight months to eight years. The patients were followed up for 2 to 4 years (mean: 2 years).
Results: The mean operation time was 60 min (range: 50-75 min). All incisions were closed primarily without skin grafting. There were 2 partial flap necrosis, 2cases of partial wound dehiscence, 1 case of dorsal metacarpal hypertrophic scar, 2cases of contractures and one case of web creep.
Conclusion: The use of dorsal island metacarpal advancement flap is reliable method for syndyctyly repair and it obviates the need for skin graft with less complication rate.
Keywords: Flap, Dorsal island metacarpal, Syndactyly, Web space.

Introduction:

Syndactyly is one of the most common congenital hand malformation with an incidence of 1 in 2000 live births [(1)], it describes a variable fusion of soft tissue, skeletal or both elements of adjacent digits [(2)], it is usually congenital due to failure of differentiation [(3)], and is thought to result from a failure of programmed cell death during six to eight weeks of development [(4)].

Although most cases of syndactyly arise spontaneously without family history, the deformity also exhibits an autosomal dominant pattern of inheritance with variable expressivity and this account for (15%) to (40%) of cases. Syndactyly is also associated with a number of limb and craniosynostosis syndromes, like Poland and Apert syndromes [(5)].

Boys are affected twice as girls, in isolated or sporadic cases the distribution of the frequency of web involvement is (50%) for third interdigital web space, (30%) for fourth interdigital web space, (15%) for second interdigital web space and the first interdigital web space is least frequently affected about (5%). While in syndromic cases, the first and second web spaces are relatively more frequently affected [(6)].

Syndactyly can be classified as incomplete (soft tissue only, not extending to the tip), complete (soft tissue only, extending to the tip), complex (with distal bone union) [(7)].

The aim of treatment in syndactyly is to separate the fused digits, provide cutaneous cover and create a normal web space, with minimal functional and long-term morbidity [(8)]. Syndactyly release can be performed from 12 months onwards, and reconstruction is best to be completed before the child is of school age [(9)].

The traditional method of repair over the past 60 years has involved the creation of dorsal rectangular flap with

interdigitating flaps and full-thickness skin grafts has the most widely used method [10].

Although this method of syndactyly repair has been used for decades, some practitioners believe that the incorporation of full-thickness skin grafts and the presence of the linear scar along the palmar border of the webspace are the leading cause of complications such web creep, partial graft loss, hyperpigmentation, hair growth, hypertrophic scarring and donor site morbidity [11].

More recently, a few methods have advocated for syndactyly repair that reconstruct the web space and resurface the fingers using local skin flaps alone and obviate the use of full-thickness skin grafts [12, 13].

By design, the dorsal island metacarpal flap has been advocated for use in syndactyly repair as a subcutaneous pedicled V-Y advancement flap, and it reduces the need for skin grafts [4, 10, 14].

The goal of this study is to review the results of using a modified version of the V-Y dorsal metacarpal flap in the treatment of congenital syndactyly of the hand.

Patients and Methods:

Between October 2014 to October 2017, 21 patients of sydactyly with 26 webs were conducted. The operations had been done in Kirkuk General Hospital. There were 15 males and 6 females, their ages ranged from eight months to eight years, the web space affected was third web (11 cases), second web (6cases), forth web (9 cases). 6 cases were bilateral syndactyly. 19 of the webs were simple type syndactyly (11 complete with 8 cases incomplete). The remaining 7 cases were complex type syndactyly.

Post burn syndactyly not included in this study.

Informed consent had been taken from the parents; all patients were sent for hematological and plain radiological investigations, figure (1) and anesthetic evaluation.

Operative Procedure:

Marking started at the dorsum of the hand, the center of each metacarpo-phalangeal joint were dotted, from which two dotted lines drawn along the fused fingers, these lines served a border line on which the triangular flaps for their sides were designed [4, 12, 14]. The marking is shown in figure (2).

The red dotted point in figure (2) is the central part of the island randomly based subcutaneous skin flap.

The dorsal side and palmar side flaps were designed with zigzag fashion in a mirror-image pattern in the first case figure (3 A and B) so the apex of each flap would lie at the center of the base of corresponding triangular flap at the dotted lines on the other side, the apex of each flap would not extend beyond the dotted lines [4, 12, 14].

The V-Y dorsal metacarpal flap is designed on the dorsum of the hand between the metacarpal heads of the involved fingers as a modification of the V-Y dorsal metacarpal flap described by Sherif figure (4), it is hexagonal shape, with a 3:1 length to width ratio. Its distal end is V shaped and laid at the level of the proposed web and the base of this V at the level of the metacarpo-phalangeal joint figure (2) [4, 10, 12].

The width of the flap made about 1 cm (4 mm to 11 mm), the length was ranging between 1-3 cm, according to the age of the patient. The middle portion of the flap can be narrowed slightly to be inset comfortably in the created web space [4, 10, 12]. At the palmar

aspect, a transverse line is drawn at 5 mm proximal to the depth of the proposed web space figure (3 B) [4].

After these markings, the arm exsanguinated and a tourniquet inflated, using loupe magnification, the fingers separated along the zigzag incisions. The V-Y dorsal island flap raised and mobilized distally. The fat between the proximal phalanges had been excised while avoiding injury to the digital neurovascular bundles figure (4).

The dorsal V-Y flap was advanced through the web space, 7 mm to 15 mm advancement can be done figure (5 A) [4] . Distal tip is sutured to the palmar skin to create the volar aspect of the web. The triangular flaps then wrapped around the newly separated fingers and sutured in place. The dorsal wound then closed in a V-Y fashion. There should be minimal or no tension at the flap insetting, undermining of the skin flaps were done in all cases.

The flap donor area closed primarily with simple interrupted or transverse mattress suture and other incisions were closed with simple interrupted sutures figure (5 B). The small gaps between the triangular flaps and the surrounding skin were left open to heal by secondary intension without any consequence.

Dressing consisted of three layers: inner layer was topical antibiotic ointment-impregnated gauze, followed by a layer of dry sterile gauzes, which covered the operated web and fingers, the outer layer was a bulky fluffy dressing put in between the repaired fingers which kept in maximal abduction, the dressing kept in place by some rolls of crepe bandage.

Postoperatively the hand must be kept elevated, antibiotics and analgesic drugs were administered. It is important to change the dressing on the first post-operative day and inspect the wound for the viability of the flaps. Then the patient will be checked as outpatient clinic weekly for three weeks. Then monthly up to six months, figure (6) show first case after 6 months.

The follow up of these patients included assessment of the incidence of the following postoperative complications; (1) infection, (2) full or partial flap loss, (3) wound dehiscence (4) Neurovascular bundle injury (5)web creep, (6) abnormal scarring (contractures, hypertrophic scars or keloid) (7) range of motion of the separated fingers (8) need for reoperation.

Results:

21 patients with 26 webs had been operated on by using dorsal Metacarpal Island V-Y advancement flap. The mean operative time was 60 minutes. Patient's age at the time of presentation ranged between eight months to eight years, with mean age 4 years, and the mean follow up was 2 years, the summary of the syndactyly types and percentages are shown in the table (1) below;

After follow up of mean period 2 years some of them about 4 years others about several months, the reconstructed web remained satisfactory in both appearance and function, and the anticipated complications are summarized in the table (2):

There were two of wound dehiscence happened after 5 days postoperatively, which were the possible cause of mild contracture that happened later on but no one of them operated again, there was a case of mild dorsal hand hypertrophic scar, also there was 2 cases of partial flap necrosis figure (8 E), and was treated by local wound care. Figure (7) shows the second case of simple syndactyly treated by the dorsal metacarpal island flap with skin graft.

Table (1): The number and the percentage of the syndactyly tape.

Syndactyly type	Simple		Complex
	Incomplete	Complete	
Number of patients	8	11	7
Percentage	30.7	42.3	26.9

Table (2): list of possible complications after syndactyly repair with the number of the involved patients.

Complications	No. of patients
Early	
Infection	0
Flap necrosis	2
Wound dehiscence	2
Neurovascular bundle injury	0
Late	
Web creep	1
Contracture	2
Hypertrophic scar	1
Abnormal range of movement	0
Need for re-operation	0

Figure (1): X-ray of case of a simple syndactyly.

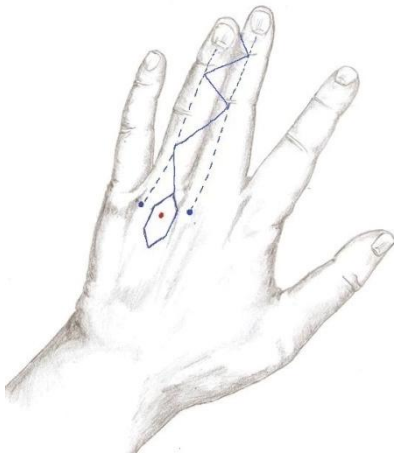

Figure (2): The marking of the dorsal metacarpal flap, the red dot represents the central part of the random island subcutaneous skin flap.

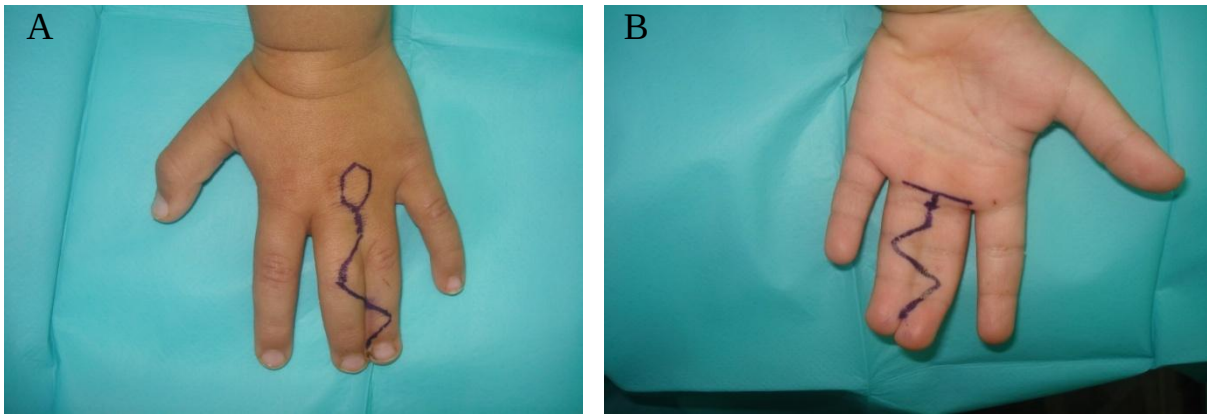

Figure (3): A: Marking of the dorsal metacarpal flap and zigzag flaps in the first case.
B: Marking of the volar zigzag flaps.

Figure (4): Fat parcels after defatting from proximal phalanx.

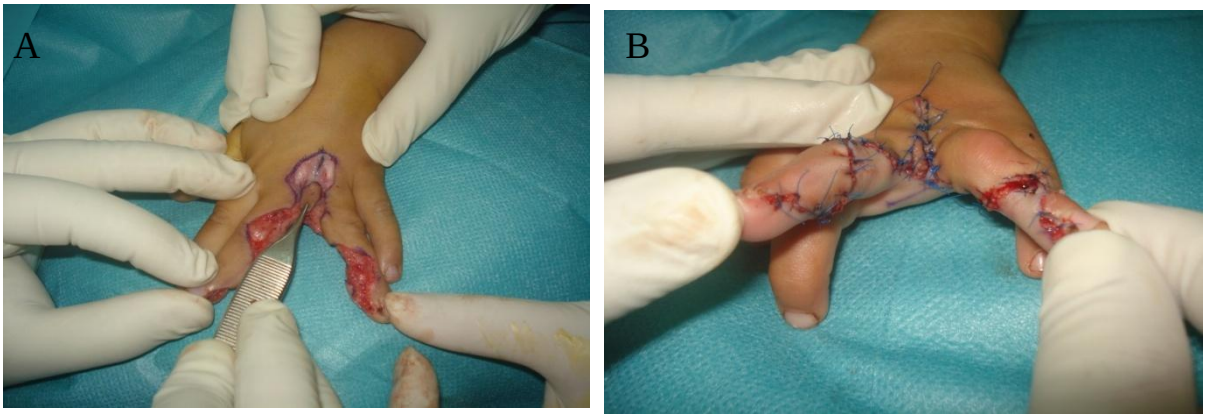

Figure (5): A: advancement of dorsal metacarpal flap to create a web- case number one.
B: Closure of the defect.

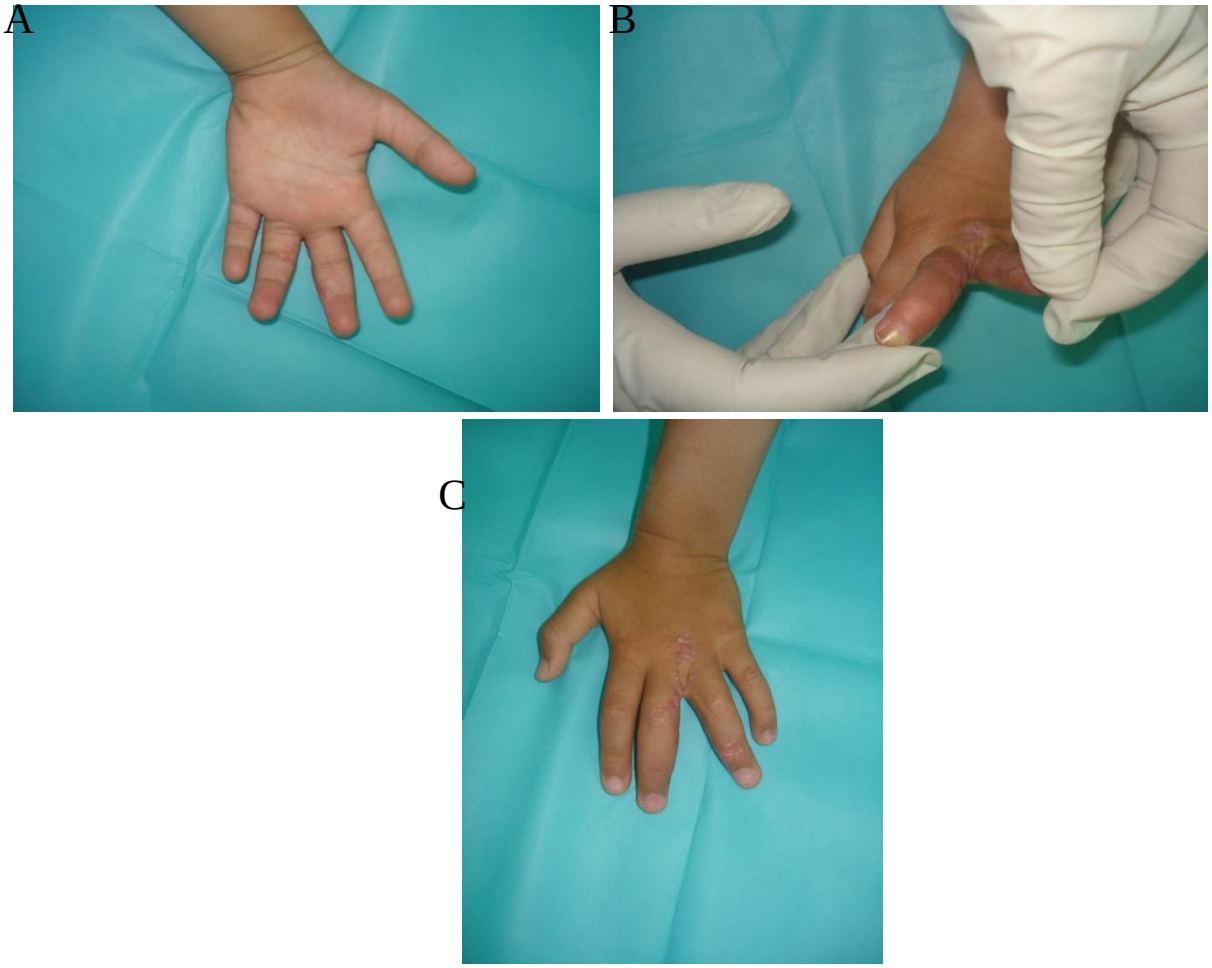

Figure (6): Show the same patient after six month
A: Palmar view.
B: Frontal view.
C: Dorsal view.

Figure (7): A: Marking of dorsal metacarpal flap and dorsal zigzag. **B:** Palmar zigzag flaps marking. **C:** Closing the flaps and the remaining defect with skin graft. **D:** After five days **E:** After five month - dorsal view **F:** After five months - palmar view

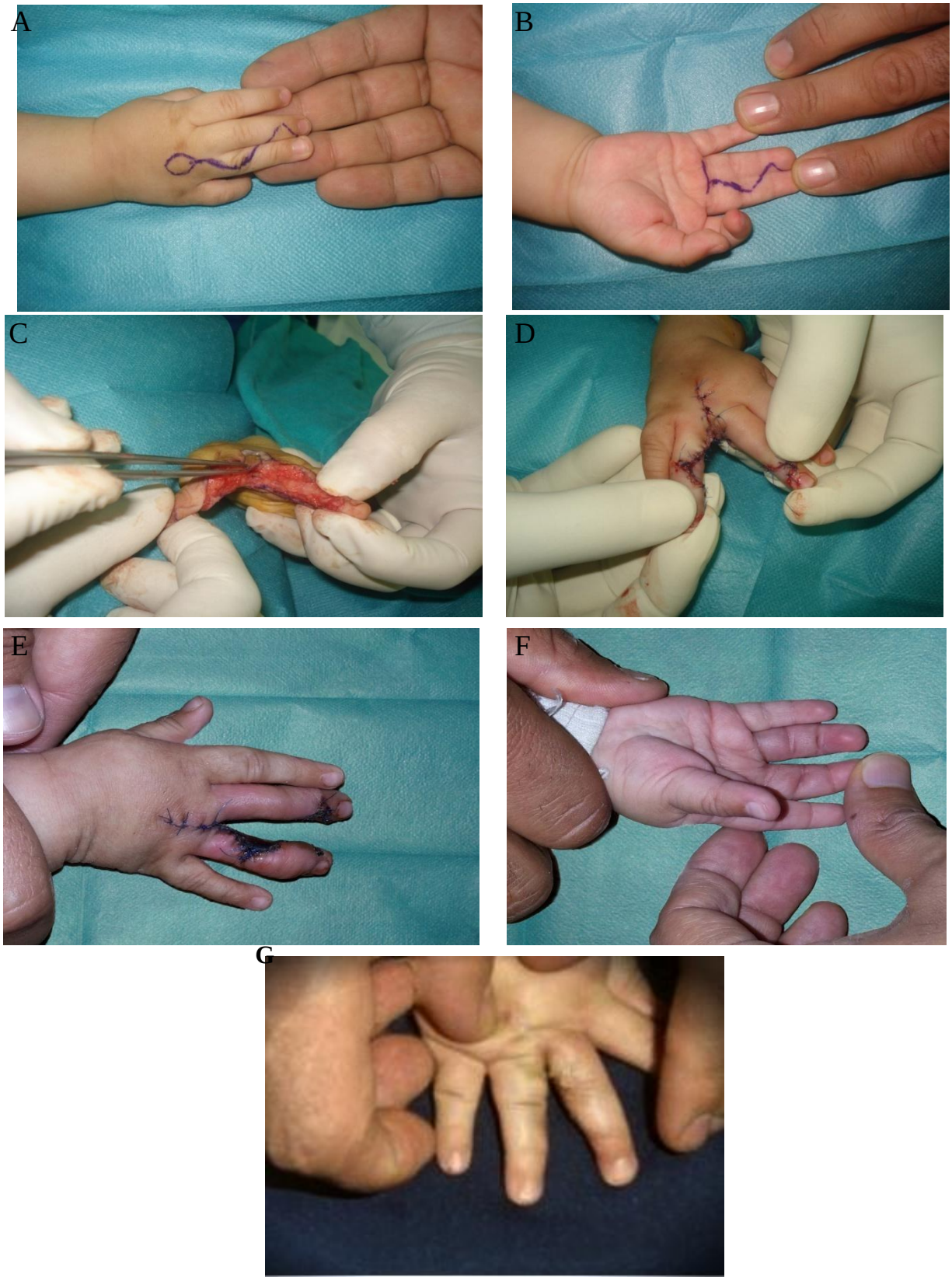

Figure (8): A: Marking of dorsal metacarpal flap and dorsal zigzag. B: Marking palmar view. C: Finger separation and advancement of dorsal metacarpal flap. D: Closure of the flap and the defect. E: Post operatively after six days F: After five months G: After eight months.

Discussion:

Long term stability of the newly created web space is best achieved when lined with well-vascularized native skin [3, 4, 10]. Traditional surgical approaches of syndactyly repair have used flaps from the dorsum of the involved fingers which are already insufficient in surface area; as a result, skin grafts have often been used to cover remaining surgical defects [4, 10]. The possibility of skin graft also high in the repair with V-Y advancement flap if the skin over the dorsum of the proximal phalanx of syndactylous finger is tight [14], Figure (8).

On the other hand, the linear scar along the palmar border of the web space may lead to secondary contracture and weep creep which is recurrence of the syndactyly distally beyond one quarter of the distance between the metacarpal joint and the finger tip, and modifications have been strongly recommended for this procedure [4, 15].

As the distal end of the flap is V shaped, this will decrease the maximal amount of stress applied on the flap more than when the distal end is straight line [11].

Several techniques had been introduced to facilitate closure without skin graft, one of them was using dorsal V-Y advancement flap for syndactyly repair which first advocated at 1998, in a study that included 21 cases of syndactyly and there where no complications like flap loss or web creep only one case developed hypertrophic scar. The flap had been designated originally as concave distal portion [10]. As a result, the bulk of the flap resides within the new web space, potentially limiting adequate advancement of the flap and making primary closure of the proximal phalanges of the newly separated fingers more difficult [4].

In another study which was conducted in U.S.A [4], from which our study had been cited, used a modified V-Y dorsal metacarpal flap for repair of syndactyly, a total of 28 syndactylies were included, 25 were simple incomplete and three simple complete, no skin graft needed, also web creep had been avoided by advancing the flap 5 mm distally and this agree with the concept and result of this study that had been made for elimination the needs of skin graft and web creep.

Similar study was conducted in Baghdad [16], dorsal V-Y metacarpal flap was used for the repair, but without making the palmar incision 5 mm proximally. They were operated 17 patients (19 webs), two out of the total patients had developed web creeping, such complication was not founded in this study.

By design, the dorsal V-Y flap reduces the need for skin grafting in syndactyly repair by using skin from the dorsum of the hand, rather than the proximal phalanges, to line the web. Because this is a local flap, it offers an excellent color, thickness, and texture match to the adjacent [4, 10, 12, 15].

Skin insufficiency and tightness over the dorsum of the syndactylus fingers create limitation for doing this procedure, as there is high possibility for skin graft requirement for the coverage of digits, so the time saved by doing this flap is negated by use of skin grafts. Additionally, a prominent dorsal scar is created [14].

Conclusions and Recommendations:

This is an evaluation study for assessing the reliability of the use of dorsal metacarpal advancement flap for treating simple syndactyly.

- This procedure of syndactyly repair is a simple and reliable for the reconstruction of web space in congenital simple syndactyly.
- This flap reduces the need for a skin graft, so the operative time will be reduced, the disadvantages of skin graft use like hair growth, donor site morbidity, contracture and web creep will be obviated. Skin tightness over the dorsum of the syndactylus fingers should be checked to measure the sufficiency of skin for repair and prediction for the need of skin graft for each case of syndactyly.
- This technique reduces the size of the graft if needed by recruiting more skin from outside the fingers, sparing more skin flaps for closure at the base of proximal phalanges.
- The use of this flap creates a new web with the same skin color and texture match to the fingers and dorsum of the hand.
- The disadvantage of this procedure is the presence of a scar over the dorsum of the hand.
- Conduct further evaluations and researches to compare this current study procedure and the outcome of its complications with traditional dorsal rectangular procedure of syndactyly repair.

References:

[1]. Neligan PC.Plastic Surgery. 3rd ed. Saunders: Steven E .R. Hovius; 2013 .Vol. VI, Chapter 28, Congenital Hand (Disorders of Differentiation and Duplication); P. 604.

[2]. Chopra, Karan et al, Kashyap K.Tandisina, BS, Devinder P. Singh, MD. Syndactyly Repair. Eplasty. 2013; 13: ic51.

[3]. Ahmed, Humayun BA; Akbari, Hossein MD; Emami, Abdolhasan MD; Akbari, Mohammad R. MD, PhD. Genetic Overview of Syndactyly and Polydactyly. November 2017 - Volume 5 - Issue 11.

[4]. Hsu V, Smartt J, Chang B. The Modified V_Y Dorsal Metacarpal flap for Repair of Syndactyly without Skin Graft. Plast Reconstr Surg. 2009, Aug, 3; 125(1): 225 – 32.

[5]. Mathes SJ, Hentz VR. Mathes Plastic Surgery. 2 nd ed. Saunders: Joseph Upton III; 2006. Vol. VIII, Chapter 204, Management of disorder of separation-syndactyly; p. 141.

[6]. Deng H, Tan T Advances in the Molecular Genetics of Non-syndromic Syndactyly. Curr Genomics v.16(3); 2015 Jun PMC4460222.

[7]. Sajid Malik, Syndactyly: Phenotypes, Genetics and Current Classification, *European Journal of Human Genetics* volume20, pages817–824 (2012) doi:10.1038/ejhg.2012.1.

[8]. Dao K, Shin AY, Bilinges A. Surgical Treatment of Congenital Syndactyly of the Hand. 1 st ed. Saunders: J Am Acad; 2004. Orthopedic Surgery; P. 39-48.

[9]. Tara L. Braun, BS, Jeffrey G. Trost, BS, and William C. Pederson, MD. Syndactyly Release. Semin Plast Surg. 2016 Nov; 30(4): 162–170.

[10]. Miyamoto J, Nagasao T, Miyamoto Sh, Biomechanical Analysis of Surgical Correction of Syndactyly. *Plast. Reconstr. Surg.* 2009, Sep, 17; 125 (3): 965.

[11]. Sullivan MA, Adkinson JM, A Systematic Review and Comparison of Outcomes Following Simple Syndactyly Reconstruction With Skin Grafts or a Dorsal Metacarpal Advancement Flap, J

Hand Surg Am. 2017 Jan; 42(1):34-40.e6. doi: 10.1016/ j.jhsa.2016.11.006.
[12]. Liu J1, Zheng H2, Chen Z3, Dai X4, Schilling AF4, Machens HG, Dorsal plane-shaped advancement flap for the reconstruction of web space in syndactyly without skin grafting: A preliminary report. J Plast Reconstr Aesthet Surg. 2015 Nov; 68(11): e167-73. doi: 10.1016/j.bjps. 2015.06.016. Epub 2015 Jun 27.
[13]. Chung KC. Hand and Wrist Surgery. 2 nd ed. Saunders: Jennifer Waljee, Sandeep J. Sebastin, and Kevin C. Chung; 2012 .Chapter 6, Syndactyly Release; P 332 – 45.
[14]. Feng Ni, MD , Hailei Mao , MD , Xi Yang , MD, Shengbo Zhou , MD, Yongkang Jiang MD, Bin Wang , MD, PhD. The Use of an Hourglass Dorsal Advancement Flap Without Skin Graft for Congenital Syndactyly.J Hand Surg Am. 2015; 40 (9): 1748 – 1754.
[15]. Attiyah AN. Evaluation of the Use of the Dorsal Metacarpal Artery Island Flap for the Treatment of the Simple Congenital Syndactyly [FICMS]. Baghdad: 2012'.