

Primary Thumb Reconstruction in a Mutilated Hand



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KEYWORDS

• Ectopic replantation • Toe-to-hand transfer • Partial thumb defects • Mutilating injuries

KEY POINTS

- Thumb reconstruction is the priority in any reconstructive plan.
- Toe transfer is an effective method of thumb reconstruction.
- Trim toe transfer (from great toe) gives better result than second toe transfer.
- Reducing the donor site morbidity by transfer of second toe to the harvested great toe site increases patient satisfaction and acceptance of the procedure.
- Conventional techniques like pollicization and Littler neurovascular island flap can be helpful in patients who decline toe transfer or do not have toes.

INTRODUCTION

Without doubt, the most effective way of restoring the amputated thumb function is by replanting it. Any major effort is justifiable to do so. This article discusses succinctly the classic alternatives and expends more time on others. **Box 1** summarizes the ideal methods (the first being replantation, not discussed here) and contains the topics dealt with in this article.

Ectopic Banking

Ectopic banking was first described by Marco Godina.¹ It consists of temporarily reconnecting an amputated or devascularized element in a nonanatomic position. The main reasons for doing so are in cases where there is concomitant major soft tissue damage around the thumb or if the patient is critically ill, and thus major surgery is not wise. The rationale to indicate ectopic

banking in the former case is that debridement can be staged, and cover can be delayed, while in the latter, surgery can be carried out expeditiously and under regional anesthesia. Most authors have found the ideal place for ectopic replantation as the contralateral forearm.² Generally, after several weeks, the digit is elevated in continuity with the radial artery and local veins, thus preserving the previous anastomoses, and planted in the proper location. In most published cases, a flap in continuity, or a flap from another location, is needed concomitantly. This is so, because as stated previously, the major indication for ectopic replantation is precisely an associated soft tissue defect.

The authors must confess that their personal experience with ectopic banking of digits is nil. This is so, because although there is an indication for resorting to ectopic replantation in the fatidic

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Box 1

Summary of the methods the authors use to deal with thumb amputation

- **Replantation**
- Ectopic banking
- **Ectopic replantation (spare parts)**
- Intercalated defects:
 - **Partial toe transfer**
- Terminal defects:
 - Littler flap
 - Pollicization
 - **Toe-to-hand transfer**

The authors' preferred methods are in bold.

coincidence of a major soft tissue defect around the amputated thumb and a critically ill patient, the authors believe most other cases can be solved by means of combining a (flow-through) free flap at the same time as the replantation. Despite the fact that at first glance it may be considered as a nonsensical venture, thinking objectively, it is not. The flap permits one to skip the area of damage in the thumb and proximal stump, allowing much faster and safer anastomoses, as the surgeon can much more radically debride damaged tissues. The authors' preferred flap is the dorsalis pedis (**Fig. 1**), but the contralateral radial forearm flap (perhaps the only indication the authors have found for using this flap presently) is even better.

Lesser catastrophic soft tissue losses can be dealt by local flaps. For dorsal defects, the authors

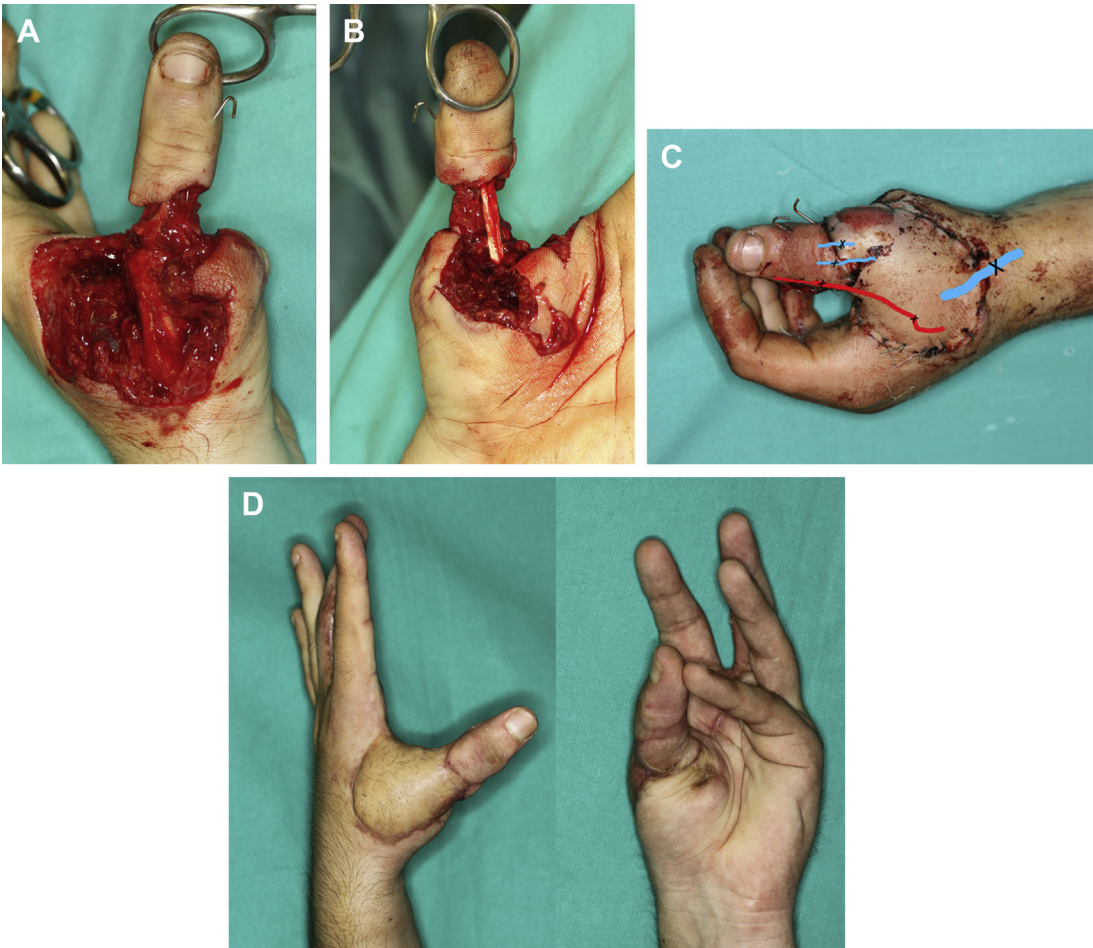


Fig. 1. (A) Status after debridement and fixation of the thumb in its position demonstrating massive soft tissue defect. (B) The dorsalis pedis flap has been used as an arterial and vein carrier. (C) Function 8 weeks after the accident. (D) Result. (Copyright © 2016 Dr Piñal.)

will underscore the utility of the first dorsal metacarpal flap as their preferred flap (Fig. 2).³ Not only will this flap permit closure of moderate size defects, but it can be used as a vein carrier, avoiding the use of interpositional veins. For palmar defects, the authors would opt for an island flap from the ulnar aspect of the index or radial aspect of the middle⁴ and transpose it to the volar aspect of the thumb. Not only will this provide cover, but also healthy arterial inflow.

Ectopic Replantation (Spare Parts Replantation)

Ectopic replantation consists of replanting a part away from its anatomic position. In the case here presented to replant an amputated finger onto the thumb position.

The authors' own results with ectopic replantation have not been as satisfactory as other authors might have found. The thumb that one obtains after such an operation is much less sturdy and thin, providing a poor surface for opposition. This is partly because any finger is thinner than the thumb, and because fat atrophy after replantation always occurs. Nevertheless, ectopic replantation has the unarguable advantage of not requiring sacrificing a toe. It should be stressed that a stiff index finger with poor sensibility will be skipped

during pinch. For this reason, the best indication for ectopic replantation is an amputated index finger proximal to the proximal interphalangeal (PIP) joint, and a nonreplantable thumb. The technique of ectopic replantation is exactly the same as standard replantation, except that the structures will not match. The surgeon has to be prepared to sort this problem out by using interpositional vein grafts as required, particularly for the veins (Fig. 3).

Major Intercalated Defects

A painful, insensate, or unstable thumb is, functionally speaking, as much use as having no thumb at all; the patient would not use it. So, despite the fact that it may look less dramatic than when a thumb is lost, the wary surgeon should try to use all resources when dealing with such scenarios.

Major defects of bone/nerve/soft tissue are managed in the authors' practice resorting to the toe, and in most circumstances to the second toe (Fig. 4).⁵⁻⁸

- Despite the modifications needed according to the contents of the flap, the technique of elevation is similar to all partial toe flaps. All dissection is carried out with 3.5× loupes, and the leg is exsanguinated by elevation. This is so, because it is crucial when dissecting the veins

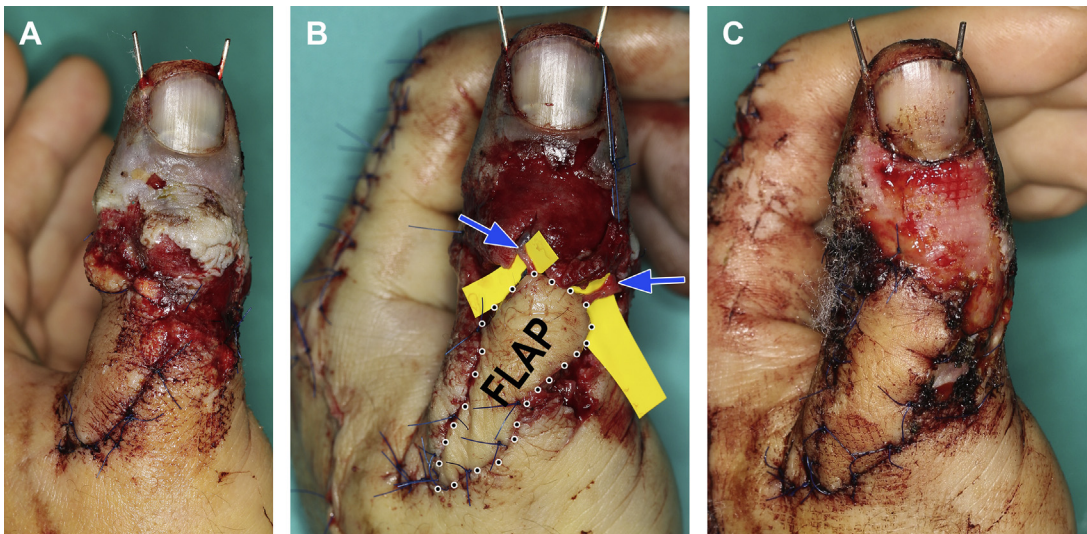


Fig. 2. (A) This patient was referred 48 hours after replantation for impending venous failure. The thumb drainage seemed to be strangled by the shortage of soft tissues, and the previous surgeons already used a local flap in attempt to overcome this, actually compounding the problem. (B) A 1.0 × 2.5 cm first dorsal metacarpal flap has been elevated from the dorsum of the index, permitting primary closure of the donor site. The flap eased the circular soft tissue constriction of the thumb, and most importantly carried 2 veins that re-established the amputated part drainage (blue arrows). (C) Complete survival at 2 weeks. (Copyright © 2016 Dr Piñal.)

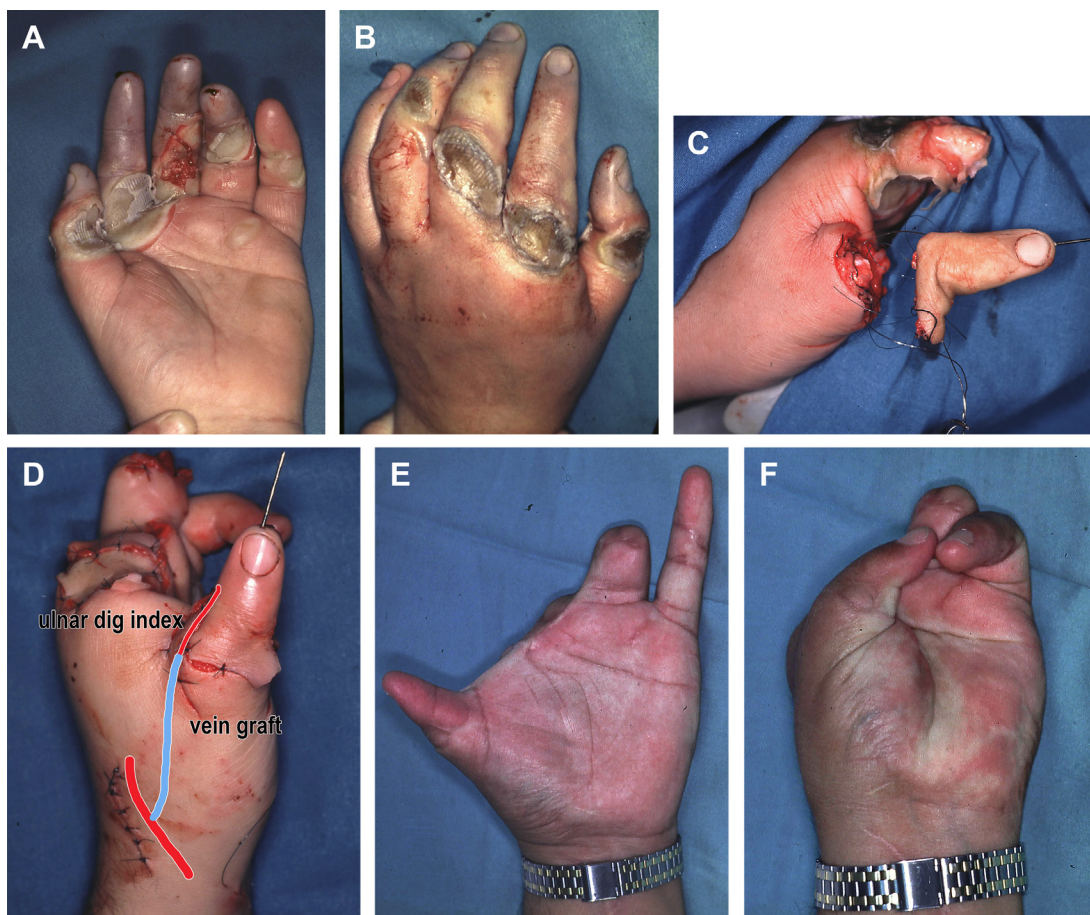
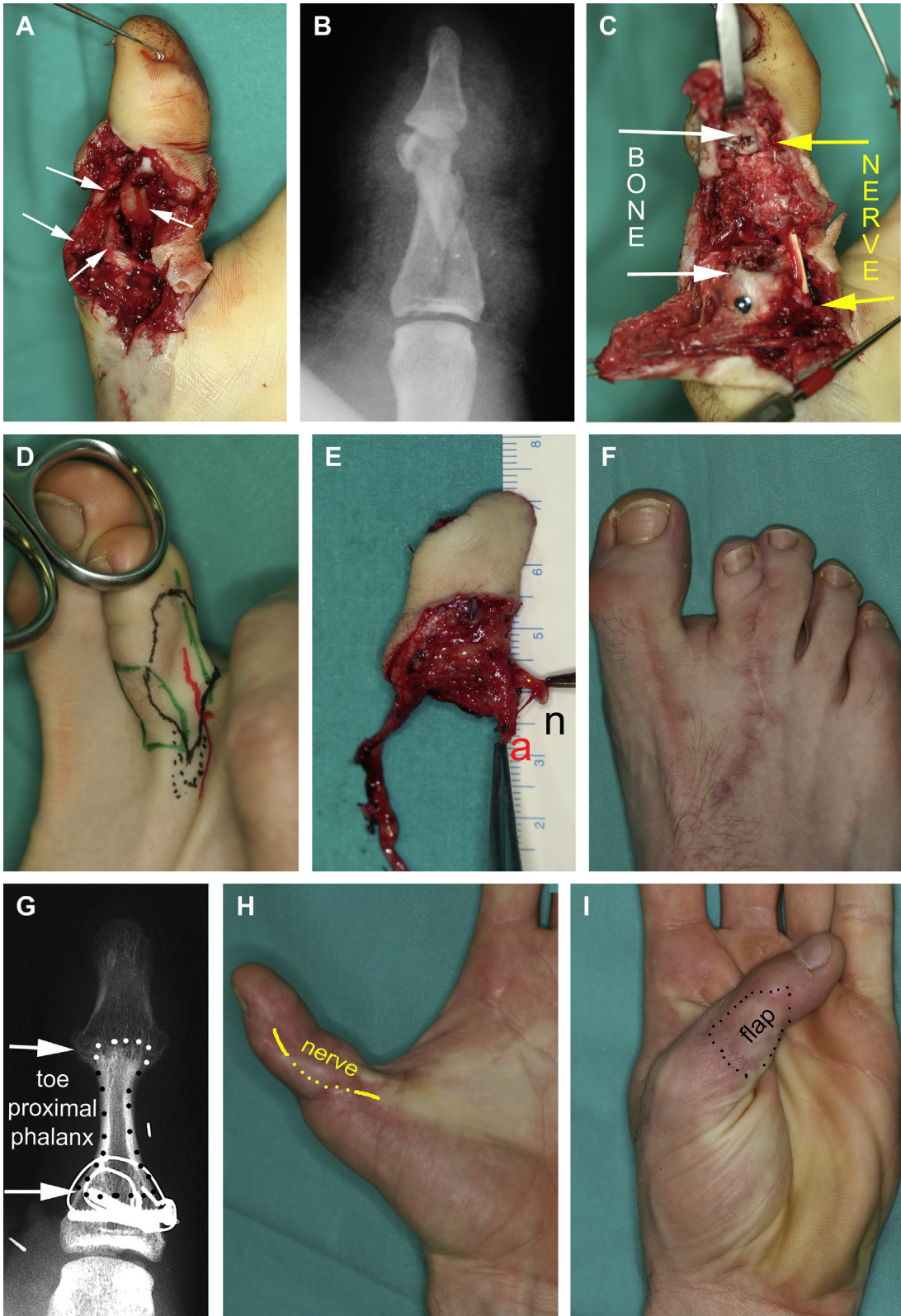


Fig. 3. (A, B) This patient suffered a hot-press injury 23 years ago (too early on in the first author's career for such a complex case). The fingers were unsalvageable, and only the index could be replanted in the thumb position (C). Primary arterial anastomoses to the thumb digital arteries provided only sluggish flow. (D) A long vein graft to the radial artery solved the problem. (E, F) The result is shown at 1 year. Note: a much better option would have been to replant the index distal to the PIP joint on the middle finger and then to carry out a second toe transfer to the stump of the ring finger and a hallux to the thumb. This patient was unwilling to pursue any reconstruction, perhaps influenced by the surgeon's hesitant attitude at the time of proposing the operation. Patients need to have a clear plan and a strong conviction by the surgeon that that is the best option. If not, in the authors' experience, they would reject reconstruction 9 times out of 10. See Fig. 9 for the current management of a similar case. (Copyright © 2016 Dr Piñal.)

that they contain some blood for identification. Vein harvesting is sometimes the most difficult part of the whole operation, as veins are very small, and might be easily damaged. The authors used to do the dissection of the veins going from the distal edge of the flap and then directed proximally. This is very time consuming, and the tiny veins are at risk. Now the authors prefer to dissect the veins in the dorsum of the foot and track the vein and its branches distally, to the proximal edge of the flap. This is much faster and safer. Contrarily, the digital artery is located distally and traced proximally. Usually the digital artery is the donor

artery, and the dissection stops at the toe web. Once the vessels are isolated, elevation of the flap itself is carried out expeditiously, by following the periosteum and flexor sheath plane with a knife. The nerve is included or not depending on whether it is needed.

- In the osseous variant, great care should be taken not to damage the connections of the soft tissue to the bone and the vessels. The bone type flap also adds some extra difficulties at the time of elevating the bone from the opposite side of the pedicle. The digital artery of the other side would remain as the only source of blood supply to the toe. Staying



close to the periosteum of the phalanx, one will safeguard the artery.

- Once the flap is fitted into position, the anastomoses are carried out. The authors' preferred suture technique is running suture with 10/0 nylon in a 100 μ needle for both artery and vein. Two or three epineural stitches with the same material are placed in the nerve.
- After completion of the anastomoses and just before tourniquet release, a bolus of 1500 U heparin is injected intravenously. Thereafter, a continuous infusion of heparin diluted in saline at a rate of 250 to 500 U per hour is given for 4 days, which is reduced by half on the fifth day. Patients are discharged on day, 6 receiving low molecular weight heparin for an average of 2 more weeks.
- The donor toe is rarely sacrificed. A skin graft applied to the periosteum is all that is required in the soft tissue variants flaps. When a phalanx is harvested, usually this is solved by a resection arthroplasty or arthrodesis. In some cases in which a large piece of bone has been harvested, a syndactyly with the third toe is carried out (see also [Fig. 8](#)).
- Postoperatively, the flaps are monitored by the help of Doppler and color of the flap by the nurse on an hourly basis for the first 48 hours, thereafter every 2 hours except at nights (every 3 hours) for 2 more days.

The authors have also faced the case of patients whose thumb is alive but marginally perfused by dorsal arterial branches. If left untreated, the end result is a shrunken thumb with dystrophic nail, minimal sensibility, intolerance to minor temperature changes, and pain (ie, a useless thumb). To prevent this scenario, or to treat it in the subacute setting, flow-through versions of the second toe neurocutaneous flap are unparalleled.⁹ This type of flap provides good cover (always needed), and, at the same time, pristine quality vessels to skip small defects ([Fig. 5](#)).

TERMINAL DEFECTS

Box 2 summarizes the methods available in the literature to reconstruct terminal defects. The

authors must advance that the discussion of this subheading is going to be biased. In the authors' hands, the results a toe transfer gives to the patient are unsurpassed by any other method. This restricts the authors to rarely or never recommend some of the techniques available.

For example, in the authors' practice, it is difficult to find an indication for operations such as the Gillies cocked-hat, or the Matev first metacarpal lengthening. These time-honored methods are out of the current dot-com world in the authors' view. Although a bone lengthening may be better than nothing, the procedure at best procures a very poor thumb: no nail, no pulp, and usually too short of a thumb. These patients for whom those solutions may have served, totally appreciate when a proper reconstruction is performed ([Fig. 6](#)).

Conversely, other alternatives (eg, the Littler flap, pollicization of an index finger and, particularly, pollicization of a useless stump) might have a role in the armamentarium. The first is reserved for patients who have an exposed skeleton and do not want a toe transfer at any price. Pollicization is for the same group of patients who have no bone framework to cover. Pollicization of a useless stump, however, can be a definitive operation or might serve to reduce the needs from the foot. The authors often use this last option, and very rarely the first 2 options.

These 3 procedures are based on the same principle: to skeletonize the part to be transplanted in the volar arteries and nerves and move it as an island to the new location.

The Littler flap¹⁰ consists of a neurovascular flap taken from the ulnar aspect of the middle finger and transposed under a tunnel to the pulp area of the thumb, thus providing sensibility to the pulp. Classically, the flap was the last stage after a neo-thumb reconstruction with a tube flap, usually an osteocutaneous flap from the groin, to provide sensibility to the palmar aspect of the thumb. According to Littler, there was no need to connect any nerve, as the patient will learn to reorientate the sensibility from the middle finger to the thumb. The authors, as several others have, have found that patients actually may be permanently disoriented, and might not use the thumb due to this

Fig. 4. (A, B) This 19-year-old patient sustained a crush to his left thumb. (C) Apart from the obvious bony loss and interphalangeal joint destruction, the radial digital nerve and a soft tissue cover were missing all along the radial aspect of the thumb. (D–F) An osteo-neuro-cutaneous flap harvested from the fibular side of the second toe, which included the proximal phalanx, the fibular digital nerve (n), and the skin, based on the fibular digital artery (a), allowed the compound defect to be reconstructed in 1 stage. The donor site was closed by primary syndactyly. (G–I) Result at 6 months. (Copyright © 2016 Dr Piñal.)

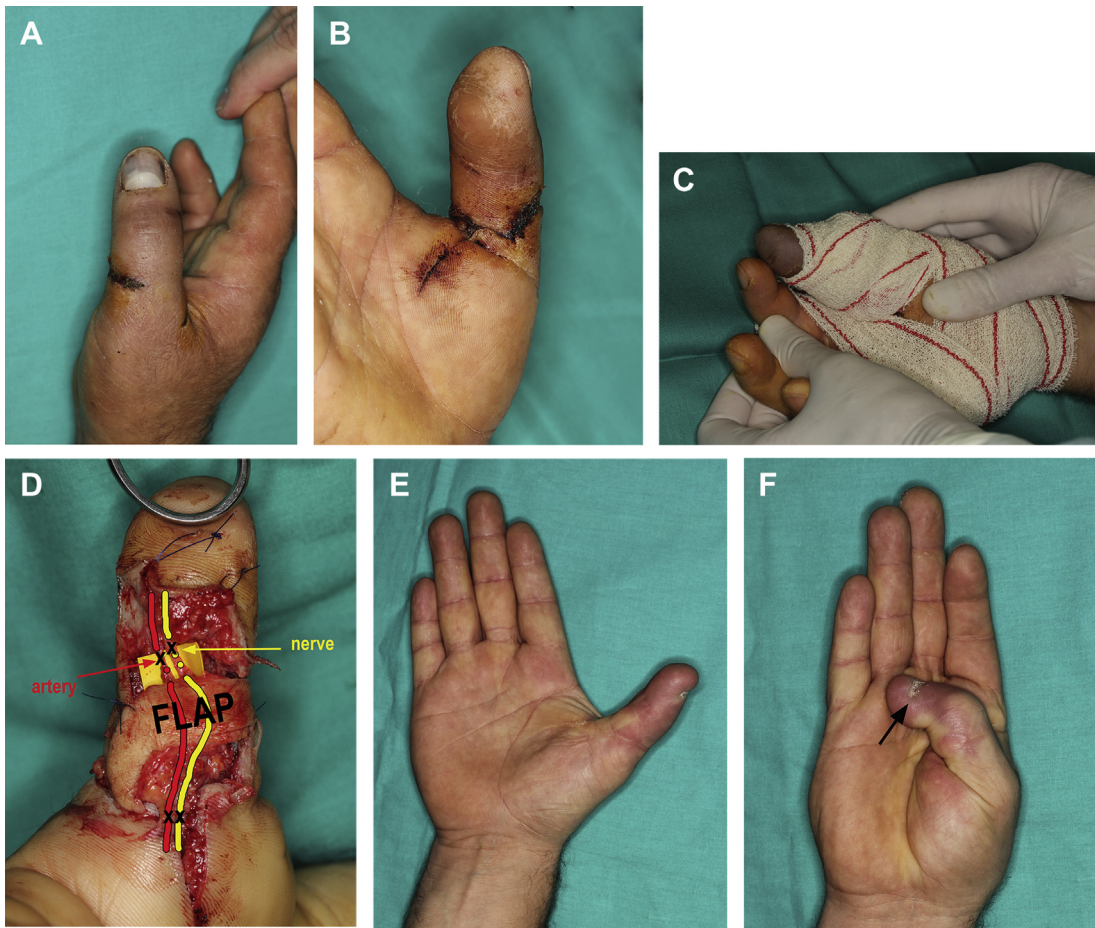


Fig. 5. (A) This patient was referred 3 weeks after his injury with an insensate and hypovascularized thumb after having sustained a near-circular injury. No Doppler sign could be detected. The marginal blood supply can be inferred by the bluish discoloration of the nail bed (B) and is much more evident at the time of surgery when the tourniquet was released (C). (D) A second toe neurovascular flap restored the arterial inflow as well as the ulnar digital nerve. (E, F) A useful painless thumb was obtained, but the damage at the nail matrix during the ischemic period produced a dystrophic nail (arrow). (Copyright © 2016 Dr Piñal.)

Box 2

Classic thumb reconstruction methods

- Cock-up of Gillies
- Matev metacarpal lengthening
- Littler type operations
 - **Neurovascular flap**
 - Pollicization
 - **Stump transplantation**
- **Toe-to-hand transfer**

The authors preferred methods are in bold.

lack of proper sensibility. For this reason, provided there are nerves available, it is wiser to perform a neurorrhaphy between the recipient thumb nerves and the donor middle nerve to avoid cortical disorientation. As mentioned previously, the authors find this flap indicated for the patient who has some bone exposed and who does not want to have a more complex reconstruction (Fig. 7).

Pollicization consists of moving the index to the thumb position. Again, the authors must say from the beginning, that conceptually, except in severe forms of thumb hypoplasia, they rarely find room to recommend this operation. In adults, transposing an index results in a much thinner thumb

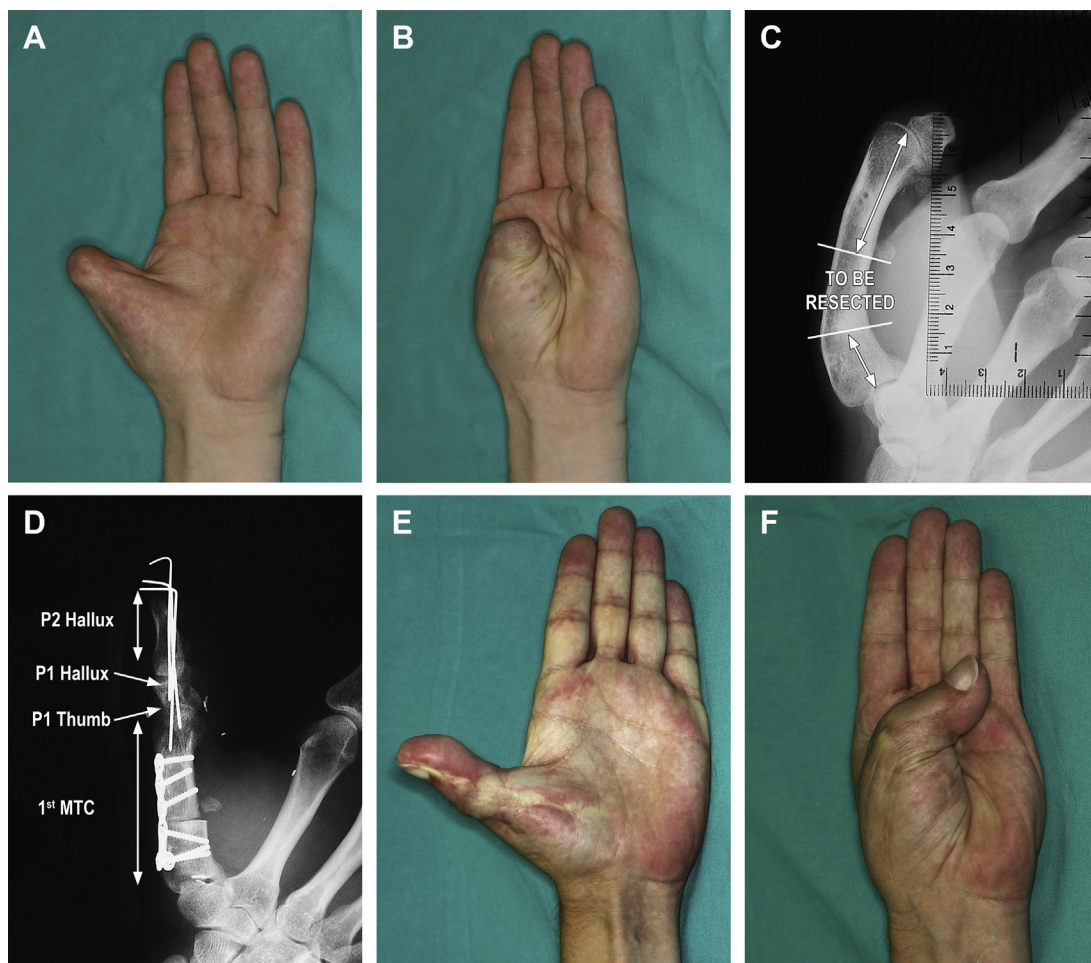


Fig. 6. (A, B) This 35-year-old sustained at the age of 20 a traumatic thumb amputation that was managed by lengthening. He had been seeking a better alternative ever since. (C, D) The author offered to straighten and shorten the metacarpal, and at the same time to carry out a trimmed toe hallux transfer. (E, F) Result at 3 years. (Copyright © 2016 Dr Piñal.)

than the original, and, worst of all, one sacrifices a finger.¹¹ Needless to say, in a severely mutilated hand, the indication of transposing a finger is nearly zero in the authors' view, as this will decrease the functional potential of the mutilated hand even further.

Nevertheless, a useless radial stump may be extremely useful for lengthening a short thumb and to increase the first web. Also, a radial stump may serve to decrease the needs from the foot. Apart from these, there are 2 more indications that the authors can foresee: the patient who does not want a toe transfer, or the patient who does not have a toe available for transfer (Fig. 8).

Technically speaking, these procedures (Littler, pollicization or stump transfer) are quite similar and based on the same principle. The flaps are

designed so the neothumb fits in its new place with the correct orientation. The neurovascular bundles are dissected as conservatively as possible (see Fig. 7C). If there are doubts about the integrity of the radial bundle and if the neighbor finger is correctly vascularized by the opposite side, the common digital artery of the ulnar side of the transferred segment is also included with the portion to be transplanted. Although for a Littler-type flap the venae comitans that accompany the digital artery are sufficient to allow safe venous drainage, in the case of a major segment, a dorsal vein needs to be included. As a rule, the nerves are minimally dissected and reconnected to the proximal stumps of the thumb digital nerves. Only in the event that the nerves have been avulsed proximally, is this step omitted.

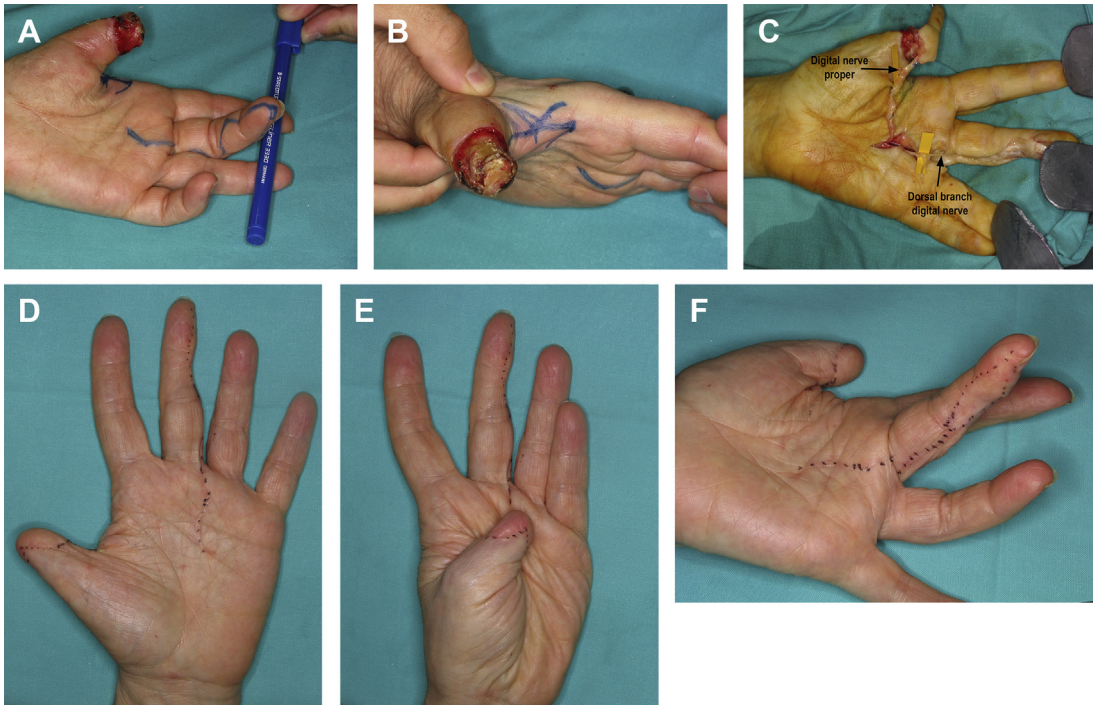


Fig. 7. (A, B) This 68-year-old patient suffered an avulsion amputation of her thumb with the seat belt as well as thoracic trauma in a car accident 10 days prior to her visit. She rejected a toe transfer, but accepted reconstruction with local tissues. To keep all the remaining bone, a large Littler flap, which allowed coverage of the palmar and dorsal defect, was planned. In order to increase the effective length of the thumb, a double opposing Z-plasty was done concomitantly. (C) The flap has now been elevated and prepared to be transposed under a skin tunnel. Notice that the dorsal branch of the donor nerve has been kept in place (arrow) and that only the palmar nerve proper has been harvested and is prepared for suturing to the ulnar digital nerve of the thumb (arrow). (D, E) The function at 1 year is shown. (F) The donor site was partially closed and the remaining defect covered with a full-thickness skin graft. (Copyright © 2016 Dr Piñal.)

Toe-to-Hand Transfer

When a patient has lost a thumb, the best option is a toe-to-hand transfer. The authors have found that even compensated amputations (distal to the IP joint) benefit enormously from toe transfer.¹² Nevertheless, the benefits of adding a toe, rather than removing anything from a mutilated hand, are self-evident.

The authors' preferred method for thumb reconstruction is by tailoring the hallux to the needs. In this sense, the procedure they use is derived from the trimmed-toe transfer described by Wei and colleagues.¹³ Other alternatives (eg, the second toe) provide a narrower and flimsier neothumb. The authors think that except in bilateral metacarpal hands, the second toe is a poor option even for children. In severe mutilating injuries that need more than one toe, the authors transplant the hallux as a first step. A week later, they carry out the reconstruction of the fingers with toes from the other foot. The authors have not had any untoward effect from such a short

delay, and this allows the patient to have the reconstruction done in one shot and start the rehabilitation without delay. Severe injuries need a plan for saving structures so that the surgeon might build an acceptable hand from scratch (Fig. 9). The authors have defined this ideal scenario—the acceptable hand—as one that has 3 fingers of the correct length with motion at the PIP joint, sensibility preserved, and a thumb.^{5,14} When this is not possible, a tripod pinch is the minimum to be sought (Fig. 10).

The dissection of the toe is similar to that described in the Intercalated Defects section. It starts from the vein, which is traced to the proximal aspect of the flap. The artery is also located at the proximal edge of the toe and traced proximally. Usually the authors only include the digital artery, so they are not worried whether the first dorsal metatarsal is a plantar or dorsal type. By terminating the dissection at the take off point from the metatarsal vessels, the



Fig. 8. (A) This 56-year-old patient was seen 1.5 years after sustaining bilateral below-the-knee amputations and loss of all digits after being critically ill due to a septic shock. Resection of both second metacarpals was done elsewhere several months later in an attempt to improve the first web space and the function. When first seen, he had no grasp or pinch with the too short right thumb except for using the thumb as a pusher for dialing on a specially designed cell phone display. (B) The plan was made to transfer the third metacarpal on both common digital arteries and nerves. (C) During surgery, the second common digital vessel was found to be scarred and hence useless. Only the third common digital vessel could be used to pedicle the stump. (D) To replace the scarred web and provide healthy tissue, a posterior interosseous flap was elevated concomitantly. (E–G) The ability to grab small- and medium-sized objects (including the handle of a crutch) was restored. (Copyright © 2016 Dr Piñal.)

surgeon will have enough length to perform a comfortable end-to-end anastomosis to the ulnar digital artery at the base of the thumb. If the base of the thumb is scarred, rather than going to the radial artery at the snuff-box, the authors prefer to dissect the radial digital artery of the index and flip it to the base of thumb. In this manner, the dissection of the foot is kept

to a minimum. This policy has the further advantage of allowing a much faster dissection in both hand and foot, but one has to be prepared to deal with vessels of a smaller diameter. Some tips have been given in Intermediate Defects section.

Toe-to-hand transfer in expert hands is an extremely reliable and safe procedure. In a

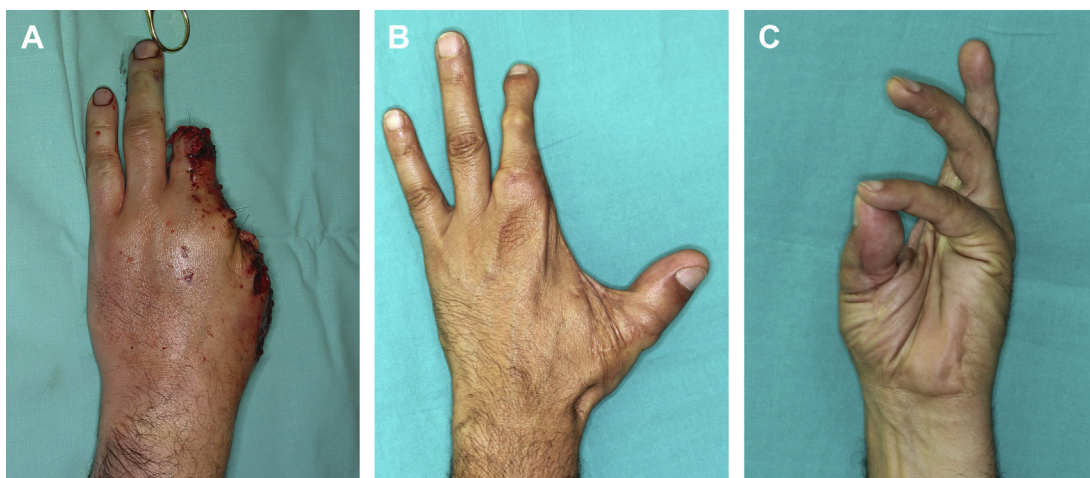


Fig. 9. (A) This patient lost the thumb and index at distal metacarpal level, and the middle finger at the proximal phalanx level. The hand was reconstructed by a trimmed toe and a second toe. Shape and acceptable function were reestablished as can be seen in these 15-year follow-up pictures (B and C). (Copyright © 2016 Dr Piñal.)

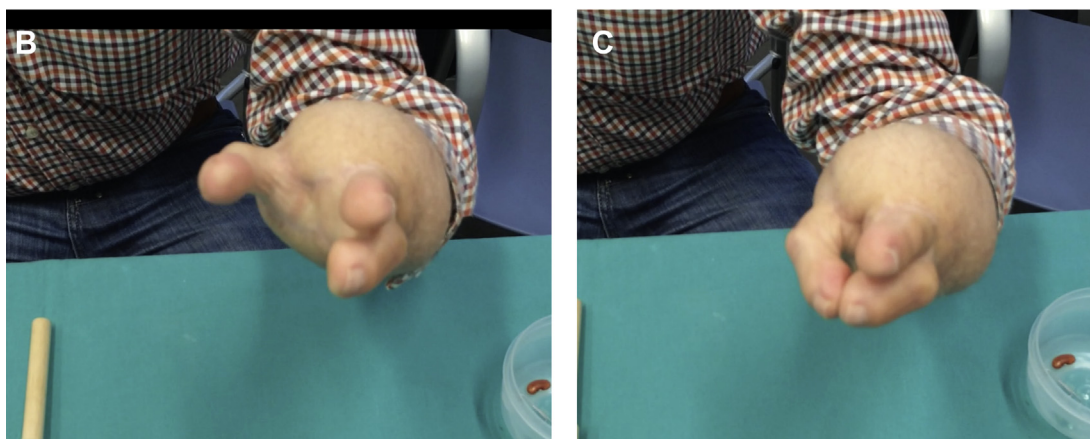
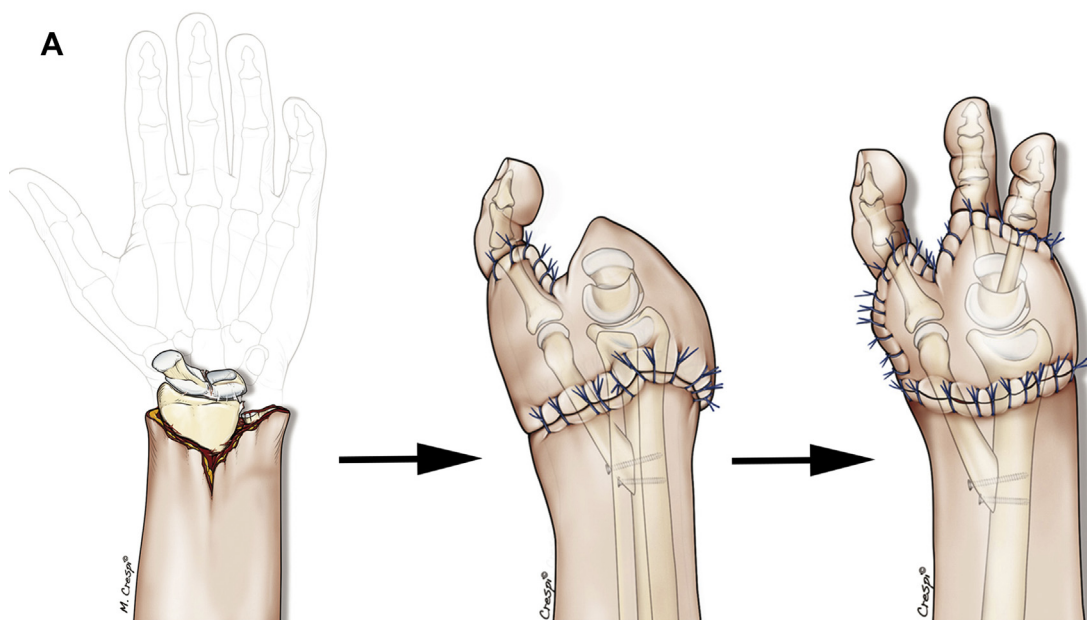


Fig. 10. (A) This patient was seen 5 days after sustaining a complex injury that ended in amputation at the wrist level. As an emergency the stump had been covered with a pedicled groin flap. In 2 stages, separated by 1 week, a tripod pinch was reconstructed. In the first stage, a second toe was planted in the radius (Furnas-Vilkkki procedure),^{15,16} and a free groin flap was used for cover. In the second stage, a combined second-third toe was transplanted on the lunate (B and C). The patient is able to grasp small objects to a 4 cm tripod pinch aperture. (Copyright © 2016 Dr Piñal.)



Fig. 11. Donor site after transposition of the proximal phalanx of the second toe on top of the base of the proximal phalanx of the hallux. Notice the flap to increase the girth of the transferred toe. On the right, the donor site of patient shown in Fig. 9 that predated the introduction of the new technique of foot closure. (Copyright © 2016 Dr Piñal.)

consecutive experience of 420 toe-to-hand transfers performed by the first author, without exclusions, there have been 3 failures to date. Although the numbers may seem overwhelming for most readers, the first author would like to stress that at some stage he also had to do his first case. In surgery one has to accept that if any given method is the best, rather than seeking a reason to dismiss it, the good surgeon should try to replicate it. Preparation is the only way to go for patients.

The most obtrusive point when indicating a hallux is donor site morbidity, cosmetic deformity being so particularly obvious. To overcome this, the authors described a method where the second toe is transferred to the position of the hallux, and they used the discarded flap to reduce the hallux size and increase the girth of the second toe **Fig. 11.**¹⁷

In summary, despite the fact that there are several methods of thumb reconstruction, only toe transfer is ideal in the authors' view. Very rarely in the authors' practice does a patient decline reconstruction with a toe. For those rare cases, the authors offer them pollicization, or alternatively coverage with a Littler-type island flap. Never in the senior author's practice has he come across a case where the indication was a metacarpal lengthening.

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