

Local and Regional Flaps in Thumb Reconstruction

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ABSTRACT

Background: The thumb represents a critical role in overall hand function particularly by pinching and grasping thus, representing about 40% of actual hand function.

Objective: Evaluation of different local and regional flaps in thumb reconstruction regarding function, sensation and aesthetic outcome.

Patients and methods: The study included 20 patients with thumb defect admitted to Al-Azhar University Hospital in New Damietta for prospective cohort study.

Results: Homodigital island flap was used in two cases (10 %), this type of flap proved to have excellent cosmetic and sensory results very close to FDMA flap, with privilege over FDMA flap in large defects where Homodigital flap proved to be better and provided adequate skin coverage. The flap was reliable, with good vascular and sensory supply, and provided thumb reconstruction in a single stage. 8 cases (40%) by volar advancement flap. Moberg flap was used in 8 cases. The flap was reliable, with good vascular and sensory supply, and provided thumb reconstruction in a single stage. This flap was found to be sufficient to cover no more than the distal one third of the distal phalanx of the thumb. Minimal flexion limitation at the interphalangeal joint occurred then returned to normal in all patients. Postoperatively, no flap loss occurred.

Conclusion: V-Y, The Moberg's flap, cross finger flap, the first dorsal metacarpal artery flap and homo-digital island flap. The volar advancement flap (Moberg's Flap) is the simplest and easier sensate flap used for reconstruction of thumb defects in distal third of distal phalanx less than one centimeter.

Keywords: Thumb Reconstruction, VY flap, Moberg flap, Cross-finger flap, Littler's neurovascular island flap.

INTRODUCTION

Post traumatic hand deformity especially thumb causes major financial burden starting from lack of productivity due to partial loss of function or residual pain up to retirement and disability. These deformities are expected to rise especially in low and middle-income countries ⁽¹⁾. Skin/soft-tissue envelope of the hand is a complex structure that not only covers the underlying structures but also has specialized functional and sensory components. The thick glabrous skin of the palm withstands shearing forces encountered during daily activities and provides discriminatory sensory function that transfers touch, pain and temperature, whereas the dorsal skin is pliable and mobile that permits a wide range of motion of the hand such as fingers pinch and grip ⁽²⁾.

The excellent results, with respect to restoring contour, sensibility of the pulp, and aesthetics of the finger will justify the more tedious and time-consuming treatment of fingertip and thumb injuries ⁽³⁾. There are a wide range of options for thumb reconstruction ranging from grafts, pedicled flaps that can be easier, dependable and time saving in centers lacking facility and equipment up to sophisticated micro-vascular replantation especially with traumatic injuries to the thumb with soft tissue or bone loss ⁽⁴⁾.

There are multiple perforators in the finger and thumb dorsum region from the proper digital artery, which are suitable for pedicled free-style

perforator flaps. These perforators increase flap flexibility and reliability in clinical applications ⁽⁵⁾. Skin flaps may be preferred since they maintain their original color and texture, undergo less contraction and have their own blood supply ⁽⁶⁾. There is deferent local flaps designed for thumb reconstruction as VY flap, Moberg advancement flap, sensate cross-finger flap, Littler's neurovascular island flap, first dorsal metacarpal artery (FDMA) flap, and Reverse homodigital dorsoradial flap ⁽⁷⁾.

AIM OF THE WORK

Evaluation of different local and regional flaps in thumb reconstruction regarding function, sensation and aesthetic outcome.

PATIENT AND METHODS

The study included 20 patients with thumb defect admitted to Al-Azhar University Hospital in New Damietta for prospective cohort study during the period from November 2018 to October 2019. They were 18 Males and 2 females.

Ethical approval:

The study was approved by the Ethics Board of Al-Azhar University and an informed written consent was taken from each participant in the study.

Inclusion criteria:

- Patients with thumb defect either isolated or associated with other hand trauma.
- Age group between 5 – 50 years old.
- Both sexes were included in the study.
- Acute hand trauma.

Exclusion criteria:

- Association with life threatening injury
- Pregnant patients
- Associated co-morbidities (Heart disease, DM and patients with blood disease)
- Previous hand or thumb trauma or pathology that affect thumb vascularity.

I- Preoperative assessment:

A) History taking:

(1) Personal history: Age: most patients are in 2nd and 3rd decades, as these are the working group. Sex: males are more affected than females because injuries are mostly associated with work. Occupation: some of patients works in furniture making.

(2) Complaint, and mode of trauma: most patients were complaining of trauma by blunt object and some of them with sharp objects with lost soft tissue + or – bony loss.

(3) Past history: Heart disease, DM and patients with blood disease were excluded from the study.

B) Examination:

General examination: For fitness for surgery and baseline assessment of the patient "vital data and over view on the body systems".

Local examination:

1. Inspection: assessment of thumb color for vascularity, deformity, defect site and size, presence of nail.

2. Palpation: capillary refilling and to confirm of presence of exposed bone.

Motor: Pre-operative for assessment of tendons affection and joint state. Post-operative for limitation of movement after flap coverage as moberg flap may affect interphalangeal joint, cross finger and FDMA flaps may affect thumb abduction and index flexion.

Sensory: Pre-operative thumb assessment for nerve affection. Post-operative assessment of the flap using 2 point discrimination after 1 month. Static Two-Point Discrimination Scoring.

Vascularity: Pre-operative assessment for the thumb and post-operative for flap as regared viability.

Assessment of the defect"

- Defect site: proximal third, middle third or distal third
- Degree of tissue loss: by centimeter varies from 0.6 to 1cm to 4 to 1.6 cm

- Type of lost tissue: skin and subcutaneous tissue, nail or bony loss.
- Availability of donor sites: volar skin of the thumb for VY and moberg or dorsal skin of the proximal phalanx of the index finger.

Thumb aesthetics:

As regard color matching of the flap with the finger, scar shape, bulkiness of the flap and presence of thumb unites "nail, pulp, joint and creases" classified into "good, fair and bad".

C) Photography: Pre-, intra- and post-operative photography at 1 month and 3 months post-operative were done.

D) Investigation: Laboratory CBC, PT and INR and Radiological "plain x ray" were done before and after intervention.

E) Consent:

- After patient consultation with written form according to Al-Azhar Basic Ethics of Scientific Research with special stress on the possibility of sloughing of the flaps and the need for another stage of surgery.
- Doppler assessment of the blood supply of the flap then marking the flap.
- Prophylactic antibiotic and good preparation at department.
- All patients entered operative room within the first 6 hours.

II-Intra-operative:

Anesthesia:

- General anesthesia for 3 patients.
- Regional anesthesia for 14 patients in the form of supraclavicular brachial plexus block using combination of lidocaine 0.5% 3 mg/kg and bupvaine 0.2% 1mg/kg to augment the action and avoid complications if we use large dose with one drug.
- Local Anastasia for 3 patients
- With tourniquet elevation 100 mmhg above systolic blood pressure at arm 5 cm above elbow joint for 17 patients with using ring tourniquet at metacarpophalngeal joint for VY flaps in 3 patients with loupe magnification.

Patient Positioning: The patient is placed in a supine position with full-abducted extended arm on table.

Disinfection: Wash of the hand by 4 bottles of normal salin and sterilization by povidone-iodine.

Operative procedure: The techniques used in this study were five types:

1. V Y flap for 3 cases.
2. Moberg flap for 8 cases.
3. Cross finger flap for 3 cases.
4. FDMA flap for 3 cases.
5. Homodigital flap for 2 cases.
6. Extended homodigital flap for 1 case.

III-Post-operative:

- Bulk dressing, hand elevation, follow up every hour for the first 4 hours, then every 2 hours for the next 6 hours then every 4 hours for the 1st day as regard color, capillary refilling, warmth, and pin prick if needed.
- Then outpatient clinic follow up
- Twice/week for the first month then every month for 3 months
- Stitch removal at the 10th day.

Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Independent-samples t-test of significance was used when comparing between two means.
- Chi-square (x²) test of significance was used in order to compare proportions between two qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant as the following:
 - Probability (P-value)
 - P-value < 0.05 was considered significant.
 - P-value < 0.001 was considered as highly significant.
 - P-value > 0.05 was considered insignificant.

RESULTS

In this prospective study on twenty patients with thumb defects, throughout 2018 and 2019. 18 males represent (90 %) and 2 females represent (10%) at age from 10 years to 40 years old with mean age of 27.33 ± 11.17 years. Dominant hand was the right hand in all patients and the right thumb defect was in 12 patient (60 %), the left thumb defect represent 8 patients (40 %). All Patients presented by trauma. Post-burn and congenital thumb anomalies were excluded from this study.

Table (1): Descriptive statistics of age and sex of the studied cases.

The studied cases N = 20			
Age	Mean ± SD	25 ±7.426836	
	Range	10 – 40	
		Number	%
Sex	Male	18	90%
	Female	2	10%

Special habit (smoking).

Table (2): Descriptive statistics of special habits of the studied cases.

	Smokers	Non smokers
Number	6	14
Percentage	30 %	70 %

Dominant hand and injured hand: All cases were right handed with right hand affection in 12 patient, while left hand affection in 8 patients as demonstrated in table (3).

Table (3): Dominant hand & affected thumb

	Right	Left
Dominant hand	20	0
Injured hand	12	8

Flap design:

Table (4): Six designs were included in the study.

Flap design	Number of cases
VY	3
Moberg	8
FDMA	3
Cross finger	3
Homodigital	3

Flap viability:

Table (5): Classified as complete take, partial or complete loss.

Flap viability	Number of cases	percentage
Complete take	20	100%
Complete loss	0	0%

Stages of the flaps:

Table (6): All flaps in the study were one stage except cross finger in 3 patients.

Flap stages	Number of cases	Percentage
One stage	17	85%
Two stages	3	15%

Sensation of the flaps:

Table (7): As regard 2 point discrimination test classified as good, average and fair.

Vo. Of cases	Percentage	Degree
8	40%	good
9	45%	average
3	15%	fair

Movement of the thumb:

In V-Y, cross finger and homodigital, transient limited inter-phalangeal joint extension was detected in all cases of moberg then returned to normal within 1 month, one case of FDMA flap developed limited thumb abduction and needed

surgical release due to contracture of web space with tunneling (Table 8).

Table (8): Thumb movement.

Thumb movement	Number of cases	Percentage
Normal movement	11	55%
Limited flexion	8	40%
Limited abduction	1	5%

Thumb aesthetics:

Table (9): Classified into good, fair and poor.

No. of cases	Degree
6	Good
11	Fair
3	Poor

Donor site morbidity:

Table (10): Morbidity affection

Donor morbidity	Number of cases	Percentage
Not present	14	70%
Limited flexion of index finger	6	30%

It was present in heterodigital flaps as in FDMA and cross finger flap showing transient limited interphalngeal joint flexion (Table 10).

Time to return to work or normal activity:

Most of patients returned to normal activity within the first month especially with V-Y and moberg flap, the longest recovery time was with extended homodigital flap due to multiple stages after flap loss.

Table (11): Time of recovery and return to work by weeks

Number of cases	Number of weeks
5	2
4	3
5	4
3	5
1	6
1	7
1	8

DISCUSSION

In two and half years, fifteen 1st dorsal metacarpal artery island flaps were used for reconstruction of complex post-traumatic soft

tissue thumb defects in 15 cases with an average age of 34.8 years 13 males and 2 females (8).

19 cases (95%) presented with injuries to the volar surface of the thumb, 1 case (5%), presented with injuries to the dorsal surface of the thumb. Volar surface injuries are more frequent than dorsal surface injuries and this can be easily explained as the volar surface is the contact surface, all cases with distal third affection.

In our study, 20 cases with thumb defects ranging from soft tissue loss up to exposed structures as bones were managed with local and regional flaps, where the techniques used in reconstruction were as follows; 8 cases (40%), by volar advancement flap; (Moberg) flap was used in 8 cases. The flap was reliable, with good vascular and sensory supply and provided thumb reconstruction in a single stage, this flap was found to be sufficient to cover no more than the distal one third of the distal phalanx of the thumb and otherwise, minimal flexion limitation at the interphalngeal joint occurred then returned to normal in all patients. Postoperatively, no flap loss occurred.

Application of the same technique for fingertip injuries was later suggested by Snow, but differences in digital blood supply led to dorsal tip necrosis and selection of other reconstructive techniques by many surgeons. Other methods have the disadvantages of widened two-point discrimination, a tender pulp scar, or an unacceptable donor site. The volar advancement flap applied to fingers restores nearly normal sensation and an adequate pulp with minimal deformity. Our experience with the volar advancement flap in 69 digits from 1969 to 1978 is reviewed. Preservation of the dorsal perforating vessels is most important in successfully executing this procedure. No dorsal tip or flap necrosis occurred. Two-point discrimination was normal or within 2 mm of contralateral values in every digit. Full range of motion, or less than 5 degrees extension loss was recorded in all fingers that were normal prior to operation. Our results suggest this to be a safe as well as effective adjunct in the treatment of fingertip injuries (9).

First dorsal metacarpal artery flap in 3 cases (15 %), and it is a reliable local neurovascular island flap option offering acceptable functional and cosmetic outcomes in respect to sensation, elasticity, durability and skin match. It provides elastic, durable and sensate coverage for soft tissue defects of the thumb and provided thumb reconstruction in a single stage. Donor site morbidity is minimal with an acceptable scar on the dorsum of the index and adequate tendon gliding without producing extension deficit (10). No major complications except in postoperatively, 2 patients

had stiffness in the proximal interphalangeal joint of the donor finger (index finger) and one patient had web space narrowing. On the other hand, this kind of flap was found to have excellent cosmetic results, with minimal donor site morbidity and good sensory results.

Homodigital island flap was used in two cases (10 %), this type of flap proved to have excellent cosmetic and sensory results very close to FDMA flap, with privilege over FDMA flap in large defects where homodigital flap proved to be better and provided adequate skin coverage. The flap was reliable, with good vascular and sensory supply and provided thumb reconstruction in a single stage. The homodigital reverse island flap is an ideal surgical treatment for distal digital defects with a lower complication rate and good functional result. The indication of age can be extended for older patients with a good preoperative evaluation (11).

Immediate reconstruction was performed in 20 patients (100 %) within first 6 hours. It may be concluded that the earlier the intervention, the better the results and that the first chance may be the best chance. Wide range of procedures are available to reconstruct the thumb. Microsurgery has provided numerous options to reconstruct part or whole of the thumb. Proper assessment of the patient enables the surgeon to choose the correct procedure. If planned and executed meticulously, the results of thumb reconstruction can be excellent. Diligent post-operative care, supervised rehabilitation therapy, and early intervention or unfavourable results, can make the difference between a good and an excellent result (12). Cortical reorientation is the fact that the brain recognizes a stimulus from the flap area as a stimulus from the thumb, and not from the index finger. This process takes some time, but is usually complete after 2 years (13).

Cross finger flap is simple option in thumb reconstruction, in this study 3 cases underwent cross finger flap with good take and regaining of sensation, normal thumb and index function postoperatively, except with transient limitations of index finger. The cross finger flap is a useful and dependable mean of resurfacing thumb pulp defects that do not warrant free toe-pulp transfers or long pedicled regional transfers. It is an acceptable alternative in patients unsuitable or unfit for microsurgical free tissue transfers. Donor site permutations allow some flexibility in positioning the flaps to resurface radial- or ulnar-biased defects. From our experience, we believe that dorsal skin from the index finger proximal segment provides the largest available donor surface (14).

It may be concluded that local flaps can be used to manage more than half the cases of thumb

reconstruction in spite of the versatility of the recent micro-vascular reconstructive techniques, which proved to be satisfactory for both the surgeon and the patient, the simpler and may be the older techniques must remain in mind, because it is the commonest solution in many cases. It is the surgeon's responsibility to be imaginative and wise enough to secure the best solution for the patient (15).

CONCLUSION

Four surgical approaches are applied and discussed in this study for reconstruction of thumb defects which are:

V-Y, The Moberg's flap, cross finger flap, the first dorsal metacarpal artery flap and homo-digital island flap.

The volar advancement flap (Moberg's Flap) is the simplest and easier sensate flap used for reconstruction of thumb defects in distal third of distal phalanx less than one centimeter. It gives excellent sensation to tip of thumb in one stage operation and less complication as donor morbidity and post-operative disfigurement.

The cross Flap is flexible flap based on neurovascular bundle of thumb to cover wider area of the defect and less thumb extension limitation.

First dorsal metacarpal artery flap (Kite's flap) was a reliable local neurovascular island flap for thumb reconstruction, offering acceptable functional and cosmetic outcomes in respect to sensation, elasticity, durability, and skin match. It provides elastic, durable, and sensate coverage for soft tissue defects of the thumb. Donor site morbidity is minimal with an acceptable scar on the dorsum of index and adequate tendon gliding without producing extension deficit. It is the first treatment of choice for defects of the proximal phalanx and proximal part of the distal phalanx of the thumb zone 4. Contraindications of the FDMCA flap are circular defects at the proximal or distal phalanx and previous injury at the second metacarpal level.

The homo-digital flap was reliable, with good vascular and sensory supply, and provided thumb reconstruction in a single stage with more suitable for larger defects. It provides protective sensation and an acceptable cosmetic result with good vascular and sensory supply, and provided thumb reconstruction in a single stage.

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