

Original Research Article

Assessment of soft tissue reconstruction of the thumb after injuries

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Received: 24 January 2020

Revised: 12 February 2020

Accepted: 13 February 2020

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ABSTRACT

Background: This study is to formulate a strategic approach for soft tissue reconstruction of the thumb and study of different modalities of soft tissue reconstruction of the thumb and try to clarify advantage and discuss complication of each modality.

Methods: This is a prospective study done on 20 patients with thumb defects and deformities, presented at Menoufia University and Al-Ahrar Zagazig Teaching Hospitals during the period from January 2017 to July 2019. They were 14 Males and 6 females classified according to age, sex, type of trauma, dominant hand, type of flap used for reconstruction.

Results: The most type of injury was trauma in all technique accept digital artery perforator (DAP) flap and groin flap of the half patients were trauma (50%) and other half were post burn (50%). Most patients were early timing of interference in all techniques accept replantation was immediate time of interference (100%) and groin flap was late time of interference (100%). Most patients in Moberg flap had minimal scare complication (60%). Whereas half patients had minimal scare complication in replantation, little flap and DAP flap (50%, 50% and 50%). While half patients had volar contracture, graft complication in thumb cross finger and groin flap (50% and 50%).

Conclusions: Replantation is the first choice for thumb amputations proximal to the base of the distal phalanx. It is impossible or fails, other methods of thumb reconstruction. Thumb cross finger flap is an excellent reconstructive technique for larger volar and tip defects of the thumb, up to 2-3 cm².

Keywords: Complication, Injuries, Reconstruction, Soft tissue, Thumb

INTRODUCTION

The significance of the thumb in its contribution to overall hand function cannot be overestimated. Indeed, the thumb contributes approximately 40 percent of hand function.^{1,2} The thumb plays an important role in hand function. Daily tasks involving pinch, grip, grasp and precise handling are more easily accomplished with an opposable thumb, loss of thumb diminish much the hand abilities and function.³

The hand, as the human executing organ, is in the center of daily life activities in professions and sports. In this outstanding position, the hand is always exposed to injuries and overuse. With the change of this society from an industrial society to a service-based society, surprisingly, an assumed decrease in hand injuries has not been detected, probably due to an increase in private activities, such as sports and do-it-yourself work.⁴ Soft tissue injuries of the hand frequently require flap coverage, either to preserve structures or even to facilitate later reconstruction.⁵

The absence of the thumb, whether due to failure of formation or loss from trauma, significantly impairs hand function.^{6,7} The goals of thumb reconstruction are sensate and non-tender thumb tip, stability of thumb joints, adequate length to resist the forces of the fingers, correct posture and positioning of the thumb with a wide adductor space.⁸

Strategic positioning of the thumb is the key factor to achieving optimal function. Emphasizing this, he stated, "it is not the full length of the thumb, nor its great strength and movement, but rather its strategic position relative to the fingers and the integrity of the specialized terminal pulp tissue which determines prehensile status". The reconstruction should be cosmetically acceptable and have minimal donor site morbidity.⁹

An ideal reconstruction of the thumb 'would replace like with like', restoring both function and appearance. Opposition, the hallmark of 'thumbness', necessitates length, stability, strength and mobility, exactly how important each of these factors becomes will vary depending on the needs of the patient, the jeweler who seeks sensibility and mobility may require different management than the manual laborer who may sacrifice mobility for stability and power.^{10,11}

The aim of this work was formulating a strategic approach for soft tissue reconstruction of the thumb. And study of different modalities of soft tissue reconstruction of the thumb and try to clarify advantage and discuss complication of each modality.

METHODS

This is a prospective study done on 20 patients with thumb defects and deformities, presented at Menoufia University and Al-Ahrar Zagazig Teaching Hospitals during the period from January 2017 to July 2019. They were 14 males and 6 females classified according to age, sex, type of trauma, dominant hand, type of flap used for reconstruction.

Patients

Twenty patients with thumb defects and deformities were managed over the past two years between January 2017 to July 2019.

Inclusion criteria

Patient selection done according to patients with only thumb defect, trauma and postburn, size of defect about 2-4 cm and available donor site.

Exclusion criteria

Patients with age less than 5 y or more than 60 yrs, patients suffering from major uncontrollable medical illness and the defect measured 2-3 cm in ten cases and

more than 3 cm in ten cases. Age of patients ranged from 15-46 yrs with mean (27.33) years. Patients were evaluated by history taking, physical examination, investigations, consent taking and photographs. The techniques used were replantation and reconstruction by flaps as (Moberg flap, littler flap, kite flap, digital artery perforator (DAP) flap, cross finger to thumb flap, groin flap), the follow up period ranged from 3 months to 10 months.

All patients included in this study were subjected to the following details:

History

Patients age, type of work, right or left hand, mode of trauma, time lag between the injury and attendance to hospital and special habits are noted (e.g. smoking).

Physical examination

Standard hand examination was performed in the form of degree of tissue loss, skin quality, functions of muscles, tendons and nerves and grips.

Investigations

Laboratory and radiological investigations in the form of CBC and X-ray of the hand were done before any maneuver. Photographs for patients' hands were imaged before and after surgical intervention after informing them for follow up.

Standard consents were taken from the patients or the parents (in patients under 21 years) with special stress on the possibility of sloughing of the flaps and the need for resurvey.

Methods

All the patients had the following steps intraoperatively.

Anesthesia: General anesthesia, regional anesthesia with tourniquet on arm.

Patient positioning: The patient is placed in a supine position with extended arm. Disinfection was done by povidone-iodine, alcohol.

Operative procedures

The techniques used in this study were replantation done in two cases, volar advancement flap (Moberg's flap) done in five cases, first dorsal metacarpal artery flap (kite flap) done in five cases, hetero digital island flap (littler flap) done in two cases, DAP flap (dorsal radial or ulnar artery flap) done in two cases, cross finger to thumb flap done in two cases and groin flap done in two cases.

Surgical technique of DAP flap

The amputated part of the thumb is aseptically prepped and surgically exposed/tagged under loupe magnification. This done before the patient is asleep on a separate tagging table. The patient is brought into the operating room and the amputation site is aseptically prepped and draped. The site is surgically exposed under loupe magnification after induction of anesthesia. The replantation here is indicated and possible. So, it proceeds in the following order.

Debridement and preparation, bone shortening and fixation, extensor tendon repair, flexor tendon repair, arterial repair, nerve repair, vein repair and skin closure and coverage. The replantation of the thumb is done then the replantation of the index done also in the same manner with arthrodesis in PIP joint of index finger. The order can be changed is the anatomy and configuration of the injury preclude proceeding as above. For instance, a part with a volar skin bridge that would impede arterial repair after bone and tendon repair may need arterial repair first, followed by tendon and nerve repair. Partial placement of K-wires or plates may be helpful in this situation, with completion of fixation after arterial and tendon repair (Figure 2 and 3).



Figure 1: Completely amputated thumb with partially amputated index and the amputated part of the thumb.



Figure 2: Intraoperative replantation of the thumb.



Figure 3: Postoperative replantation of the thumb.

Surgical technique of groin flap

The operation was done under general anesthesia with patient in supine and arm on arm table. Groin and arm were prepped, and thumb is debrided. The flap was designed using “two finger width” rule. Femoral artery represents the medial border of flap. Superficial circumflex iliac (SCIA) originates from the femoral artery, about two finger widths below the inguinal ligament.

The course of this artery, also the axis of flap, is then drawn from its origin on femoral artery to the anterosuperior iliac spine.

The upper flap border is identified medially two finger widths above the inguinal ligament parallel to the SCIA course. The lower flap border is also parallel to the SCIA course and is marked two finger widths below the SCIA origin. The position of the lateral flap border is determined by recipient-site requirements. With proper technique about 12 cm of flap can be raised and donor site closed primarily with undermining. The flap is quite mobile.

The grafted limb is totally immobilized to the abdomen so that the flap rests without undue stretch. The flap was detached from the groin at about 3 weeks, as the second stage, and soon afterwards the patients were discharged from hospital. However, in some patients where a sizeable portion of the flap remained to be set into the recipient site a delay was done and then flap detached after 3-4 days.

The SCIA is ligated leaving the major portion of the base intact and wound closed primarily. When 80% or more of the flap is set in at the initial operation, however, no delay was done in patients in whom 80% or more of the flap was set at 3 weeks. In patients in whom flap was bulky thinning of flap was done after 3 weeks (Figure 5 and 6).



Figure 4: Preoperative figure of injury of the thumb.



Figure 5: Intraoperative figure of groin flap.



Figure 6: Postoperative figure of groin flap.

RESULTS

This study shows that there were statistically significant differences between the studied different techniques regarding site of injury and volar vs. dorsal ($p=0.001$). While the site of injury in all patients was in the right hand in all technique. Whereas the most common in all patients was volar accept Groin flap both was the common.

Also, there were statistically significant differences

between the studied different techniques regarding smoking ($p=0.04$). While most patients were smoker in Moberg flap but most patients were Non-smoker in kite flap, groin flap.

Whereas in replantation, little flap, DAP flap and thumb cross finger half of them were Non-Smoker. Whereas, there was no statistically significant differences between the studied different techniques regarding general health problems (diabetic hypertensive) ($p=0.134$).

While the most common type of general health problems was non in replantation, Moberg flap, kite flap, litter flap, DAP flap, thumb cross finger and groin flap (100%, 60%, 80%, 100%, 100%, 100% and 100%) (Table 1).

This study shows that, there was statistically significant differences between the studied different techniques regarding type of injury ($p=0.012$) with the most type of injury was trauma in all technique accept DAP flap and groin flap the half patients were trauma (50%) and other half were post burn (50%). Whereas there were highly statistically significant differences between the studied different techniques regarding size of the defect ($p<0.05$).

Also, there was highly statistically significant differences between the studied different techniques regarding timing of interference ($p=0.00$). While most patients were early timing of interference in all techniques accept replantation was immediate time of interference (100%) and groin flap was late time of interference (100%) (Table 2).

This study shows that, most patients in Moberg flap had Minimal scare complication (60%). Whereas half patients had minimal scare complication in replantation, little flap and DAP flap (50%, 50% and 50%). While half patients had Volar contracture, graft complication in thumb cross finger and groin flap (50% and 50%) (Table 3).

This study shows that there were no statistically significant differences between the studied different techniques regarding patient satisfaction ($p=0.17$) (Table 4).

Table 1: Demographic and clinical problems of patients undergoing different techniques.

Variable	Technique														Chi square and p value
	Replanta-tion		Moberg flap		Kite flap		Littler flap		DAP flap		Thumb cross finger		Groin flap		
Age (in years)															X ² =108.90 P=0.001
Mean±SD	29.5±5		23±13.4		32±13.1		40.8±13.8		25±10.29		29.5±6.8		31±4.4		
Range	27-32		20-26		23-55		29-53		23-27		26-33		28-34		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
Sex															X ² =28.11 P=0.014
Male	2	100	4	80	5	100	2	100	2	100	2	100	1	50	
Female	0	0	1	20	0	0	0	0	0	0	0	0	1	50	
Site of injury															X ² =17.43 P=0.037
Right hand	1	50	4	80	2	40	1	50	1	50	1	50	2	100	
left hand	1	50	1	20	3	60	1	50	1	50	1	50	0	0	
Volar vs dorsal															X ² =48.95 P=0.001
Volar	1	50	5	100	3	75	1	50	1	50	2	100	0	0	
Dorsal	0	0	0	0	0	0	1	50	1	50	0	0	0	0	
Both	1	50	0	0	1	25	0	0	0	0	0	0	2	100	
Special habits															X ² =24.44 P=0.04
Smoker	1	50	3	60	2	40	1	50	1	50	1	50	0	0	
Non-smoker	5	50	2	40	3	60	1	50	1	50	1	50	2	100	
General health problems															X ² =28.21 P=0.013
Diabetic	0	0	1	20	1	20	0	0	0	0	0	0	0	0	
Hypertensive	0	0	1	20	0	0	0	0	0	0	0	0	0	0	
None	2	100	3	60	4	80	2	100	2	100	2	100	2	100	

Table 2: Type of injury, size of the defect and timing of operation of patients undergoing different techniques.

Variable	Technique														Chi square and p value
	Replantation		Moberg flap		Kite flap		Littler flap		DAP flap		Thumb cross finger		Groin flap		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
Type of injury															
Trauma	2	100	5	100	4	80	2	100	1	50	2	100	1	50	X ² =28.47 P=0.012
Post burn	0	0	0	0	1	20	0	0	1	50	0	0	1	50	
Size of the defect															
≤2×3 cm	0	0	5	100	4	80	1	50	2	100	2	100	0	0	X ² =39.31 P=0.001
≥3×3 cm	2	100	0	0	1	20	1	50	0	0	0	0	2	100	
Timing of interference															
Immediate	2	100	0	0	0	0	0	0	0	0	0	0	0	0	X ² =66.00 P=0.001
Early	0	0	5	100	5	100	2	100	2	100	2	100	0	0	
Late	0	0	0	0	0	0	0	0	0	0	0	0	2	110	

DISCUSSION

In this work, a study of twenty cases that underwent reconstruction of the thumb injuries caused by different etiologies. Reconstruction for injuries caused by trauma were seventeen cases, more in males and this meets what was mentioned by Petkova¹² who stated that the highest incidence of trauma to the hand and digits is in the males below the age of 30 years.

In the seventeen cases caused by trauma, ten cases were caused by blunt-trauma, eight cases were caused by injury with sharp object, and blunt trauma may be more injurious to the hand than trauma with sharp object. Ten cases (50%) presented with injuries to the volar surface of the thumb, six cases (30%) presented with injuries to the dorsal surface of the thumb and four cases (20%) presented with injuries to both volar and dorsal surfaces of 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.

In this study 20 cases with thumb defects ranging from soft-tissue loss up to exposed structures as bones were managed with replantation and reconstruction by local neurovascular flaps. Replantation done in two cases (10%) where the techniques used in reconstruction were as follows, neurovascular flaps were used in eighteen

cases (90%), and they are: five cases (40%), by volar advancement flap; (Moberg) flap was used in five 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, flexion contracture deformity at the inter-phalangeal joint may occur. Postoperatively, one partial flap loss occurred.

Table 3: Flap outcome and complications undergoing different techniques.

Complications	Technique													
	Replantation		Moberg flap		Kite flap		Littler flap		DAP flap		Thumb cross finger		Groin flap	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Minimal scar	1	50	3	60	2	40	1	50	1	50	1	50	0	0
Volar contracture, graft complication	0	0	0	0	0	0	0	0	0	0	1	50	1	50
Ugly scar, graft complication	0	0	1	20	1	20	0	0	1	50	0	0	0	0
Ugly scar, sensory affection	1	50	1	20	2	40	1	50	0	0	0	0	1	50

Table 4: Patient satisfaction among patients undergoing different techniques.

Patient satisfaction	Technique														Chi square and p value
	Replantation		Moberg flap		Kite flap		Littler flap		DAP flap		Thumb cross finger		Groin flap		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
Poor	1	50	3	60	2	40	1	50	1	50	1	50	0	0	X ² =35.00 P=0.17
Fair	0	0	0	0	0	0	0	0	0	0	1	50	1	50	
Good	0	0	1	20	1	20	0	0	1	50	0	0	0	0	
Excellent	1	50	1	20	2	40	1	50	0	0	0	0	1	50	

First dorsal metacarpal artery flap in five cases (40%), 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.¹³ Also, Al-Baz et al found that donor site morbidity was minimal with nice esthetic results; only two cases suffered from hypertrophic scars and three cases with hyperpigmentation. Also, the functional and esthetic outcomes of the recipient site were good with no complications.¹⁴

No major complications except in postoperatively, one partial flap loss occurred, and another patient had stiffness in the proximal interphalangeal joint of the donor finger (index finger). Where the flap was lost totally, on the other hand this kind of flap was found to have excellent cosmetic results, with minimal donor site morbidity and good sensory results. While, Al-Baz et al

found that complications were distal necrosis in two flaps and congestion in two flaps. Wound dehiscence of the donor site occurred in two cases.¹⁴

The Littler's flap (fasciocutaneous heterodigital island neurovascular flap) was used in two cases (20%), this type of flap proved to have excellent cosmetic and sensory results very close to kite flap, with privilege over kite flap in large defects where hetero digital flap proved to be better and provide adequate skin coverage. The flap was reliable, with good vascular and sensory supply, and provided thumb reconstruction in a single stage. Postoperatively, one patient complained of slight pain in cold weather a second patient complained of numbness at the donor site, these complications were mentioned by Adani et al.¹⁵

The DAP flap was used in two cases (20%), this type of flap has many advantages include it is easier than the flag or kite flaps in addition to the closure of the donor site without using skin graft and the fact that it is a one-stage procedure resulting in a reliable vascular pedicle and extensive arc of rotation. Its disadvantages include

increases in cold intolerance by 41.6%, sacrifice of a digital artery, long operating procedure, venous congestion, PIP joint contracture and higher incidence of total or partial loss.¹⁶

The thumb cross finger flap has been a reliable and efficient procedure in providing sensibility, preserving the finger length, and coverage of exposed tendons and bones. Its advantages are it is easy to perform, reliable flap with large margin of safety, negligible donor-site morbidity, can be performed under regional block anesthesia, can be used even for coverage of thumb defects, the contour reconstruction when given for tip and pulp defects is satisfactory. Its disadvantages are it is a two-staged procedure, skin color match may not be perfect, may not be suitable for a variety of defects such as defects on the dorsum of the fingers, radial or ulnar borders, stumps of fingers, or proximal defects on fingers.

The groin flap is an axial-patterned cutaneous flap based on the superficial circumflex artery. Groin flaps have been the most widely used pedicled flaps in hand reconstruction. They can cover extensive defects of over 10×15 cm without sacrificing a major artery or the need for end-to-end micro-vascular anastomosis. Groin flap is a simple procedure with short operating time and can be used in emergency settings because of technical ease, short operation time and large size flap. The flap has a reliable vascular supply. Secondary division and inset procedures can be performed in a short outpatient procedure. The flap is hairless with good skin color and cosmetic appearance. The donor site has acceptable scar which is easily hidden by underwear and thus preferable in females. Groin flap is contraindicated in cases with previous groin surgery, or radiotherapy. The groin flap has a disadvantage of being bulky (which can be improved after flap thinning), needs long hospital stay, limb immobilization and vague flap sensation.

Immediate reconstruction was performed in two patients (10%) and early reconstruction was performed in sixteen patients (80%) and late reconstruction was performed in two patients (10%). It may be concluded that the earlier the intervention, the better the results, and that the first chance may be the best chance. 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.¹⁷

CONCLUSION

Replantation is the first choice for thumb amputations proximal to the base of the distal phalanx. It is impossible

or fails, other methods of thumb reconstruction. Thumb cross finger flap is an excellent reconstructive technique for larger volar and tip defects of the thumb, up to 2-3 cm².

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee of Menoufia University Hospital and Al-Ahrar Zagazig Teaching Hospitals.

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Cite this article as: Gad SS, Keshk TF, Nassar AT, Bassiouny HGZ. Assessment of soft tissue reconstruction of the thumb after injuries. *Int Surg J* 2020;7:617-24.