RECONSTRUCTION OF THUMB IN TRAUMATIC OR CONGENITAL LOSS

Pages with reference to book, From 10 To 17

Tahseen A Cheema, Mohammed Amin Cheema (Quaid-e-Azam Medical College and Bahawal-Victoria Hospital, Bahawalpur.)

ABSTRACT

Reconstruction of thumb after traumatic or congenital loss in 17 cases is reported. Cases were divided into three groups according to the level of thumb loss. There were two cases in distal zone, seven in middle and eight in proximal zone. Thirteen cases were traumatic in origin and four had congenital loss. Different reconstruction procedures were used at each level. Osteoplastic reconstruction for the middle zone and index finger pollicization for proximal thumb loss are considered to be most useful methods of thumb reconstruction if microsurgical facilities are not available (JPMA 42:10, 1992).

INTRODUCTION

Thumb is the most important digit of the hand. Its location and specialized muscular control provides the hand most of its pre hensile function. Due to its rotatory, abductor, flexion and adductor mechanisms it is able to oppose all the fingers which is essential for all the intricate functions of the hand. Loss of thumb as a result of injury or by congenital absence causes tremendous disability. Out of eight basic functions of the hand[1], only two, i.e., hook grip and flat hand functions can be performed without the thumb. Opposition, precision pinch, pulp pinch, key pinch, chuck grip, large object grasp and power grasp are all compromised if all or part of thumb is absent. Phalangization, use of pectoral flap, policization, big and second toe transfer and wrap around technique have been used for the reconstruction of the thumb[2-5]. We are reporting our experience with reconstruction of thumb in 17 patients at different levels.

PATIENTS AND METHODS

During 1988 and 1990 seventeen patients underwent reconstruction of their thumbs in Bahawal Victoria Hospital. Thirteen presented with loss of whole or portion of their thumbs secondary to trauma and 4 had congenital absence of hypoplasia of thumb. Age ranged from two to forty five years with average being eighteen years. For traumatic cases average age was 21.4 years ranging from 5 to 45 years. In congenital cases age range was from 2 to 19 years with average at 7 years. For appropriate selection of method for reconstruction in an individual case, the loss of thumb was divided into proximal, middle and distal levels[6]. Amputations or injuries at or distal to interphalageal joint are considered to be in distal zone. From the head of first metacarpal to interpha langeal joint is the middle zone. This zone is further divided into proximal and distal parts. Proximal to the head of first metacarpal is the proximal zone. In this study 2 injuries were in distal, 7 in the middle and 8 in the proximal zone. Loss of thumb was traumatic in 3 and congenital in 4 cases. In two congenital cases thumb loss was associated with radial club hand deformity. Other two cases had fourth degree thumb hypoplasia. Thumblet was attached to the hand by a very narrow soft tissue tube, the so called, floating thumb or pouce flottant. Seven of the traumatic cases were secondary to farm or industrial machine accidents, two due to gunshot wounds, two from printing press injuries and two were avulsion injuries. In the distal zone, one case (Figure 1)

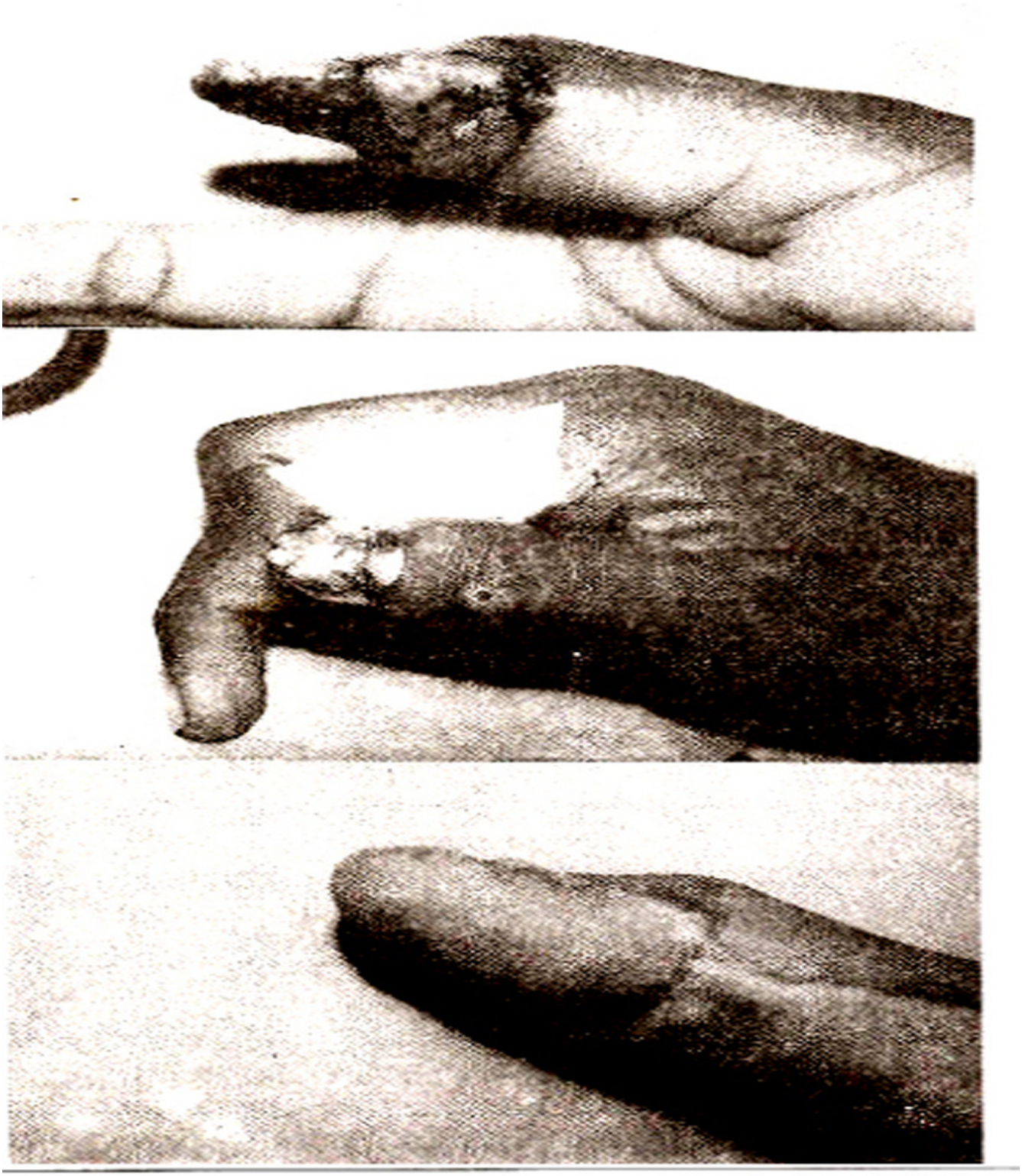

Figure 1 (Case 1) A: Injury of thumb in distal zone with complete loss of pulp. B: Reconstruction with cross finger sensory flap. C: Final cosmetic result with normal two point discrimination.

with complete loss of volar pulp was treated with cross finger sensory flap using the technique described by Sucar and Radivojevic[7]. Second case in this zone had amputation through interphalangeal joint with degloving of thumb at more proximal level. In this case reconstruction was achieved by radial forearm flap. In the middle zone, one case had amputation of thumb through distal part of middle

phalanx. In this case reconstruction was done by deepening the first web i.e., phalangization and increasing the apparent length of the thumb. Other six cases had thumb loss in the proximal part of the middle zone. One case who also had amputation of index finger through proximal phalanx was treated with finger stump pollicization (Figure 2).

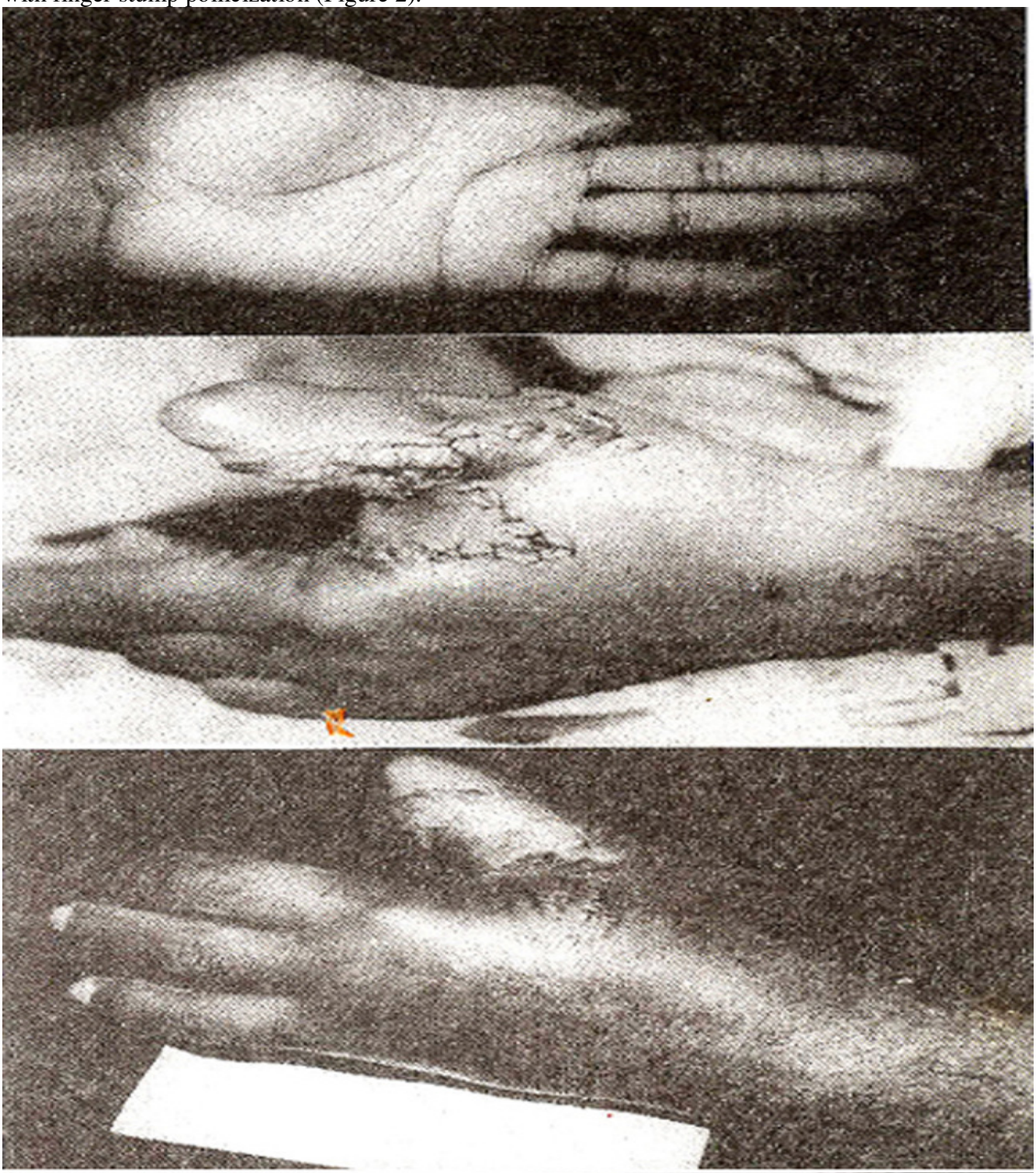

Figure 2 (Case 7) A: Amputation of thumb through proximal portion of middle zone with amputation of index finger. B: Index finger stump pollicization. C: Appearance two weeks post-operatively.

In three cases traditional osteocutaneous reconstruction was used (Figure 3).

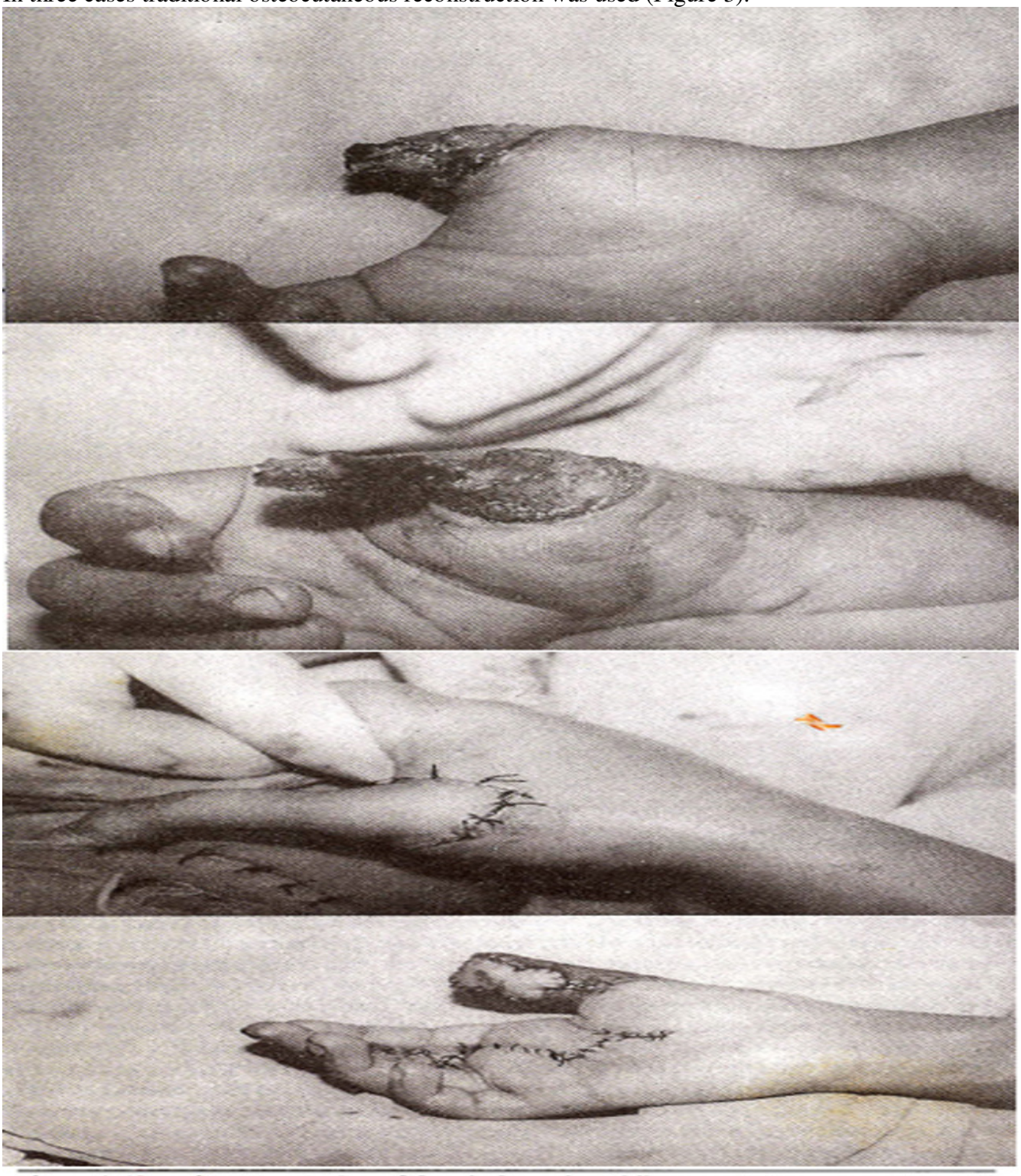

figure 3 (Case 4) A: Amputation of thumb through middle zone. B: Reconstruction with osteoplastic method. Bone graft from iliac crest. C: Skin coverage with groin flap. D: Second stage -- Neurovascular island flap to improve sensation and appearance.

Bone graft was taken from iliac crest and was covered with groin pedicle graft. Two of these cases had subsequent transfer of island pedicle sensory fiat from the radial side of middle finger to improve the sensation over the opposing surface of the newly reconstructed thumb. The third case, a child is using

the thumb very effectively and has protective sensation and has not required transfer of island flap (Figure 4).

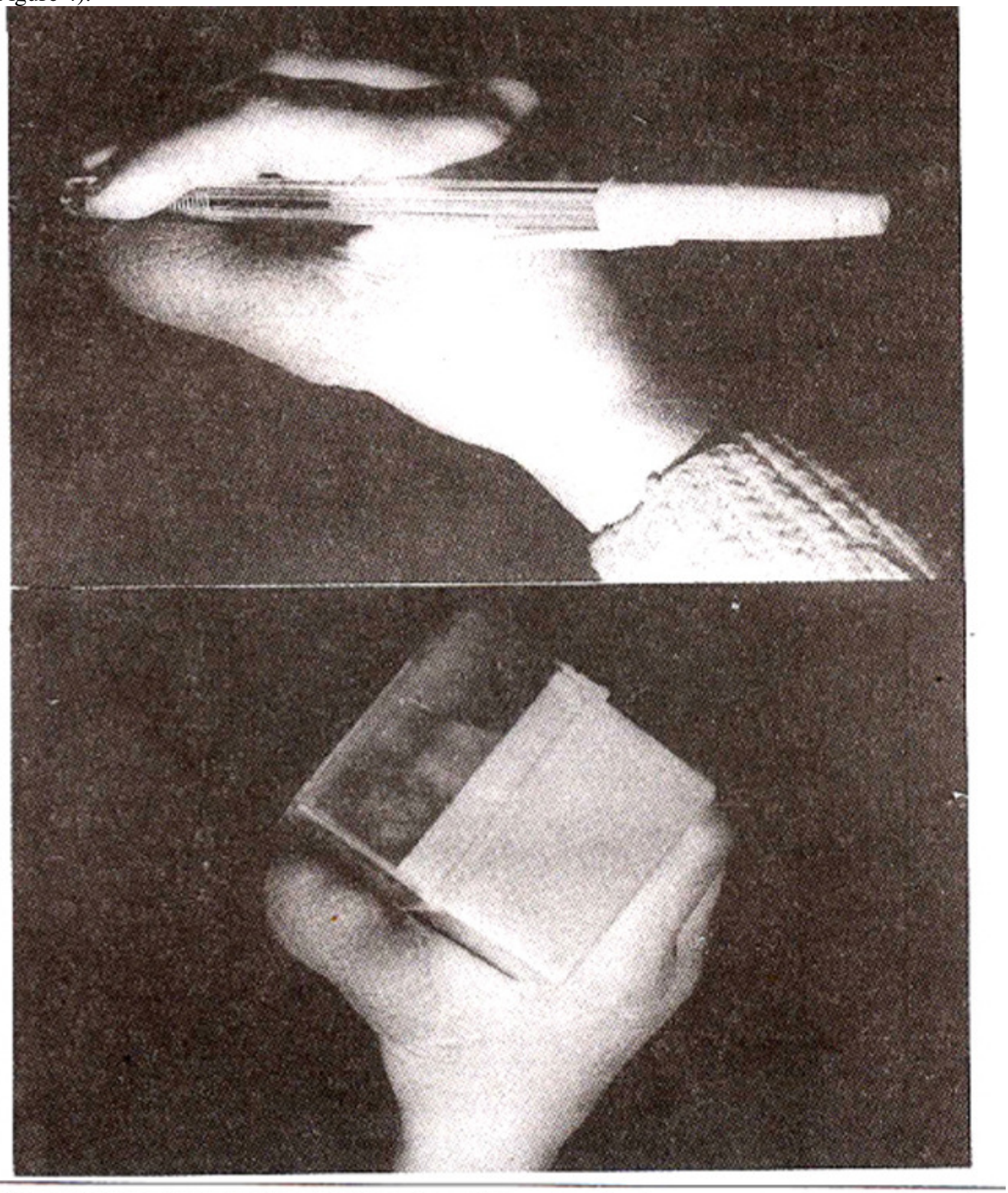

Figure 4 (Case 6) A: Prehensile function after osteoplastic reconstruction. B: Grasp for large objects.

In two cases one stage reconstruction was achieved usingradial artery forearm osteocutaneous sensory flap (Figure 5).

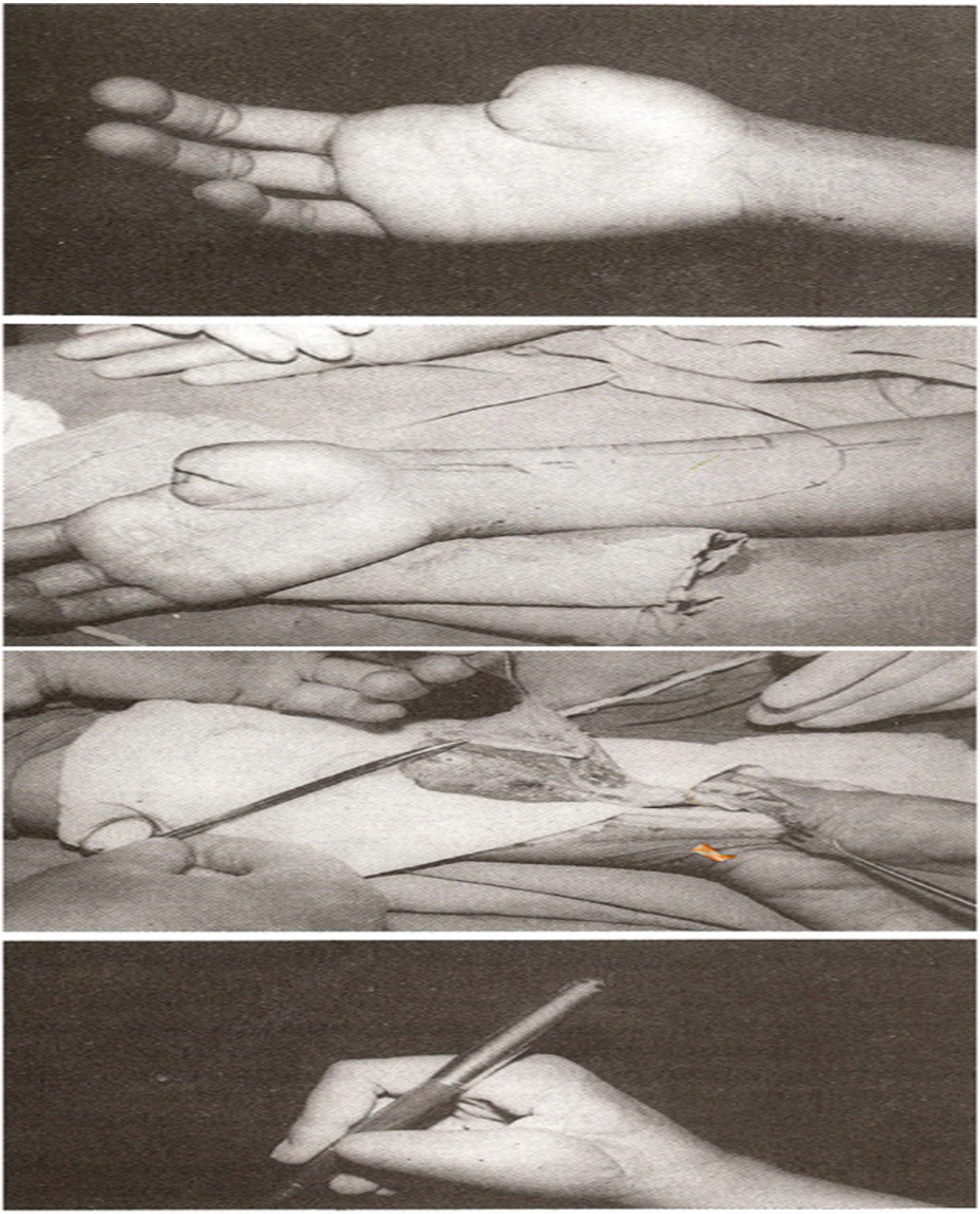

Figure 5 (Case 8) A: Amputation of thumb just proximal to metacarpal head and amputation of index finger. B: Reconstruction with radial artery forearm osteocutaneous sensory flap. Outline of incision. C: Skin flap and portion of radius is harvested based on distal part of radial artery. D: Cosmetic and functional result.

Both of these flaps were used as sensory flaps by transferring the antebrachial cutaneous nerves with the flaps and anastomosing them with the digital nerves of thumbs. In the proximal zone, four cases were traumatic in origin and four were congenital. In all the cases index finger pollicization was used for reconstruction of thumb (Figure 6).

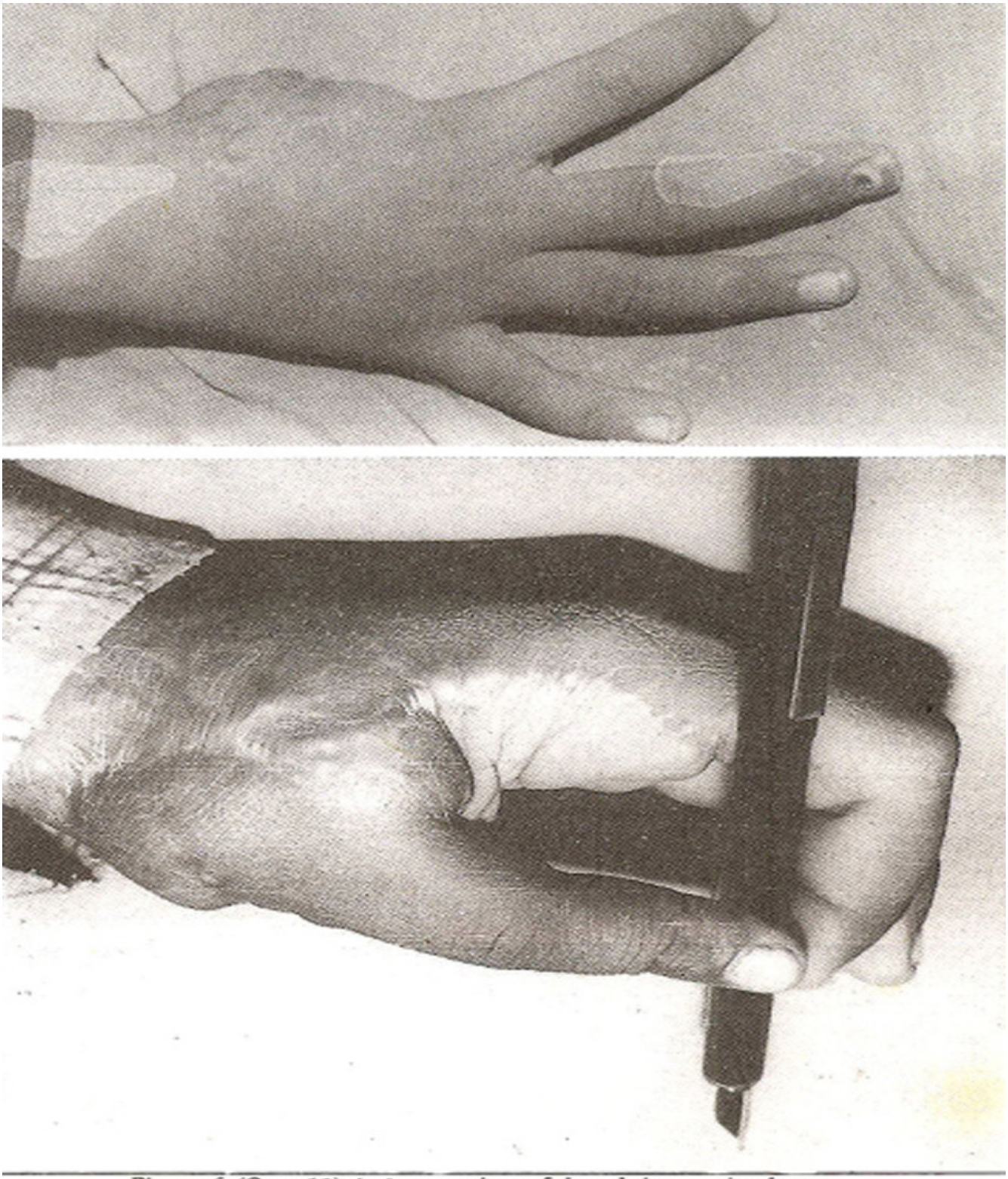

Figure 6 (Case 11) A: Amputation of thumb in proximal zone.
B: Index finger pollicization.

In all traumatic cases trapeziometacarpal joint was present. Basically in all of these cases Euler's technique for pollicization of index finger was used with some modifications in the incision due to local conditions of skin and scar[9,10]. In one of these cases (case 12) both digital arteries of the index finger were found to be lacerated after making incision but the procedure was success fully completed

by transferring the digit based on deep metacar pal arteries. In congenital cases with isolated thumb hypoplasia, Blauth incision was used in one case and Buck-Gramcko[4] incision was used in the other case (Figure 7).

Figure 7 (Case 15) A: Congenital loss of thumb with pouse floutant. B and C outline of incision. D: Appearance at completion of procedure. E and F prehensile function.

In these cases metacarpophalangeal joint of the index finger was preserved and was transformed into trapeziometacarpal joint by fixing the head of metacarpal in hyperextended position, the head acting like a trapezium. Its growth plate was destroyed before fixation. Muscular stabilfzation in the newly reconstructed thumbs was achieved as described by Buck-Gramcko[11]. The two cases of congenital absence of thumb associated with radial club hand were treated with correction of wrist deformity and index finger pollicization in one stage as described by Tsuge and Watari[12]. All of these cases were followed and evaluated in the hand clinic of B.V. Hospital. They were discharged from follow-up only

after it was considered that maximum function has been regained. No patient was lost from follow up.

RESULTS

The clinical data and results are summarized in Table.

TABLE.

No.	Patient	Age	Sex	Mechanism of injury	operation	Postoperative status
				Distal Zone		
1	M.R.	25	M	Machine injury	Cross finger sensory flap	Normal two point discrimination. Good cosmetic appearance. No pain.
2	M.A.	12	M	Avulsion injury	Radial artery forearm flap	Protective sansation. Reasonable appearance. No pain.
				Midle zone		
3	M.I.	10	M	Gun shot wound	Phalangization	Improved prehension.
4	A.R.	6	M	Machine injury	1. Bone graft and groin flap tuboplasty 2. Neurovascular island flap	6 mm two point discrimination over N.V. island flap. Good appearance. No pain.
5	M.H.	20	M	Printing press injury	1. Bone graft and groin flap tuboplasty 2. Neurovascular island flap	8 mm two point discrimination over N.V. island flap. Good appearance. No pain.
6	A.B.	5	F	Avulsion injury	Bone graft and groin flap tuboplasty	Protective sensation. Acceptable appearance. Using thumb very effectively.
7	M.R.	25	M	Farm machine injury	Index finger stump pollicization	Improved length and prehension. Reasonable appearance.
8	F.T.	24	F	Fodder cutting machine injury	Radial artery forearm Osteocutaneous sensory reconstruction	Good appearance. Protective sensation. No pain. No symptom related to forearm scar.
9	M.A.	45	M	Farm machine injury	Radial artery forearm osteocutaneous sensory reconstruction	Reasonable appearance. Protective sensation. No symptom related to forearm scar.
				Proximal zone		
				Proximal zone		
10	Z.H.	25	M	Press machine injury	Index finger pollicization	Excellent cosmetic appearance. Normal two point discrimination. Good muscular control and opposition
11	M.I.	16	M	Wheat thresher injury	Index finger pollicization	Good appearance, prehensile ability and opposition.
12	M.A.	25	M	Industrial machine injury	Index finger pollicization	Improved prehension. Stiffness of IP joint due to previous injury.
13	M.A.	39	M	Gun shot injury	1. Groin flap for skin coverage 2. Index finger pollicization	Developed temporary tourniquet paralysis. Good appearance. Improved prehension.
14	I.A.	3	M	Congenital Blauth IV hypoplasia	Index finger pollicization Blauth incision	Good appearance. Good key pinch but ineffective precision pinch.
15	I.A.	4	M	Congenital Blauth IV Hypoplasia	Index finger pollicization Buck-Gramcko incision	Excellent cosmetic and functional improvement.
16	H.R.	19	M	Congenital Radial club hand and Blauth V hypoplasia	One stage centralization of wrist, recession of 2nd metacarpal and index finger pollicization	Good cosmetic improvement but poor muscular control of reconstructed thumb. Needs further tendon transfers.
17	Z.B.	2	F	Congenital Radial club hand and Blauth V hypoplasia	One stage centralization of wrist, recession of 2nd metacarpal and index finger pollicization	Good cosmetic improvement.

Distal zone: There were two patients in distal zone. The patient who had a sensory cross finger flap achieved two point discrimination of 6 mm. There was no complaint of pain or hypersensitivity. Cosmetic appearance was considered to be excellent (Figure 1). His ability to handle small and large

objects was comparable to his other hand. Other patient had a radial forearm flap. She achieved only protective sensation over the tip of her thumb but her manual dexterity was good. There was no complaint of pain. She was offered an island neurovascular flap to improve sensation over the tactile portion of the thumb but patient was satisfied with the status of her thumb and declined further surgery. Middle zone: In distal portion the only case was dealt with phalangilazation. His grasp and ability to handle large and medium size objects was considerably improved. In proximal portion three cases had conventional osteoplastic reconstruction of their thumbs. Two patients had second stage neurovascular island flap transfer from radial side of middle finger. All three of these patients were satisfied with the appearance of their reconstructed thumbs and were using them very effectively (Figure 4). Two point discrimination over the neurovascular island flap area was six and eight millimeters in two cases. The patient who did not have second stage island transfer, had good protective sensation and almost normal use of her thumb. No need for further surgery was felt. In none of these cases there has been breakage or absorption of the bone graft. One case in this group was treated with pollicizadon of index finger slump. Appearance of the hand improved and prehensile ability of the hand became normal except the precision pinch in which patient had some difficulty. In two patients reconstruction was done with one stage radial artery forearm osteocutaneous sensory flap. Period of total disability was much reduced. Appearance in both cases was good and both developed protective sensation (Figure 5). Follow-up period is short and with the time we expect further improvement in sensory level. Proximal zone: There were four cases secondary to traumatic loss of their thumbs. All were treated with index finger pollicization. There was no incidence of vascular complication of loss of the transferred digit. In one case (case 12) both digital arteries were found to be lacerated on exploration but the transfer was successfully carried out based upon deep metacarpal arteries. One case (case 13) developed temporary tourniquet paralysis. It recovered without any residual deficit. The appearance of recon structed digits was from good to excellent (Figure 6). In two cases there was impression of new thumb being somewhat longer as compared to normal thumbs though the actual length was equal. In case 12 PIP joint of the transferred digit was stiff due to previous injury. In all of these cases there was preservation of the base of first metacarpal and part of thenar muscles, there was good control of movement of thumb and opposition. None of these cases needed further tendon transfers. In congenital case with isolated deformity, there was excellent cosmetic improvement and parents were highly pleased. There was good muscular control of reconstructed thumbs and in one case there was true opposition (Figure 7). In other case we planned to perform further tendon transfer to improve opposition of the thumb. In two cases associated with club hand there is good cosmetic improvement of both deformities but muscular control of thumb is poor and need further tendon transfers. In one case (case 16), being twenty years of age at the time of reconstruction, age is also a factor. But the patient is very much satisfied with the improvement in appearance.

DISCUSSION

Loss of thumb is a serious injury and amounts to thirty to forty percent loss of function in disability evaluations. Appropriate reconstruction surgery provides the patient with an opportunity to gain useful function of the thumb. Quality of function depends upon level of pre-existing function of hand, surgical technique, postoperative care and the patient's integration of the recon structed thumb. Functional requirements in reconstruction of thumb are partly mechanical like correct length, position and stability and partly physiological like strength, movements and sensibility[10]. Aims of reconstruction are to be established sufficient forceful flexion-extension to permit grasp and ability to oppose at least one and preferably two fingers. Tactile sensation over volar-ulnar aspect of the reconstructed thumb is essential and appearance should be acceptable to the patient. Choice of surgical technique depends upon level of thumb loss, patients needs, desires and cultural background and available facilities. With the

advancements in microsurgical techniques, replantation of amputated digits has become highly rewarding and predictable surgical affair in suitable cases. Amputation of thumb is always a very strong indication of replantation. Excellent restoration of function after replantation of thumb has been reported by several authors[13,14]. Replantation, when successful, is more beneficial than any type of reconstruction. Microsurgery has also provided many innovative techniques for reconstruction for almost all levels of thumb loss. As micrósurgical facilities are not available in our unit, we have been restricted in our choice of techniques for reconstruction to more conventional methods. Distal third of thumb has been described as "compensated amputation zone". Thumb can function quite effectively without addition of length. More important requirements in reconstruction are to provide well padded painless skin and satisfactory sensory perception. There are numerous methods available for reconstruction at this level. They range from spontaneous healing by secondary intention, free skin graft, V-Y flaps, advancement flaps, NV island flaps, to many types of cross finger and regional flaps. Our case with complete pulp loss in this zone (case 1), managed by sensory cross finger flap, has near normal two point discrimination and excellent cosmetic appearance. Advantage of this technique is that sensation is conveyed through digital nerves of thumb and there is no problem of cortical reorientation and we feel it may be superior to NV island flap technique for this problem. Other case in this zone had a degloving injury at more proximal levelin addition to amputation through interphalangeal level. Use of radial forearm flap or so called "Chinese flap", afforded a one stage reconstruction with stable skin coverage. Other alternatives would have been use of distal flap or free flap. Free flap would require microsurgical facilities and use of distant pedicle flaps have their own disadvantages. In the distal part of middle zone, phalangization increases the grasping ability by deepening the first web and increasing the mechanical advantage. It is suitable if patient does not opt for more complicated procedures. If microsurgical facilities are available more sophisticated techniques like toe to thumb transfer or wrap around technique would be preferable. In the proximal portion of middle zone, addition of length may substantially improve the function if satisfactory sensation can be restored[6]. Available methods for reconstruction at this level are pollicization of an injured finger stump, "cocked hat" flap, metacarpal lengthening and osteoplastic reconstruction. This is the most suitable level for toe to thumb transfer with microsurgical technique[15]. Pollicization of index finger stump adds length to the thumb and also deepens the first web space. It improves the overall appearance and function of the hand[7]. Osteoplastic recon struction is a time honoured technique. Advantage of this tech nique are: (1) no finger or toe is sacrificed, (2) with addition of NV island flap durable skin with intact sensation covers the more important contact areas, (3) length equal to normal size can be restored[9]. Disadvantages inherent in a multi-stage procedure have been overcome by use of radial artery forearm flap containing vascularized bone graft from distal radius and innervated by. anastomosis of lateral antebrachial nerve of the forearm to digital nerve of the thumb[16,17]. In the two cases we used this technique, both recovered protective sensation over the reconstructed thumbs. It substantially reduced the disability time and appearance was quite reasonable. In proximal zone pollicization of index finger is the classic procedure and gives superior cosmetic and functional results than any other techniques. 'When this can be performed without severe damage to the rest of the hand, pollicization gives results better than microsurgical techniques. Its advantages are: that is strictly a local operation, has no vascular problem as no anastomosis is required, has perfect sensation without a blind period, a good mobility is acquired if the transferred digit was not injured and finally has very pleasing cosmetic appearance. Disadvantages are a decrease in grip strength and width of hand. In congenital cases, reconstruction of trapeziometacarpal joint by using metacarpophalangeal joint of index finger restores the mobility at the base of the thumb. Careful reconstruction of tendons and intrinsic muscles is necessary for balance, stability and true opposition in the pollicized digit.

REFERENCES

1. Lister, G. The hand; diagnosis and indications. Edinburgh, Churchill Livingstone, 1984, p. 19.
2. Littler, J.W. On making a thumb: one hundred years of surgical effort. J. Hand Surg., 1976; 1:35 -51.
3. Liuler, J.W. The neurovascular pedicle method of digital trans position for reconstruction of the thumb. Plast. Reconstr. Surg., 1953; 12:303-319.
4. Buck-Gramcko, D. Pollicization of the index finger. Method and results in aplasia and hypoplasia of the thumb. J. Bone Joint Surg., 1971; 53A:1605.
5. Morrison, W.A., O'Brien, B.M. and McLeod, AM. Thumb reconstruction with a free neurovascular wrap-around flap from the bigtoe. 3. Hand Surg., 1980; 5:575 -583.
6. Strickland, J.W. Thumb reconstruction, in operative hand surgery. Edited by D.P. Green. Edinburgh, Churchill Livingstone, 1988, p. 2175,
7. Sucar, D. and Radivojevic, M. Cross finger flap. A new technique. 3. Hand Surg., 1985; 10B:452.
8. Chacha, B.,Soin, K. and Tan, K.C. Oncstage reconstruction of intercalated defectofthe thumb usingthe osteocutaneous radial forearm flap. J. Hand Surg., 1987; 12B:86-92.
9. Hentz, V.R. and Littler, 3W. Traditional techniques for thumb reconstruction; guidelines for indications, in reconstruction of thumb. Edited by A. Landi. London. Chapman and Hall Medical, 1989, p. 170.
10. Littler, J.W. Reconstruction of the thumb in traumatic loss, in reconstructive plastic surgery. Edited byJ.M. Converse. Phila delphia, Saunders, 1977, p.3352.
11. BuckGramcko, D. Thumb reconstruction by digital transposition. Orthop. Clin. North Am., 1977; 8-2:329-342.
12. Tsuge, K. and Watari, S. New surgical procedure for correction of club hand. J. Hand Surg., 1985; 10-B:90 -94.
13. Early, M.J. and Watson, iS. Twenty-four thumb replantations. 3. Hand Surg., 1984; 9B:102.
14. Klienert, HE., Juhala, C.A., Tsai, T.M. and VanBeek, A. Digital replantation selection, technique and results. Orthop. Clin. North Am., 1977; 8-2:309 - 31&
15. Michon, 3. Present state of thumb reconstruction, in reconstruction of thumb. Edited by A. Landi. London, Chapman and Hall medical, 1989. p. 297.