

Free second toe transfer in reconstruction of different level of thumb injuries

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Abstract: The thumb is the master key for hand function. Loss of thumb partially or completely will affect the essential hand functions. Restoration of finger losses by second toe transfer is a well known procedure. In this work the second toe was transferred microsurgically to reconstruct old post traumatic partial or complete thumb losses. Ten patients were included in the study, 8 males and 2 females (age range 18-51 years, mean 35 years). The amputation level was proximal to MCP joint in 5 patients, at or distal to the MCP joint in 3 patients, and lastly at or distal to IP joint in 2 patients. The follow up period ranged from 1-2 years (mean 13.5 months). All flaps survived completely. In one patient, reexploration of the pedicle was done to solve vascular compromise and the toe salvaged completely. Another case local wound infection occurred and treated conservatively. In 2 patients, tendon adhesions occurred and tenolysis was done around 2 months postoperatively. Rehabilitation continued for 2 months after removal of k wires. Patients were asked to wear volar splints at night for one year to prevent finger clawing. The sensory re-education and rehabilitation continued for 8 months. All patients got good range of finger motions with establishment of 2 point discrimination.

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1. Introduction

The dexterity of hand allows the human being to perform several unique daily functions. These functions are largely dependent on the thumb which accounts for 40 to 50% of the total hand functions⁽¹⁾. These thumb functions are of paramount importance especially in the dominant one. In the human hand by virtue of strength and mobility of thumb, power and twist grip is possible. In the mutilated hand the thumb takes on an even greater role providing prehension to an otherwise fairly useless extremity⁽¹³⁾.

Forty percent loss of hand function is encountered in case of amputation of thumb at the carpometacarpal joint, 30% at metacarpophalangeal joint, and 20% at interphalangeal joint. In fact the thumb is the master finger of the hand⁽⁴⁾.

Restoration of thumb length partially or completely represents a great problem for plastic surgeons. Tremendous techniques were used to restore thumb length. This includes pollicization⁽²⁾, distraction lengthening⁽¹³⁾, central core of bone and pedicle skin flap. All have some pros and cons, advantages and disadvantages. Fulfilling the ideal digital length, good motor and sensory function, and lastly a reasonable external appearance of the reconstructed finger are among the profiles that always considered when selecting a method for thumb reconstruction.

Microsurgical techniques have solved the problem of missing thumb component by transferring composite tissue from toes of the foot^(11,18). In this report the author presents his experience with isolated

second toe transfer to reconstruct partial or complete loss of the thumb.

2. Patients and methods (table 1)

This study included 10 patients, 8 males and 2 females their ages ranged from 18-51 years (mean 35 years).

The study was conducted in the department of plastic and reconstructive surgery, Al-Azhar university, Egypt and Fakeeh Hospital, Saudia Arabia in the period between January 2010-to- March 2013.

The Second toe was selected and transferred microsurgically to reconstruct old post traumatic partial and complete loss of the thumb.

Anteroposterior and lateral roentgenograms were taken to document the level of amputation. Also Preoperative routine laboratory investigations were done.

The amputation level was classified into 3 groups:

(A): Amputation proximal to the metacarpophalangeal (MCP) joint: 5 patients.

(B): Amputation at or distal to the MCP joint: 3 patients.

(C): Amputation at or distal to the interphalangeal (IP) joint: 2 patients.

After giving general anesthesia and patient redrapping, a routine brachial block was done to avoid arterial spasm. On the recipient hand a dorso- ulnar incision was done, and the dorsal branch of the radial artery, its venae comitantes, tributary of the cephalic vein, the dorsal digital nerve and the

proximal end of the extensor pollicis longus (EPL) were explored and tagged. Through another volar incision, flexor pollicis longus (FPL) and digital nerves were explored. The bony stump was freshened.

The dissection is then shifted to the donor foot. The *dorsalis pedis* artery and dorsal superficial veins are marked. After tourniquet elevation, a 'V' shaped incision was taken at the base of the second toe and extended proximally. Superficial dorsal veins were dissected. The first dorsal metatarsal artery (FDMA) was traced above, inside, or below the dorsal interosseous muscle, and dissected proximally with the *dorsalis pedis* artery. The slip of extensor *digitorum longus* (EDL) and the deep peroneal and dorsal digital nerves were dissected proximally. The plantar dissection was started by taking 'a V' shaped incision extending proximally up to the instep area. Plantar digital arteries and nerves were identified and dissected proximally. The flexor *Hallucis longus* (FHL) tendon was dissected proximally for adequate length. Disarticulation at the proximal interphalangeal joint of the second toe was done in 2 cases, at the metatarsophalangeal (MTP) joint in 3 cases, and bone sawing of second metatarsal in 5 cases. Vascularity to the toe was confirmed after the release of tourniquet. After toe separation from the

foot and before toe inset the excess bone was either sawed or bared.

Toe inset started by osteosynthesis using axial k wire and interosseous wiring. Flexor and extensor tendons were repaired, FDL to FPL, and EDL to EPL. Bilateral plantar digital nerves were coapted to volar digital nerves of the thumb, and the dorsal digital nerve was coapted to the dorsal digital nerve of thumb. The venae comitantes of the toe were anastomosed with a tributary of cephalic vein. Arterial anastomosis was done between the first dorsal metatarsal artery or the *dorsalis pedis* artery and the digital or the radial artery respectively.

Vascularity of the toe was confirmed and wounds were closed without any undue tension. Residual raw areas on the radial and ulnar aspect of the reconstructed thumb were grafted.

Regarding the donor area, the gap between the first and third toe was reduced by repair of intermetatarsal ligament and transverse K wire.

Rehabilitation: After 3-4 weeks, the K wires were removed. Physiotherapy following Durans protocol was started and continued for 2 months. Patients were asked to wear volar splints at night for one year to prevent finger clawing. The sensory re-education and rehabilitation was continued for 8 months.

Table 1:

No.	Age	Sex	Level of thumb injury	Timing of reconstruction	Method of reconstruction	Follow up	Complications	Secondary procedures
1	31	M	Neck of 1 st metacarpal	13m	Transmetatarsal 2 nd toe	9m	None	None
2	29	M	MCP joint	36m	Transmetatarsal 2 nd toe	11m	Wound infection treated conservatively	None
3	42	M	Base of proximal phalanx	23m	Disarticulated 2 nd toe at MTP joint	6m	None	None
4	38	F	At the IP joint	18m	Transmiddle phalangeal 2 nd toe	24m	Tendon adhesions	Tendon lyses
5	37	M	Middle part of 1 st metacarpal	42m	Transmetatarsal 2 nd toe	18m	None	None
6	18	M	Distal part of 1 st metacarpal	45m	Transmetatarsal 2 nd toe	21m	None	None
7	49	M	Neck of 1 st metacarpal	38m	Transmetatarsal 2 nd toe	14m	Reexploration revealed blood clot at arterial anastomosis and the toe salvaged	None
8	51	M	MCP joint	33m	Transmetatarsal 2 nd toe	7m	None	None
9	22	F	Distal to IP joint	28m	Transmetatarsal 2 nd toe	10m	None	None
10	33	M	Neck of 1 st metacarpal	36m	Transmetatarsal 2 nd toe	15m	Tendon adhesions	Tendon lyses

3.Results:

All flaps survived completely. In one patient (Case no.7), reexploration of the pedicle was done to solve vascular compromise (clot at the site of arterial anastomosis) and the toes were salvaged. In another

case (Case no.2) local wound infection occurred and treated conservatively.

Functional assessment was conducted at frequent intervals postoperatively and lasted from 1-2 years (mean 13.5 months). Patients return to their duties, daily hand activities, range of finger motion,

disability, restricted flexion in terminal joint and sensory recovery were among the titles that were considered.

In 2 patients (Case no. 4,10), tendon adhesions occurred and tenolysis was done around 2 months

postoperatively. In the other patients (the 8 cases), they had good range of motion and satisfactory verification of daily activities. Also in all patients satisfactory 2 point discrimination was established.

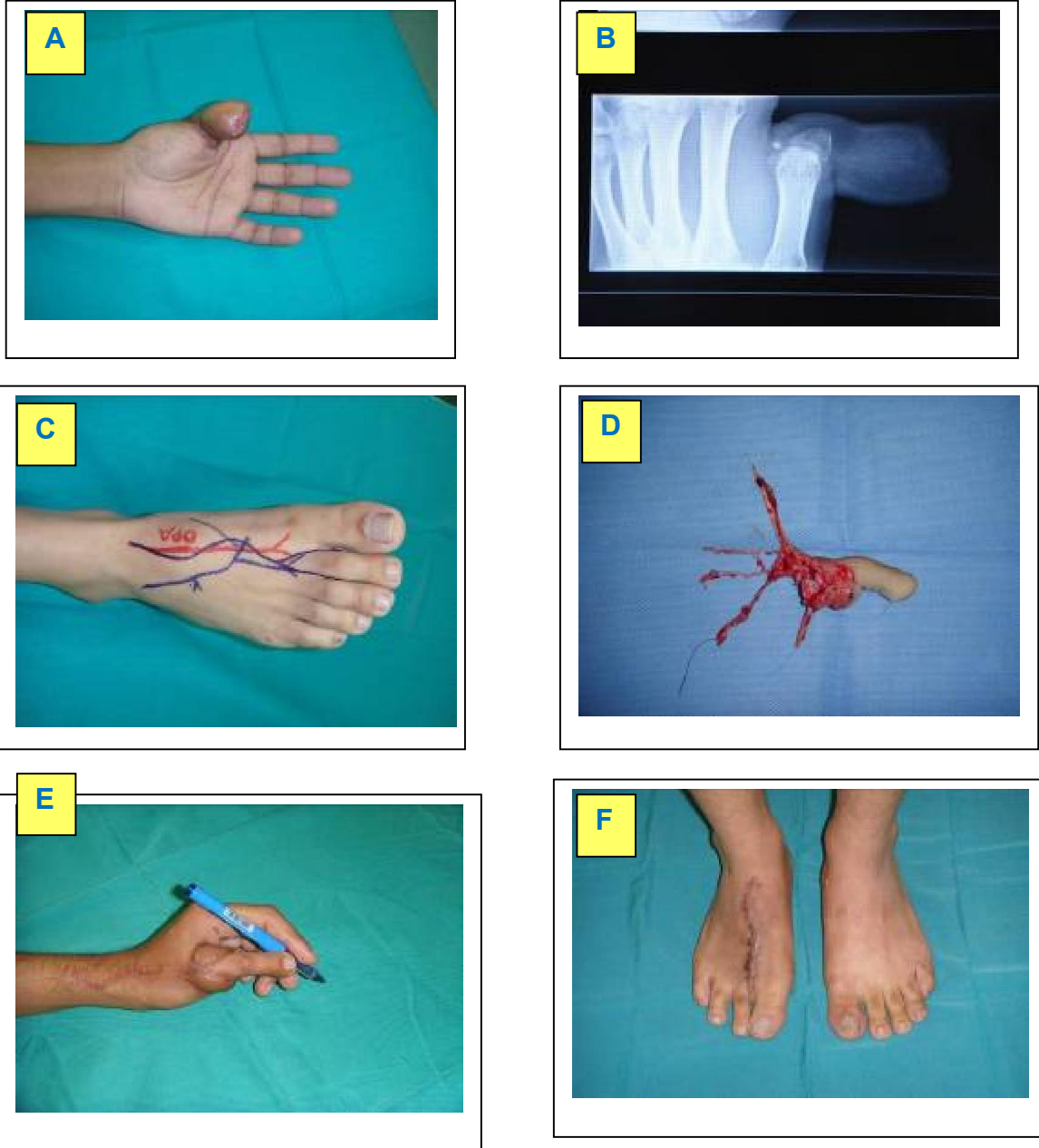


Fig.1a: Lt. thumb amputated at the MCP Joint level with groin flap covering the stump

Fig.1b: X-ray showing the level of thumb injury

Fig.1c,d: The design of Rt. 2nd toe and the intraoperative photograph of the toe after harvesting

Fig.1e: One year postoperative photo showing good pinch function of the reconstructed thumb

Fig.1f: The donor site appearance after one year

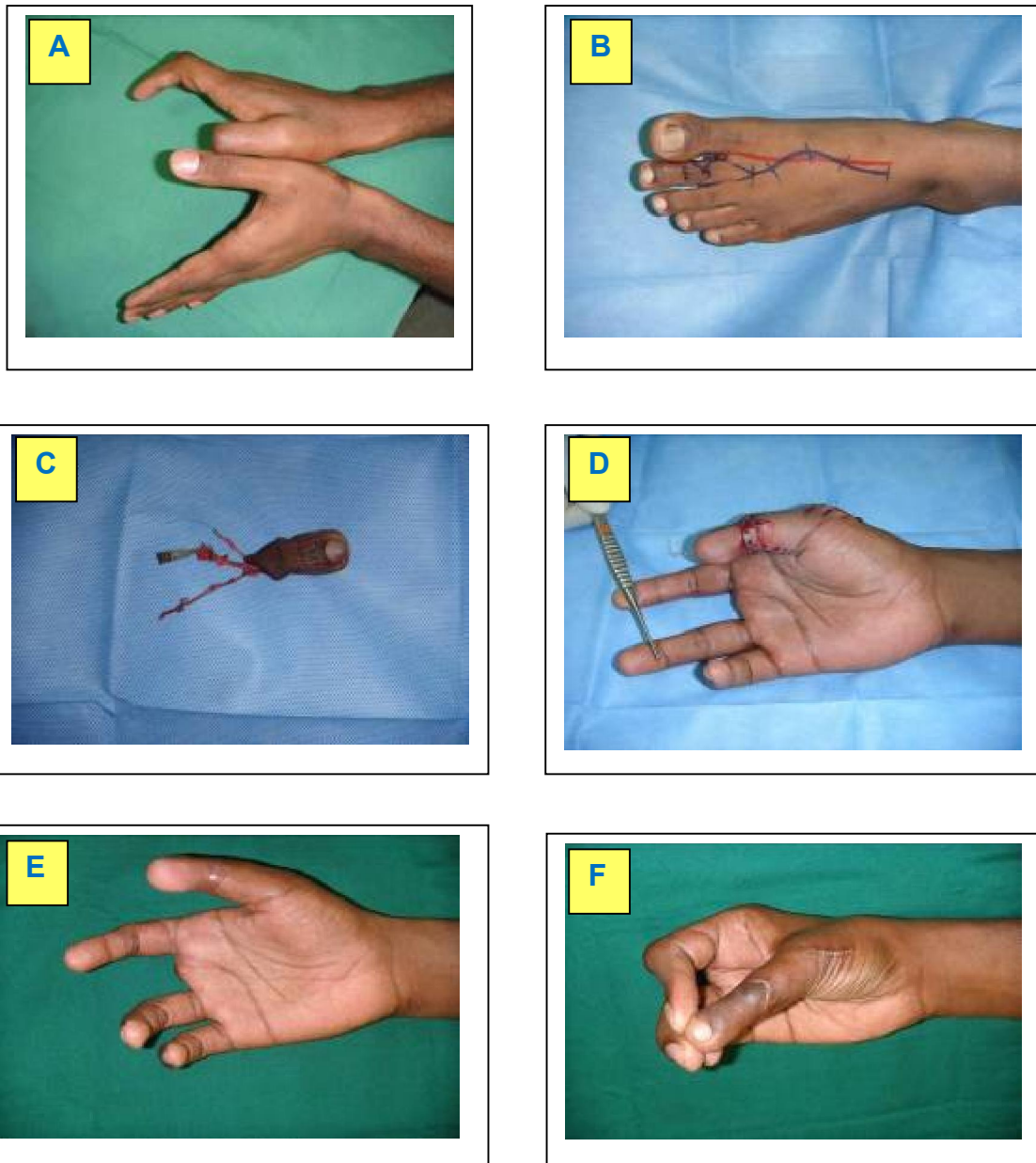


Fig. 2a: Old amputated Rt. thumb at the level of IP joint

Fig. 2b: The design of 2nd toe to the level of middle phalanx

Fig. 2c,d: Intraoperative photos showing the 2nd toe after elevation and inset

Fig. 2e,f: Follow up 9 months after surgery good length of the reconstructed thumb in relation to the index finger and also good prehension

4. Discussion

The first reported two-stage toe-to-hand transplantation was performed in 1897 by Nicolardoni⁽¹⁹⁾. **Buncke in 1966**^(4,5) first reported the success of microsurgical one-stage toe-to-hand transplantation in animals. The first application on human was done by **Cobbett in 1969**^(4,6), who

transplanted a great toe to replace an amputated thumb.

With the development of instrumentation and uprising learning curve in microsurgery a great perfection, refinements and variations in toe-to hand transplantation is achieved and toe-to hand transplantation became a well established method for

reconstruction of single or multiple digits⁽¹⁰⁾, of distal digits^(7,8), and of congenital deficits^(9,15).

Reconstruction of the thumb requires careful evaluation and discussion of the patient's occupational and social profile, and the treatment options available. Microvascular partial or total, single or multiple, isolated or combined toe transfer has become an invaluable tool to restore hand function in such patients. It provides all components necessary for good thumb function⁽⁴⁾.

The aesthetic appearance of the transferred toe is as much important as the function. Big toe for thumb reconstruction was used intensively. However big toe from the aesthetic point of view is wider in antero-posterior and transverse dimensions than the thumb. The square shaped appearance and big size of the distal pulp of the great toe in the face of rounded and smaller distal pulp of the thumb are also disadvantages of big toe transfer for thumb reconstruction⁽¹⁶⁾. This calls some^(14,16) to invent their sophisticated techniques to reduce both dimensions to match the size of the thumb. *Morison in 1980*⁽¹³⁾ used big toe wrap-around flap and *wei in 1996*⁽¹⁶⁾ have done big toe trimming either primarily or secondarily and found that is useful in reducing big toe size without any drawbacks. Wei also claimed that great toe transfer is better than lesser toes from the aesthetic point of view, in spite he needed to do reduction in both dimensions over a protracted period of time to get the ideal size match and contour between the reconstructed thumb and the normal thumb. In this report the size match, length, and posture of second toe was found to be near normal to thumb where there is no requirement for more sophisticated steps that can add more risk factors for (Figures 1A, 2A,E).

Proper length of the reconstructed thumb is of paramount importance. Ideally the thumb should not exceed the proximal interphalangeal joint of index finger^(3,17,18) (Figure 2E). Second toe transfer allows the harvest of the required length for thumb reconstruction. In this report 3 distal phalangeal, 2 middle phalangeal, and 5 metacarpal levels reconstruction of the thumb were done using second toe. Preoperative evaluation of the length required was done. Intraoperatively disarticulation of second toe at the level of metatarsophalangeal (MTP) joint level (Case no.3), and bone sawing at the level of phalanges (Case no.4) or metatarsals (Case no.1,2,5,6,7,8,9,10) was done to match the level of thumb reconstruction without any morbidity.

The most common drawback of the second toe transfer is its tendency to claw and/or drum stick appearance^(16,19). However, tightening of the extensor tendon repair, fusion of the distal interphalangeal joint in extension, and prolonged use of a nighttime

splint to keep the proximal interphalangeal joint in extension, will aid in preventing a claw appearance of the reconstructed thumb. The author used to put k-pin fixation for 4 weeks postoperatively to keep the distal interphalangeal joint in extension and the patients were advised to apply finger splint at night for around 1 year and found this protocol works well.

Secondary procedures after toe transfer are possible. Contour matching and / or tenolysis are among these secondary procedures required. There were no need for contour matching in any of the 10 cases reported here, however 2 cases (Case no. 4,10) required tenolysis.

Conclusion

The optimal appearance of the reconstructed thumb can be achieved by careful evaluation of the differences in size, shape and length between the reconstructed thumb and the transferred toe. The advantages of the second toe transfer are minimal donor site morbidity, excellent appearance and good function, making it the author's preferred toe for any level of thumb reconstruction.

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