Avulsion injuries of the thumb

Similar findings in a series of seven avulsions of the thumb suggest that this injury is a well-defined entity. In all cases avulsion was the result of catching the digit in a rotating machine. In most cases a glove was worn. The usual clinical findings included extrinsic tendon avulsion from the forearm, nerve avulsion from the median nerve within the carpal tunnel, extensive arterial damage in the amputated thumb, and partial degloving of soft tissues. Successful replantation was possible in every case. We believe that vein grafts should be used routinely, anastomosed to normal distal vessels. The site of nerve injury should be identified by dissection of the median nerve within the carpal tunnel. Retrograde flaps should not be sutured for wound closure. We believe that replantation should be attempted in all cases of thumb amputation in which the part is available. (J HAND SURG 11A:51-56, 1986.)

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We describe the clinical appearance, the surgical technique of replantation and the results in a series of patients who have been treated for complete avulsion of the thumb, a condition that appears to be a well-defined clinical entity. Successful replantation should be possible in almost every case and will give a more satisfactory functional and cosmetic result than can be achieved with later pollicization of the index finger, toe-to-thumb transfer, or other means of reconstruction.

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Material and methods

In the seven-year period between Jan. 1, 1978, and Dec. 30, 1984, we identified 23 patients who sustained single-digit complete amputations of the thumb and who had replantation. (This time span was chosen arbitrarily to include the first thumb avulsion treated.) Of the 23 cases, seven (30%) were avulsed. Five of these were treated in the past year, a coincidence that brought our attention to this entity. Patients' ages varied from 10 to 56 years; all but one were males. Four of the seven avulsions involved the right hand.

Mechanism of injury

All seven patients were injured in a remarkably similar manner. Each gave a history of having had the hand caught in a rotating machine. Five of the patients were wearing gloves and one of the others, a 10-year-old boy, was holding a towel in his hand. Only one patient

REFERENCES

had an avulsion of a bare, ungloved thumb. In all patients, when the thumb was caught, the arm was pulled back sharply and the thumb was avulsed.

Clinical findings

Although not uniform in every case, the clinical findings were surprisingly similar. These included:

1. Five of the seven patients had bony separation either through the distal portion of the proximal phalanx (four cases) or through the adjacent interphalangeal (IP) joint (one patient). In one (the only patient with a bare thumb), the amputation occurred distally through the waist of the terminal phalanx beyond the insertion of the tendons. The remaining patient sustained a proximal amputation through the metacarpophalangeal (MP) joint. These two patients were the only ones who had soft tissue and bony separation at the same level. The other five had degloving injuries. In these patients, the palmar skin and soft tissues were divided at the level of the MP joint, and the dorsal skin was avulsed at the mid-metacarpal level (Fig. 1).

2. The digital nerves were avulsed from the main trunk of the median nerve in every patient except the one with the distal amputation. In that patient, the nerves (and vessels) were divided at the point at which the nerves arborized.

3. The flexor pollicis longus tendon was avulsed from the forearm while remaining attached to the amputated part in all six patients in whom the bony separation occurred proximal to the tendon insertions. A second tendon, the extensor pollicis longus, was also avulsed in all but one of this group (five patients). A third extrinsic tendon, possibly an accessory extensor pollicis brevis, was also pulled out in one patient (Fig. 2).

4. In six of the seven patients the amputated part showed signs of significant injury consisting of ecchymosis most marked beneath the proximal nail bed and along the course of the vessels.

Surgical treatment

Because of (1) the extent of injury to the amputated part, (2) the difficult access to the digital arteries, (3) the length of nerve avulsed, and (4) the sleeve of proximal soft tissue obscuring the bone end, the technique of replantation of the avulsed thumb necessarily differs to some extent from that used in the treatment of other
Avulsion injuries of thumb

Fig. 4. A, Incisions along the base of thenar eminence dividing the transverse carpal ligament for exposure of the median nerve. B, Same patient after recovery.

Fig. 5. A, Soft tissues are partially closed to avoid tension in the retrograde skin flap. The flexor forearm incision is the site of the vein graft used in this patient. B, Final result in the patient shown in Fig. 1 and Fig. 5, A. Note minimal scarring on the dorsum of the hand. Secondary closure was not carried out in this patient.

types of digital amputation. The methods that evolved and were used successfully in the thumb avulsions reported here are as follows:

1. The amputated part is prepared for replantation while the patient is being admitted, evaluated, and given an axillary block anesthesia. Vessels and nerves are tagged with small hemoclips to aid in later identification. A mid-lateral incision is made along the side of the thumb with the dominant vessel, usually the ulnar side. This is carried as far distally as necessary to expose completely normal vessel; it may have to be carried into the pad. This incision also serves to expose the site of bony amputation if it is hidden, as it usually is, within the soft tissue sleeve. The bone and tendon ends are debrided as indicated. With the IP joint in functional flexion, a 0.62 axial wire is passed distally through the distal phalanx to exit beneath the nail. Once prepared, the part is returned to refrigeration (Fig. 3).

2. The patient is brought to the operating room and the arm prepared for surgery. In those in whom the common digital nerve is avulsed from the median nerve, an incision is made along the base of the thenar eminence proximally into the carpal tunnel, avoiding the recurrent nerve to the thenar musculature and dividing the transverse carpal ligament (Fig. 4). An appropriate artery is identified and tagged. The proximal site of avulsion of the common digital nerve of the thumb is not easily identified in the carpal tunnel. It may be exposed, however, by incising the epineurium of the median nerve proximally as far as necessary until fascicular ends are encountered at the point of avulsion. The proximal end, usually consisting only of a few fascicles, is marked with a hemoclip.

3. The venous pattern of the forearm is observed and a vessel of appropriate size is marked and taken. The amputated thumb is now retrieved from refrigeration; the vein graft is reversed and sutured to normal distal artery as suggested by Shafiroff and Palmer before the thumb is replaced on the hand. The axial wire is now passed proximally, stopping short of the MP joint whenever this is feasible.
Table I. Avulsion injuries of the thumb

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Age (yr.), sex, side involved</th>
<th>Mechanism of injury</th>
<th>Level of bony amputation</th>
<th>Level of nerve avulsion</th>
<th>Level of arterial repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20, M, left</td>
<td>Drill press; rag held in gloved hand</td>
<td>MP joint</td>
<td>Median nerve</td>
<td>Base of thumb</td>
</tr>
<tr>
<td>2</td>
<td>37, F, right</td>
<td>Rotating machine; glove worn</td>
<td>IP joint</td>
<td>Median nerve</td>
<td>Distal to IP joint</td>
</tr>
<tr>
<td>3</td>
<td>49, M, left</td>
<td>Drill press; glove worn</td>
<td>Proximal phalanx</td>
<td>Median nerve</td>
<td>IP joint</td>
</tr>
<tr>
<td>4</td>
<td>24, M, left</td>
<td>Drill press; glove worn</td>
<td>Proximal phalanx</td>
<td>Median nerve</td>
<td>IP joint</td>
</tr>
<tr>
<td>5</td>
<td>10, M, right</td>
<td>Towel caught in power take-off; no glove</td>
<td>Proximal phalanx</td>
<td>Median nerve</td>
<td>IP joint</td>
</tr>
<tr>
<td>6</td>
<td>56, M, right</td>
<td>Pulley and belt; glove worn</td>
<td>Proximal phalanx</td>
<td>Median nerve</td>
<td>IP joint</td>
</tr>
<tr>
<td>7</td>
<td>29, M right</td>
<td>Pulley and belt; no glove worn</td>
<td>Distal phalanx</td>
<td>Digital pad</td>
<td>Digital pad</td>
</tr>
</tbody>
</table>

MP, metacarpophalangeal; IP, interphalangeal; FPL, flexor pollicis longus; EPL, extensor pollicis longus; EPB, extensor pollicis brevis.

*The radial digital nerve was used in this case to permit repair of the severely damaged ulnar digital nerve.

4. Flexor and extensor pollicis longus tendons, previously shortened, are first sutured to the flexor sheath and to the dorsal periosteum to provide IP joint stability. We have not attempted reconstruction of these structures in the forearm because the muscle in all patients has been avulsed with the tendon. The replantation is completed with appropriate proximal arterial and venous anastomoses.

The stretched, avulsed digital nerve ends are cut back until fascicles are found, and an anastomosis is carried out in the carpal tunnel at the point of avulsion from the median nerve. If a choice has to be made between the two digital nerves, the ulnar digital nerve is repaired. In one patient in whom there was severe stretch damage, we used the radial digital nerve as a graft to reconstitute the ulnar digital nerve.

5. The soft tissues are closed loosely wherever they approximate easily; otherwise they are left open. No attempt is made to close the dorsal skin (Fig. 5). In several patients, a split-thickness skin graft was used to cover the exposed dorsal subcutaneous tissues and the venous anastomoses. The hand is immobilized in a bulky wrap and appropriately splinted to end the operation.

Results

Our success rate for the reviewed series of 23 thumbs was 91.3% (21 survivals). All seven cases of avulsion injury were successfully replanted; these patients were recalled and examined. All but two of these patients, both recently operated on, were found to have at least protective sensibility. Two-point discrimination was present in two of these patients. Similar results have been reported by Gelberman et al. Our results necessarily must be considered preliminary, since only two patients have been followed up for more than 1 year.

Although there was considerable variation, key pinch strength was significantly less than that of the opposite normal thumb in most patients in whom the long thumb flexor tendon was avulsed; certainly an expected finding. Again, there may be further improvement with time, but in the absence of the long thumb flexor, considerable loss of pinch strength is to be anticipated.

The incidence of reoperation in this series has been acceptably low. Two earlier patients required IP joint fusion. This encouraged us to use tenodesis of both long flexor and extensor tendons in subsequent cases. The only other secondary procedures were two Z-plasties required for scar lengthening.

Mechanism of injury, clinical findings, treatment, and results for these seven patients are reviewed in Table I.

Discussion

Apparently no special note has been made of avulsion of the thumb as a clinical entity, although several series of thumb replantations have been reported. Chow et al. presented a series of 17 patients (survival rate 82.4%) from Cook County Hospital in 1979. Only two of these were avulsion injuries; one thumb survived.
Earley and Watson recently presented a series of 40 thumb amputations (26 complete, 14 incomplete). Of the complete amputations, only 13 were replanted, with a success rate of 62% (eight cases). Although these authors mention avulsion injuries, they do not consider them separately. The largest series of thumb replantations of which we are aware is that of Schlenker and Kleinert. These authors' series consisted of 51 complete amputations (survival rate 72.5%). Seven injuries were categorized as avulsion injuries (three survived); it is not clear in their article whether these were all complete amputations since both complete and incomplete were included in their statistics. They note that the flexor pollicis longus tendon was avulsed with the thumb in most cases. The mechanism of injury was apparently similar to those in our series in that the thumb became entangled and was torn off. These authors concluded that IP joint function should be maintained if possible. We believe, however, that stability is more important than motion at this joint in the absence of effective extrinsic tendons. We found it necessary to perform arthrodesis of two IP joints in patients in whom tenodesis had not been performed to provide stability.

The similarity of etiology of the injury in these patients was remarkable. All were injured in a rotating machine of some type. Five of the seven were wearing gloves, and another had a towel in his hand that may have acted in a similar manner. One might postulate that the gloved hand lacks a degree of stereognosis in that the glove projects beyond the end of the finger and so may be carried dangerously close to a machine that may in turn pick up the material. The leather or fabric then acts as a “Chinese finger trap” to hold the digit tightly, permitting avulsion to occur. The implications of this in an industrial setting are obvious.

Three problems have to be overcome in replantation of the avulsed thumb. These are related to the extent of the arterial damage in the avulsed part, the nerve avulsion from the median nerve trunk in the carpal tunnel, and the long retrograde dorsal flap in those patients in whom there is an associated degloving injury. The problem of arterial damage can be solved by using long vein grafts for the arterial repair routinely in all patients. The only patient in our series in whom a direct arterial anastomosis was possible was the one whose amputation was at the MP joint. The other six required vein grafts to reconstitute arterial patency. In four patients these were anastomosed to normal vessel at the level of the IP flexion crease, and in two the distal anastomosis was carried out within the digital pad. We cannot overemphasize the importance of vein grafting to ensure a successful replantation.

The avulsed common digital nerve can be repaired by incising the epineurium of the median nerve to expose the torn fascicles and carrying out a fascicular repair at this level. Some type of nerve repair was possible in six of our seven patients. In the only child in this series, no proximal remnants could be found. Spontaneous return of sensibility has been common on the dorsum of replanted fingers and hands in our younger patients even though dorsal sensory nerves are usually not repaired. We have also noted that palmar sensibility has returned to replanted digits in some chil-

<table>
<thead>
<tr>
<th>Tendons avulsed</th>
<th>Arterial vein graft</th>
<th>Venous vein graft</th>
<th>Digital nerve repair</th>
<th>Key pinch strength (kg) normal/replant</th>
<th>Two point discrimination</th>
<th>Subsequent surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPL, EPL</td>
<td>-</td>
<td>-</td>
<td>Radial</td>
<td>22/12</td>
<td>5 mm on radial side</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 mo</td>
<td>3 yr</td>
<td></td>
</tr>
<tr>
<td>FPL, EPL</td>
<td>+</td>
<td>-</td>
<td>Ulnar*</td>
<td>6.5/2.0</td>
<td>Protective only</td>
<td>IP joint fusion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 yr</td>
<td>12.5/5.5</td>
<td>Protective only</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>-</td>
<td>Ulnar</td>
<td>5.7/4.0</td>
<td>Protective only</td>
<td>Z-plasty to scar</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>+</td>
<td>Proximal end not found</td>
<td>4.0/2.5</td>
<td>Recent replant</td>
<td>Z-plasty to scar</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td></td>
<td>Both</td>
<td>NA</td>
<td>Recent replant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+</td>
<td></td>
<td>Radial</td>
<td>12.5/9.5</td>
<td>1 cm</td>
<td>IP fusion</td>
</tr>
</tbody>
</table>

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dren even when no digital nerve repair was possible.)

It is surprising that retrograde flaps of the length seen in five of our patients will survive when their blood supply comes from such a distal source, but they do. It is important, as Elliot et al. have pointed out, that there be no tension whatsoever in closing these wounds. A dressing of split-thickness skin may be used if necessary to protect venous anastomoses.

Buncke et al. have characterized amputation of the thumb as a "must try" situation. We agree and believe that this is probably the best single indication for a digital replantation attempt. Various types of late thumb reconstruction are of course available; we believe that replacement of the amputated part is far preferable. This can and should be achieved in almost every patient in whom the part has been retrieved; it is often possible even in what appears to be unfavorable circumstances.

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A giant cell tumor of the thumb: A case report

Giant cell tumors of the flexor sheath are the second most common tumors of the hand. We present a case that is unusual in the extent of the tumor and the pronounced bony invasion, which is rare. Preoperative diagnosis was complicated by a history of gout in our patient. (J HAND SURG 11A:56-59, 1986.)

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A case of giant cell tumor of the thumb is presented, which was unusual in its size, bony involvement, and the difficulty with preoperative diagnosis.

Case report

A 45-year-old white man was seen in May 1984. He was a right-handed crane driver with no specialized manual skills, but spent much of his time writing.

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A large lump had developed over many years over the proximal phalanx of his right thumb. There was no history of trauma or any previous surgery, but he had been treated for gout for 15 years with allopurinol (Zyloprim) (Fig. 1).

An x-ray film taken of the hand showed a large, rounded, soft tissue tumor on the palmar aspect of the proximal phalanx. Two cystic lesions were also present in the proximal phalanx with a small amount of periosteal elevation on the palmar surface (Fig. 2).

Surgical extirpation of the mass revealed a giant cell tumor that invaded the fibrous flexor sheath of the flexor pollicis longus and penetrated the dorsal aspect of the sheath and into the proximal phalanx, creating cystic cavities (Figs. 3 and 4). These underwent curettage and were packed with can-