



REVIEW

Severe mutilating injuries to the hand: guidelines for organizing the chaos

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Summary Major hand injuries have become a rarity in Western countries. The fact that there are well trained teams devoted to their management, should not obscure the fact that the first emergency surgeon has the major role of setting the foundations for a reconstruction. Understanding the goal to be sought: the 'acceptable hand' (one with three fingers, with near normal length, near normal sensation and a functioning thumb), is hoped to be of great help in primary care. Preservation of vital structures such as joints, flexor tendons, and vessels, in the initial debridement, which will help to build this 'acceptable hand' are discussed. The general guidelines for management of finger amputation and soft tissue problems are also given.

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Safety measures, Trade Unions, and particularly high fines for the factory owner, when the safety measures are overlooked, have decreased the exposure of most surgeons to severe hand injuries in Europe. Although it is true that the definitive treatment of the severe mutilating hand injury is probably better done at referral centres with sufficient experience, some general rules of management are necessary for all. This is so because most patients are initially treated at local hospitals, not necessarily by

specifically trained surgeons, and their fate depends entirely on the knowledge of this first surgeon. Mistreatment can put the hand into such a chaotic state that not even the most skilled surgeon will be able to get anything from it. In this report we will set the goals to be aimed for, the foundations to be looked for, and general rules about the way we deal with the lack of digits, the soft tissue deficiency and other associated problems to the severe mutilating hand injury constellation. The technical issue is beyond the scope of this paper.

Definition

We have defined previously¹ the 'acceptable hand' concept: One with three fingers of near normal length,

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with near normal PIP joint motion, and good sensibility, plus a functioning thumb. An 'acceptable hand' was named so, because it is acceptable from an aesthetic and functional point of view (Fig. 1). By using toes, lengthening procedures, finger transposition ... the surgeon can change badly damaged hands into acceptable ones (Fig. 2).

Conversely, what we will deal with in this article are 'major hand injuries', in which by definition an 'acceptable hand' can not be achieved. Major hand injuries are expected to yield important sequelae even under the best of care: grasping, pinching and/or aesthetics will be severely compromised. Briefly this group is composed of patients who had two or more fingers amputated proximal to the PIP joint. We include in this group the 'mutilated hand' (two or less digits remaining)¹ and the 'metacarpal hand'.^{2,3}

The goal

Even in the middle of late night surgery of a badly damaged hand, the surgeon should be very clear about what should be left in place, what should be preserved at all costs, and those damaged parts which one should not waste time on. The surgeon has the ability to set some order amidst the chaos.

Unfortunately, there is not a recipe for managing these types of injuries, but a logical step-ladder like approach in the search of an 'acceptable hand'. Many times some compromises in the number of fingers (by carrying out selective emergency functionless ray amputations)⁴ in motion (arthrodesed joints, damaged tendons.), in length (distal amputations), or in sensibility (nerve defects.) have to be accepted. Provided the target of an 'acceptable hand' is sought at all stages, a satisfactory result will be the end (Fig. 3).

To comply with the objective I consider three issues: Number of digits, position, and aesthetic issues.

Number of digits

No matter how bad the injury was, if asked, every patient wants to have four fingers and a thumb, unfortunately this is just not plausible. It is true that we can reconstruct all

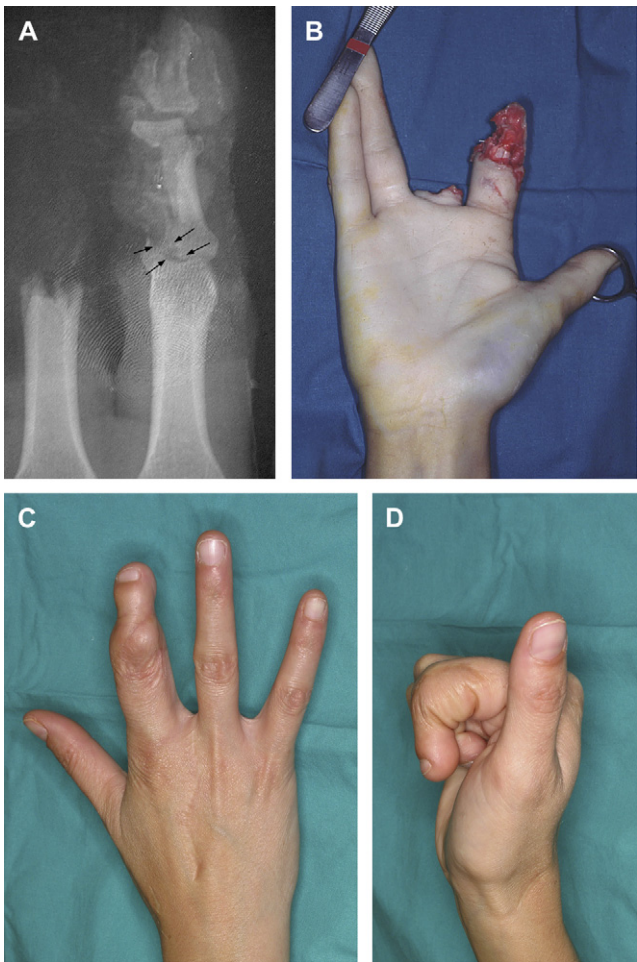


Figure 2 A: This 22-y-o patient suffered irreplantable amputations by a bread grater. Notice intraarticular fracture at the base of the middle phalanx. B: After debridement only a small remnant of middle phalanx could be preserved. Both FDS and FDP were disinserted. Seventy-two hours later in one-stage the third ray was resected, the second ray moved ulnarwards, and a toe (with an interposing bone graft) placed on top of the middle phalanx. C & D: An 'acceptable hand' resulted 5 years after the emergency reconstruction. Delayed reconstruction would have entailed loss of the flexors and PIP joint function.

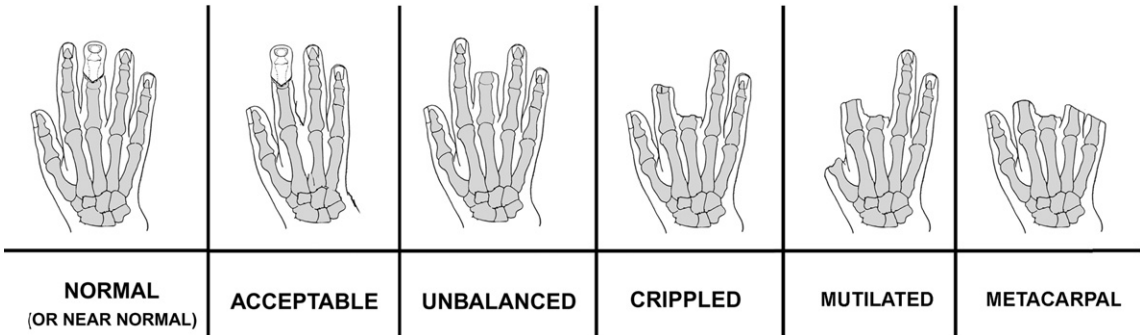


Figure 1 Author's classification¹ of the possible injuries of the fingers. Because an acceptable hand can not be achieved either in the mutilated or in the metacarpal hand types, only these two would be classified as severe hand injuries. (with permission of the British Society for Surgery of the Hand. © 2004).

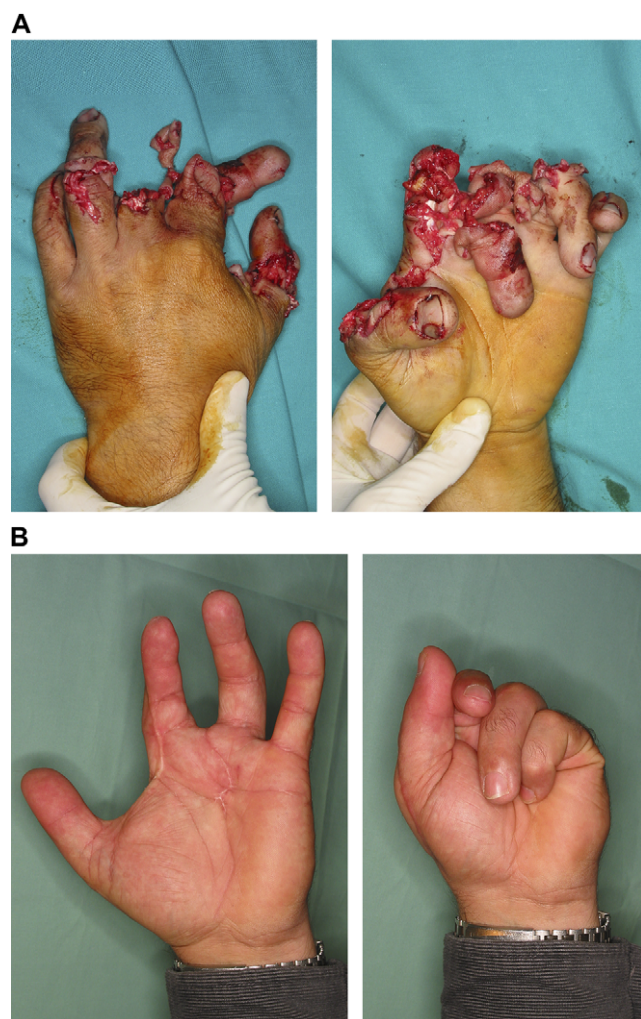


Figure 3 This patient sustained severe injuries to all digits with a circular saw. The 2nd and 4th digits were devascularized. The amputated 3rd finger was not replantable; however, it was a source of: (1) bone graft for the thumb, (2) a non-vascularized osteochondral graft for the 4th PIP joint, and (3) non-vascularized nerve graft for the thumb and index. The 2nd and 4th were revascularized, the index PIP joint was arthrodesed. All wounds healed primarily. The patient went back to his job as a cabinet maker 5 months after the accident. In spite of the good result, the goal of an 'acceptable hand' was not achieved as the index finger PIP joint was fused.

four fingers and the thumb by transferring two tandem second and third toes.^{5,6} However, the aesthetic result is not a normal hand: toes are too short, and as a result the hand looks squared, without the normal curvature of the fingers, in a somewhat similar way to a short fingered symbrachydactily hand. Furthermore, the price to the foot is high compared to the benefit at the hand.

At the other extreme is the goal in the past, the so called 'basic hand'^{2,7}: two elements (thumb and opposing digit). These reconstructions, however, provide a weak pinch and minimal grasping ability.

A tripod pinch is presently considered the minimum requirement to provide a satisfactory result^{3,8}: two 'fingers' and a 'thumb'. In this type of reconstruction the ulnar

digit supports the radial, providing a much stronger pinch, and the ability to grasp large objects is dramatically improved.

In some cases, moving a step ahead we attempt to reconstruct three 'fingers' and the 'thumb'. This not only provides a better grasping ability, but a more aesthetically pleasing hand (as it is closer to the 'acceptable hand'). The decision to proceed to a four digit reconstruction depends on the presence of at least one digit (or remnant) in the hand, as we are reluctant to take more than a hallux and two toes from the feet. Otherwise, the consequence in the foot would be too high (see below).

Position of the digits

There is some debate on where toes/fingers should ideally be placed in a mutilated hand.^{3,8-10} In the dominant hand, some recommend placing the toes in the index-middle position for fine pinching, while in the non-dominant in the 4-5th to produce a larger span. We have noticed however that unless the index is fully functional, it is better to avoid that ray for placing a toe as in that position it would be too short to produce a pulp pinch (Fig. 4-A). The CMC joint does not permit pronation if the thumb is not antepulsed¹¹ and this produces a mixed lateral-pulp pinch, which is more unstable than a true tip-pinch (Fig. 4-B). Conversely, if the reconstructed toes are placed in the 4-5th position, a true pulp-to-pulp pinch will be obtained, but the span of the first web would be too large, which is objectionable from an aesthetic standpoint. So in the rare situation where all fingers have had a similar injury, our preferred position to sit the toes are the middle and ring position, while the second ray should be better be removed to increase the web space (see below).

Many times, however, the amputation levels are dissimilar. Rather than the theoretical advantages of 2nd-3rd versus 4th-5th positioning, the most important issue,

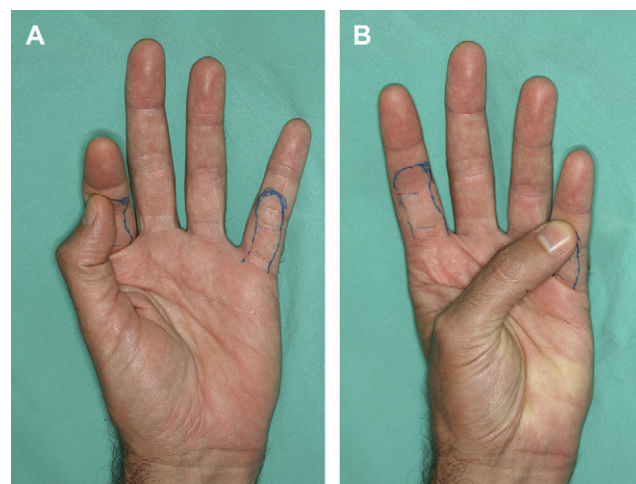


Figure 4 The constraints at the CMC joint, allowing a side pinch in the radial aspect of the index but a true pulp pinch with small, is shown in this mock example, where the imaginary toes have been drawn as compared to a normal finger length.

without doubt, is the presence and location of functioning joints. Toes transplanted to the hand rarely are able to move much.^{12–15} Their use will depend much more on the existence of functioning joints than sensibility: a moving 'blind' finger would be much more useful than a stiff but sensitive one. Another consideration is aesthetic. If there are other fingers, the reconstruction should be carried out by placing the new elements next to the existing ones to avoid gaps.

Aesthetic Issues

Interestingly, the patient will use a mutilated hand in a skilled way, only if it is tolerable to him/her. So our first goal is to 'produce' a hand that is going to be used. If time allows (in secondary cases) honest discussion with the patient about the limitations of the reconstruction and the possible end result (showing pictures of similar patients) is extremely helpful to avoid disappointment. Some patients are willing to talk to others who have had similar problems in order to exchange experiences. We promote these contacts, and stress the donor site problems (particularly in tandem transfers), and the fact that failure may occur.

In any circumstance, no matter whether one is dealing with an emergency or a reconstruction the surgeon should try to reproduce the normal finger's arcade. The fingers describe an arch distally that if disrupted even minimally, gives a mutilated appearance (Fig. 1).¹ To avoid this, amputation of potential functionless fingers and transposition of metacarpals to close the gaps is recommended.⁴ Narrowing the palm has a slight detrimental effect on power grip, but increases the span of the web. Additionally, closing central gaps has a beneficial effect on precision activities and chuck pinch, precludes the loss of small objects when grasping, and has a cosmetic reward as the digital arcade would not be broken. Even when using the (much smaller) toes, if this arch is restored, a high patient satisfaction can be anticipated. To assess the expected result yielded by the different transplants, we take plain X-rays of the normal hand, the mutilated hand and the toes in standing position (to assess their length). Then by using tracing paper, the toes are transported to the hand and compared to the healthy side. Wei et al.⁸ recommended toes only if the remaining finger stumps were not longer than the small finger, but some compromises can be accepted if interposing bone graft is used (Fig. 5).

The methods

Replantation

Is no doubt the best option to restore function after traumatic amputations of fingers particularly when multiple fingers are involved. It is rare that one of the fingers or a part that can not be used in its original place, could not be advantageously used to restore some function, as presented in this issue by Battiston and others.^{4,16} The principles that apply to replantation are similar to those stated for reconstruction and the emergency is an ideal moment to set the goal (Fig. 4) but also for suboptimal results or mismanagement (Fig. 6).



Figure 5 This patient was referred under the care of the author after a failed two finger replantation. In one stage the 3rd ray was resected, the index ray moved to close the gap, and a second toe transferred on top of the proximal phalanx. An acceptable hand was not achieved because of the arthrosis at the PIP joint location. The 'finger' is also slightly shorter than would be ideal, but the distal curvature is restored and the crippling appearance much improved. The soft tissue loss was dealt with by a fascio-subcutaneous flap.³¹

Management of the stump

To be reconstructed later is totally different from the one that is going to be terminalized. While a well-padded, non-painful stump is the goal when an amputation is to be carried out, preservation of vital structures such as nerves, skin and bone should be done at all costs if a toe transplant is considered. Wei¹⁷ emphasizes that this will reduce the needs from the foot, a precious donor site. Furthermore, he stresses the need to avoid using local flaps for cover the stumps that add scars and may compromise further reconstruction. We also think it is crucial to preserve as much bony length as possible particularly every effort should be made to preserve functioning joints. In particular we would like to make a plea for preserving even the smallest remnant of middle phalanx. Although we have all been told that a segment of middle phalanx proximal to the FDS insertion should be excised,¹⁸ if a toe is considered, removal of those segments is a major disservice to the patient. Toes placed distally to the PIP joint provide the best functional and aesthetic result a toe can give after a hand injury

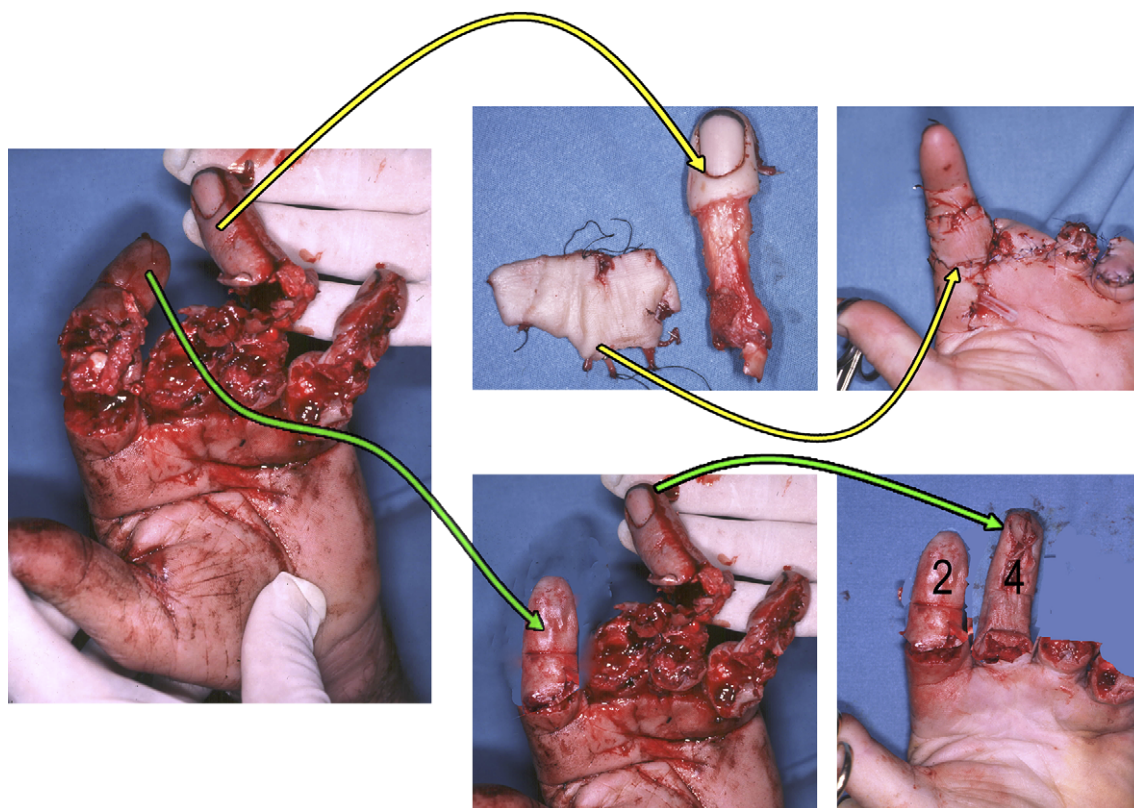


Figure 6 Suboptimal management of an acute metacarpal hand. After a devastating saw injury where the small and middle fingers were irreplantable/not found, the large volar defect that involved the volar neurovascular structures of the index, was solved by a filleted ring finger. This flap was used to restore the arterial flow and to span the large nerve gap defect. Although the operation was successful, the index, arthrodesed at the PIP, was too long and only a side pinch was restored (The case is 12 years old,... my only excuse).

A more logical approach is shown below: The index is shortened as to allow primary closure and repair of nerves and arteries end-to-end. The 4th finger would be replanted in the 3rd ray position. This treatment would have provided a tripod pinch with slight shorter (more functional) digits (Adobe Photoshop generated).

(Fig. 2).^{1,19} By the same token if toes have to be placed on top of proximal phalanx although aesthetics can be restored, the function of the toe's PIP joint is usually poor giving at best an average functional result.^{19,20}

Soft Tissue Defect

Rarely there would be sufficient pliable skin at the time of reconstruction after a major injury to the hand. To the existent deficit, one should add that the second toe only has cover up to the mid or distal third of the proximal phalanx.^{21,22} Although some authors advocate harvesting large skin flaps in continuity with the toe,^{23,24} most consider that the skin on the dorsum of the foot and in particular the web should be preserved intact if donor site problems are to be avoided.²⁵⁻²⁷ For this reason, several authors recommended a preliminary groin flap that later can be tailored at will.^{3,9,17,22,28} In most cases we prefer to proceed to an early-'aggressive' management of the combined soft tissue and finger loss with free flaps if necessary.

Several issues have influenced this policy. First of all, unnecessary intervening surgery is avoided, limiting the scarring. Secondly, early reconstruction has been shown to

be beneficial in other areas of hand surgery and the mutilated hand is just another example of this concept.²⁹ Thirdly, technically it is much easier in the first week to dissect the tissues planes to find structures to be repaired, as no tight scar is present. Much more important than this is the fact that palmar arteries to hook up the transferred toes are present just at the edge of the amputations, and they are easily dissectable and with good flow. However, later than this, as for the lower limb,³⁰ vessels are in the midst of a scar, they are difficult to dissect, break easily, and tend to go into spasm. Long vein grafts are many times required to go to the wrist to find a pulsatile artery (Fig. 7).

For the small or moderate defect we have been satisfied by using a fascio-subcutaneous flap in continuity with the toe.³¹ The fascio-subcutaneous portion of this flap is a thin tissue layer under the dermis and above the peritenon of the extensor tendons. We have harvested different combinations of toe flaps (from wrap-around to tandem 2nd-3rd toes (Fig. 8)) and very large dorsal flaps.³² The key of this operation is to remember that the flap that is retained in the foot is not a full thickness skin graft but a superthinned flap.³³ As such, during the elevation great care should be taken to maintain the superficial layer of veins on the foot flap. Delay healing

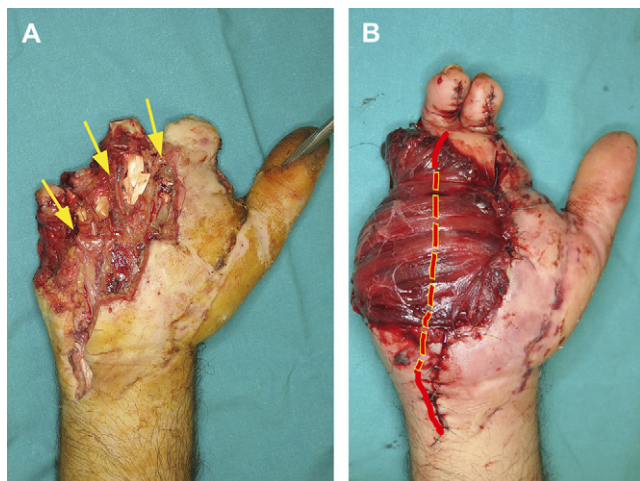


Figure 7 This patient was reconstructed when referred, 3 weeks after the injury, in a single stage by means of a gracilis and a tandem second-third toe. In spite of the presence of patent commissural arteries up to web spaces and a 'normal' superficial palmar arch, sluggish flow existed in all these vessels. Long vein grafts were required to connect the toe vessels to one (the ulnar artery) with a strong pulsatile blood spurt.

occurred in approximately 25% of our cases but we never had to perform any additional surgery. The greatest advantage of this flap is that the donor site is covered not by a skin graft but by a superthinned flap that is not stuck to the bones and glides above them, allowing dissipation of shearing forces. We have an experience of more than 20 cases with this flap; our longest follow up is 10 years, without ulceration on the dorsum of the foot. The flap in the hand adapts nicely to the defect as the lack of dermis makes it much more pliable.

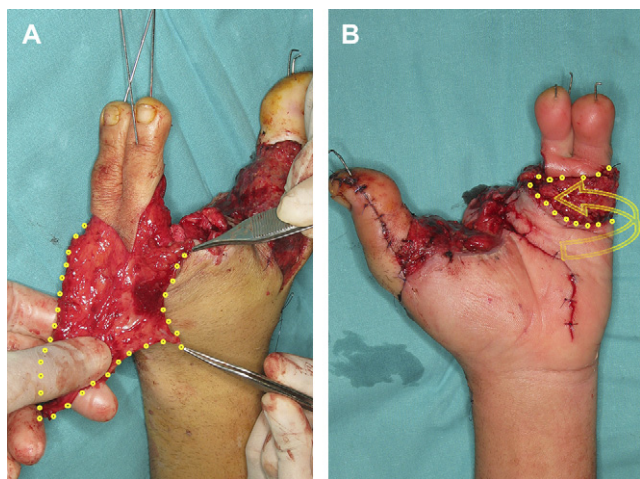


Figure 8 Toes are only covered up to the middle of the proximal phalanx. To increase the transferable length a fascio-subcutaneous flap was raised in combination with a 2nd–3rd toe tandem. Part of the flap was used to cover the dorsum (A) and the rest was swung ulnarly to protect the volar structures (B).

When the defect is large, we prefer to transfer a free flap and a toe as an emergency-early one-stage procedure. Transferring two free flaps in one stage is a major endeavour, but has advantages: single vessel exposure, possibility of combinations among the two flap's vessels reducing recipient needs, and a much shorter recovery time.^{34–37}

By the same token, I agree that there is not much benefit in achieving cover with a free flap and then, in a second stage, to proceed with the digital reconstruction. Recipient vessels will be reduced and the scarring would be present during the second stage. For this instance, the time honoured pedicled groin flap followed by the toe transfer in a second stage would seem a much more reasonable option.^{3,9,17,22,28}

We have used several flaps, including skin type flaps, and presently our preferred flap for the moderate-large defect is the gracilis muscle. We usually harvest the gracilis from the contralateral limb from where we are harvesting the toe, in this way the tourniquet can be used without any problem. The gracilis has an extremely dependable blood supply that allows for its division to cover different areas, adapts nicely to the tridimensional defect and in our hands can be harvested in less than 45 min (which is a bonus taking into consideration the complexity of these cases). By removing the epymisium of the gracilis (on the side opposite to the pedicle) the covering capabilities increase dramatically.³⁸ It has the drawback that it needs skin-grafting, and like all muscle flaps tends to swell. To combat the latter, we start a very early program of compression with Coban® type bandage, changing the bandage every 2 to 3 days. We have not noticed any adverse effects on tendon gliding as compared to fat type flaps. There is a limit to its cover capabilities, and for very large defects we consider other alternatives, such as the anterolateral thigh fascial flap,³⁹ or dorsal fascia flaps.⁴⁰

Digit reconstruction

When replantation is not possible the foundations for the reconstruction should be set and the stump managed according to the guidelines referred to above. We prefer to start the reconstruction as early as possible, not only because it avoids intermediate interventions to achieve closure while awaiting the definitive operation, but above all because it allows salvaging critical structures that would require sacrifice if the operation is delayed (Fig. 2).¹⁹ Demirkan et al.²⁰ prefer secondary reconstruction to allow an intervening 'mourning period' and avoiding unrealistic expectations. In our opinion the benefits of early reconstruction far outweigh the risk of an unhappy patient that can be combated by appropriate counselling.

One of the settings where an early treatment makes a big difference is the situation of degloved fingers, where the skeleton is preserved but the skin of the fingers is avulsed. Although some surgeons have shown considerable skill⁴¹ in replanting 'impossible' avulsions, at times it is just impracticable. The classic approach to massive avulsion type injuries is to bury the hand in an abdominal flap and later to separate the fingers⁴² or an omentum flap.⁴³ To avoid the limitations imposed by a pedicled flap we have been approaching this difficult problem by

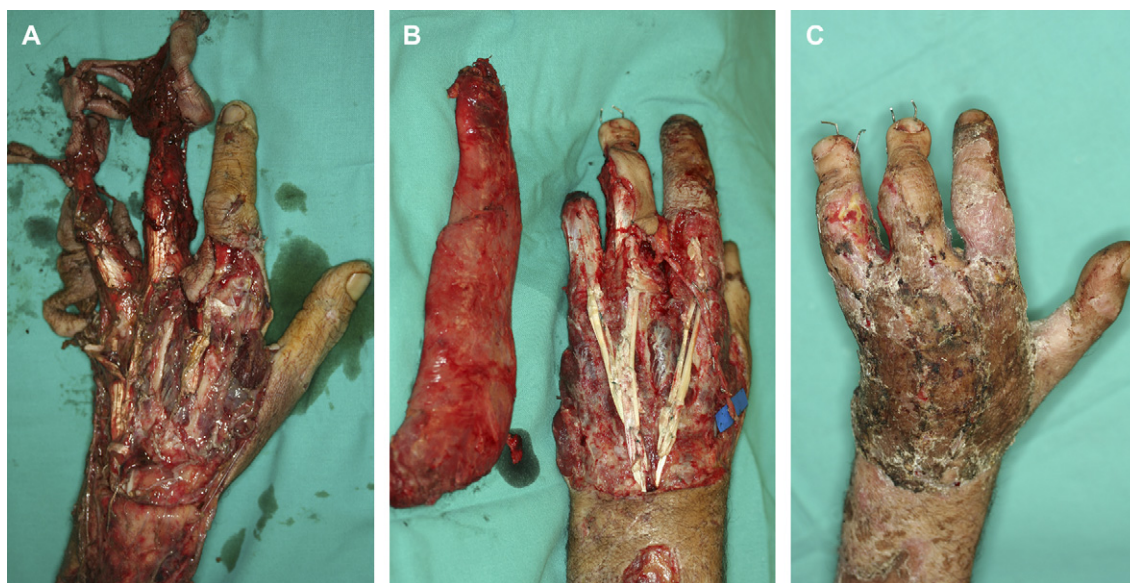


Figure 9 A: Irreplantable fingers after an avulsion injury in a car accident. Massive contamination. Initial management included radical debridement. The small finger was totally destroyed and amputated. B: 72 hours later the extensor tendons were grafted, a second toe was transplanted on top of middle phalanx in the middle finger position, and a free gracilis was used for cover. A week later the contralateral second toe was transplanted on top of the middle phalanx of the ring finger, achieving a four digit hand. C: Early result (5 weeks) after the reconstruction.

using fascio-subcutaneous free flaps. We initially debride and keep only three fingers distal to mid-middle phalanx preserving the PIP joint. By maintain only three rays (plus the thumb) the flap needs are reduced, and a more aesthetically pleasing hand obtained. The fascio-subcutaneous flap is then used to wrap all fingers, and skin grafted. After the fifth week the sindactily is released by simply cutting in the bony interspaces and skin-grafting (one at a time). In more ambitious patients toes can be placed on top of the middle phalanx of the avulsed finger (Fig. 9).

Most hints for planning the reconstruction have already been given throughout the text, and although ideally we will search for a four digit hand our limit is the donor site. We prefer to start the reconstruction in every case with the thumb (wrap around⁴⁴ or a trimmed toe⁴⁵), as this will upgrade the hand the most, and is the key to hand function. This policy gives some function in the intervening period, and also keeps the other foot intact in order to repeat the thumb reconstruction, should anything go wrong in the first operation. The tandem flap (combined 2nd and 3rd toe) is an excellent alternative when the amputations are proximal to the web^{8,46} and we strongly recommend it. The donor site, although poor cosmetically, is quite forgiving from a functional standpoint provided that the metatarsal heads are left in situ, otherwise some patients may experience foot problems. In the event that the amputation level is so proximal as to require the MCP joint reconstruction, rather than harvesting the 2nd–3rd tandem flap with the MTP joint, we prefer to harvest in a single stage two 2nd toes with the MTP joint, which yields a minimal donor site morbidity. In our scheme we limit harvesting a hallux from one foot and a 2nd and 3rd toe from the other, or more rarely a bilateral 2–3rd toes. Under

exceptional circumstances, such as the bilateral hand, more tissue can be taken from the foot^{47,48} including the triple toe transfer.⁴⁹

Finally, one should not forget that some patients may not want to invest the effort this type of reconstruction entails and may prefer a cosmetic prosthesis.^{50,51} Prosthesis can only participate in weak prehension activities (even if osteointegrated),⁵² lack sensation, wear out with time, and are expensive. In our patient population, mainly manual workers, we do not see much indication compared to the benefit afforded by toes. However, it should also be offered as a rehabilitation alternative, particularly in proximal unilateral amputations.

Avoidance of first web contracture

First web contracture is exceedingly common after trauma to the hand or the wrist, and may appear even in cases where the web was not directly injured. Due to the triangular shape of the web, even minimal degrees of contracture at the apex of this triangle, (the CMC joint), will entail severe limitations on the patient's ability to grasp large objects, thus ruining what otherwise would have been a good result.

Most of us have been taught that first web contracture is an unavoidable companion after a severe hand injury, and that our role as surgeons was limited to treating it once established. We found however, that most (if not all) posttraumatic first web contractures could be prevented and the function of the web contents preserved if one acts in a diligent manner.⁵³ We should stress that first web contracture is an ongoing process that worsens as time goes by for two reasons. Firstly, there is a progressive

involvement of previously healthy layers, i.e. the initial process may start at the fascia of the muscle but in time the skin, the ligaments, and even the perymysium itself will be contracted.^{54,55} Secondly, in time the contracture becomes progressively fixed, so much so that after a 3–6 months period, only surgery will correct the contracture. What is most annoying about the surgery of the established disease is that although the surgeon may restore the aperture of the web after severing the muscle, fascia, or even excising the trapezium, the original function of the web (suppleness, strength, dexterity) will never be restored. Many formerly healthy structures will require division, in spite of the fact that they were not originally involved.

The key to preventing first web contracture is to understand that it is multi-etiological, and each of the causes is treated differently. Disregarding obvious reasons such as tightly binding the thumb to the hand, common in some forms of immobilization in the past,^{54,56} it should be remembered that even a single linear wound may end up in a painful retracting scar if it crosses the web. Some sort of acute Z-plasty will abort this sequence of events.

When the web is directly injured, web contracture can be avoided by understanding the pathomechanism. In these cases the traumatic agent will cause muscle and soft tissue contusion and devitalization, along with haematoma accumulation. This collection, if not infected, will 'heal' by forming a massive unyielding contracting scar in the depths of the web. Early debridement of any devitalized tissue, early fixation and coverage (if needed) followed by a night splinting program is sufficient to stem the progression to a fixed web contracture.

Untreated compartment syndromes at the radial part of the hand will cause severe first web contracture.^{56–58} A previous study has revealed an unusually high incidence of silent – non-painful – acute compartment syndromes in patients who had suffered closed crush.⁵⁹ Therefore, the surgeon should have a very low threshold for measuring the intracompartmental pressure. Early opening of the offended compartments had an efficacy of 100% in preventing first web contracture.

Without doubt the most fascinating first web contracture is when no cause is evident. This idiopathic form is the most common, and may occur without any direct trauma to the body of the hand, and to the astonishment of the surgeon even after minor or distant trauma (Fig. 10-A). Several factors such as hand swelling, antifunctional positions, and secondary overtraction by the EPL tendon, interplay in this idiopathic type, driving the thumb into an adducted position.⁵³ Additionally, the flexo-adduction forces are far stronger than the extensor-abductors ones, overbalancing the situation towards adduction.⁶⁰

This form can be countered in the early stages by nightly use of a custom-made, plaster of Paris splint (Fig. 10-B). This splint which gradually causes the contracture to yield needs to be modified weekly. In our experience only very late cases (6 months or older) do not respond fully to serial casting, and even so, some correction can be expected.

First web contracture appears in a rapidly progressive fashion in the case where the thumb has been amputated.

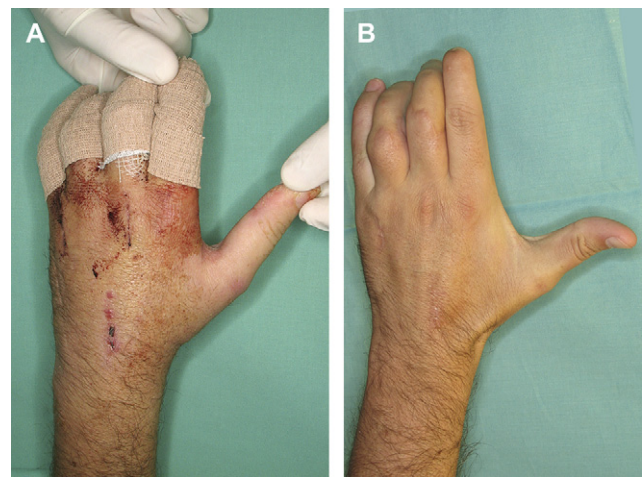


Figure 10 This patient sustained amputations of the distal index and small, and proximal to the PIP joint in the 3 and 4th. Both were reconstructed in a single stage at referral at 4 weeks. **A:** In spite of the distal damage at 7 weeks (3 weeks after the operation) the web is markedly contracted and unyielding. **B:** Progressive night splinting restored the thumb aperture without any surgery.

In this scenario a web splint has no role to halt the adduction contracture. To avoid becoming an irreversibly 'fixed contracture', we have managed these patients by very early toe-to-thumb transfer, followed by a night splinting protocol.

When multiple fingers have been amputated, and there is a web contracture, resection of the second ray will solve the problem and give a more cosmetically appealing hand. Quite often, the index stump can be advantageously used to reconstruct the thumb,⁶¹ or at least contribute to its reconstruction reducing the needs of tissue to be harvested from the foot (Fig. 11).

A proposal to classify major hand injuries

Classifications are helpful for managing difficult medical problems. Unfortunately in the case of severe hand injuries, the improbability of repetition of the same situation, and the implications each item has on the decision making process, it is impossible to make a simple classification. Wei's et al.³ and Vilkkii's⁶² itemization of the possible levels of injury and the possible combinations are extremely helpful for the sub-specialist but impossible to be remembered by the 'occasional' user. Additionally, there are disagreements among reputed authors, among simple definitions such as what a metacarpal hand is, confusing even to the specialist. Michon and Dolich,² named 'metacarpal hand' as one with no digits, regardless of whether the amputation level was the carpus or the metacarpus. Wei et al.³ on the other hand, proposed today's most popular definition: a hand whose more distal finger was the level of the proximal phalanx, including in the same term hands with (type I) or without (type II) an intact thumb. Patients, however, may find the presence of an intact thumb much more useful than a hand with

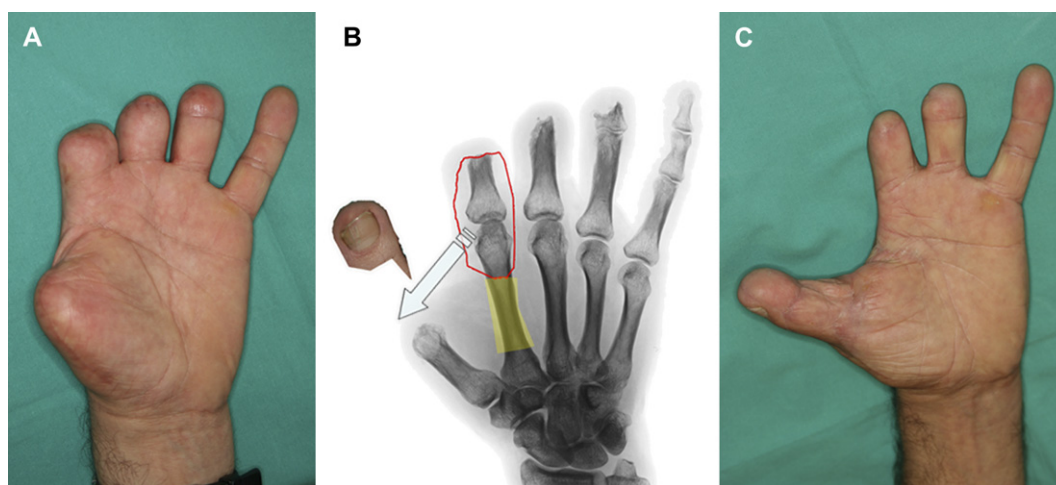


Figure 11 A: A high priority was given to the thumb reconstruction, as the first metacarpal was suffering an uncontrollable adduction. B: The web span was restored and the thumb reconstructed by transferring in a single stage a pedicled index MPJ, proximal index ray amputation and mini-wrap-around. C: Result at six months (reconstruction of the 3 and 4th finger was carried out in a 2nd stage).

two ulnar fingers, challenging the accepted concept that a metacarpal hand is more disabling than a mutilated one (Fig. 12).

All these arguments made us look for a classification easy to remember, that follows a severity scale, and at the same time that gives some guidelines as to its management. In Table 1 we have combined existing classifications^{1-3,62-64} in a comprehensive downgrading way. Additionally, my preferred solutions and secondary goals/options are presented as general guidelines. Needless to say, this should not be rigidly taken, as the final decisions would depend on many factors related to the patient (age, work, patient wishes, ...), and to local issues (scars, functioning joints, bony remnants, soft tissue conditions...).

Psychological issues

Finally, we should not forget the patient as a whole. Devastating unilateral hand injuries have a tremendous impact on the patient's welfare, let alone bilateral injuries. Fears of social rejection are the rule, but more importantly, in the worker's group, fears of inability to earn their living, may tilt the patients towards anxiety, depression or self destruction.^{65,66} For the average patient, the mourning will fade in few days, and usually they get better by taking part in the decision making process and realizing that there is a reconstructive plan that may make them get out of the chaos (Fig. 13). For some, more depressed, patient counselling by a psychologist and/or a former patient may be necessary. For severe cases we ask for immediate psychiatric consultation, as suicide attempts may occur while the reconstruction is taking place.

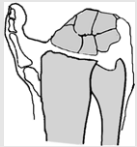
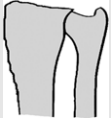
Although definitive management of the Major Hand Injury patient group is perhaps better carried out by a team of surgeons devoted to it, early management applies to any surgeon. This very first surgeon has the responsibility of laying the foundations of the reconstruction and will be the key to the end result. Management of the acute hand injury

may be simplified by having in mind the goal to be sought: a hand with three fingers, with near normal length, near normal motion at the PIP joint, and near normal sensation, with a functioning thumb.



Figure 12 Same patient with a 'mutilated type II' and a 'metacarpal type I' hands. The right hand has pinching ability and some grasping; the left hand only grasping. In spite of the fact that the left hand belongs to a less severe group, not surprisingly the patient found the metacarpal hand more useful.

Table 1 Author's classification of Major Hand Injuries and preferred management options

Grade, Type		First goal/primary needs		Secondary needs/other alternatives	
I, Ulnar amputation		1. Two 2nd toes or tandem to 3 and 4th rays. 2. Remove 2nd ray		2nd contralateral toe for a three fingered hand	
II, Radial amputation		1. Hallux to thumb, and 2. Remove 2nd ray		Contralateral 2nd toe for a three fingered hand	
III, Metacarpal hand		1. Homolat hallux to thumb 2. Contralateral tandem 3. Remove 2nd ray (exceptionally Yu's operation⁴⁹)		Three fingered hand using finger remnants, on-top, lengthening.	
iV, Carpal amputation		1. 2nd toe with 3 joints to thumb 2. Contralateral 2nd toe or tandem with 3 joints		2nd toe to volar radius ⁶⁹ Prosthesis if unilateral. ^{50,51}	
V, Forearm amputation		Vilkki's operation ^{67,68}		Bilateral 2nd toe transfer ^{70,71} Prosthesis if unilateral ^{50,51} ? Hand transplant if bilateral	

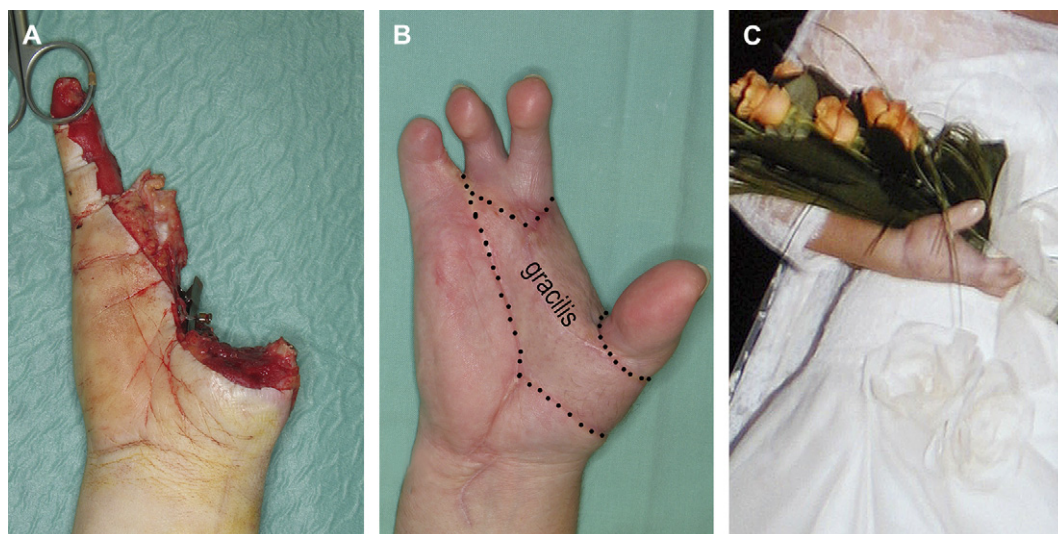


Figure 13 A: Conservative debridement after being trapped in a sealing-packaging machine for 30 min. (the small finger needed to be amputated more proximally). B: 72 hours later in one-stage a trimmed-toe and a gracilis were transplanted for coverage and thumb reconstruction. A week later a tandem 2nd–3rd were transferred. No other surgery have been done. C: Five months after the reconstruction the patient acceptance of her reconstruction is evident (picture cropped from her wedding book).

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