Post-Traumatic Thumb Reconstruction

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On the length, strength, free lateral motion and perfect mobility of the thumb depends the power of the human hand.

— Sir Charles Bell, 1833.1

Many options exist for the management of the partially or completely amputated thumb. The goals of treatment are restoration of structure and function. Factors that influence the choice of treatment include both the functional and cosmetic concerns of the patient and the type of injury that has been sustained. Perhaps the most important consideration is the level of amputation. New techniques, particularly in the area of microvascular surgery, have recently revolutionized aspects of the management of post-traumatic thumb reconstruction.

The thumb is the most important digit in the human hand. Conservative estimates state that thumb loss incapacitates the hand by 40% to 50%, but many would argue that this number should be considerably higher. The opposable thumb is a major physical attribute that separates humans from lower primates. When part or all of the thumb is lost and the amputated tissue is not replantable, various degrees of functional impairment occur. This paper will give a brief overview of the treatment options available, and the indications, advantages, and disadvantages of each procedure, as well as an historical perspective of the development of the various treatments.

The development of thumb reconstruction in many ways parallels the overall history of technical advances in hand surgery.2 Many techniques have been advanced to reconstruct the thumb, and while some have been replaced by more recent techniques, a broad armamentarium of options exists from which the surgeon can choose (Table 1).

Indications

The thumb cannot be evaluated in a vacuum, but must be assessed with respect to the rest of the hand and to the patient’s functional demands. While the level of amputation may be the single most important factor in choosing the appropriate treatment option, the larger picture must be considered and several questions answered:

1. What are the demands of the patient? If the patient is more concerned with cosmesis than function, he must be counseled that the goal of thumb reconstruction is to restore function. The patient should be carefully counseled with respect to expectations and must be included in the decision-making process.

2. What is the status of the rest of the hand? This is important for assessing the relative function of the thumb as well as determining if any injured digits may be available for reconstruction of the thumb.

3. Will the patient benefit from the procedure? Thumb reconstruction is technically demanding and requires a great deal of motivation on the part of the patient if a good result is to be achieved. A patient who has developed irreversible, maladaptive patterns of behavior, chronic pain syndrome, or who has a short life expectancy may not benefit from thumb reconstruction.

Once these questions have been answered, the injury pat-
tern is then assessed and the appropriate choice of treatment is determined.

**Level of Injury**

By convention, the thumb is divided into thirds, with the middle third being further divided into distal and proximal sections (Fig. 1).

**Distal-Third Amputations**

In general, amputations through the distal third of the thumb are well-tolerated with little functional deficit. Several soft tissue treatment options exist for amputations through this level (Table 2).

Pulp defects of up to 10 mm may be allowed to heal by secondary intent and dressing changes. The primary disadvantages of this approach are its applicability to only small wounds and the time to healing; however, nearly full sensory recovery can be expected. Skin grafts may be used for defects without exposed bone or tendon. Hypotenar skin can be used to replace palmar skin, while volar forearm skin may be used to replace dorsal digital skin. The donor sites are closed primarily when the skin graft is full-thickness and the donor site morbidity is minimal. V-Y advancement flaps are similar to those for other digital tip injuries and the reader is encouraged to consult one of the many fine references on the topic.

Palmar (Moberg) advancement flaps may be used for tip deficits that are 2 to 2.5 cm. The dissection plane is between the peritenon and the neurovascular bundle, with the neurovascular bundle being taken with the flap. A second relaxing incision may be made at the base of the flap to allow further mobilization; this relaxing incision may then be skin grafted. The interphalangeal joint is flexed 45° and may be pinned in that position for 2 to 3 weeks. Interphalangeal stiffness is not usually a problem following this procedure.

Cross-finger flaps may be used when the entire distal volar aspect of the thumb has been avulsed. The flap is elevated off of the index finger on three sides of a rectangle. It is used to cover the initial defect and then divided at its base at approximately 10 to 14 days. A full-thickness skin graft may be used to cover the resulting donor defect in the donor site. Obviously, there can be significant donor site cosmetic deformity as well as potential stiffness. However, this technique may be used to cover sizable defects, and sensory recovery tends to be fairly good.

The concept behind the neurosensory island flap is to bring soft tissue with its own nerve and vascular supply to the thumb. It may be used to cover a defect with vas-

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**Table 1 History of Surgical Procedures for Thumb Reconstruction**

<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Procedure</th>
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</thead>
<tbody>
<tr>
<td>1900</td>
<td>Nicoladoni</td>
<td>Osteoplastic Reconstruction</td>
</tr>
<tr>
<td>1931</td>
<td>Bunnell</td>
<td>Pollicization of Injured Digit</td>
</tr>
<tr>
<td>1946</td>
<td>Gilles</td>
<td>Cocked Hat</td>
</tr>
<tr>
<td>1948</td>
<td>Littler</td>
<td>Pollicization</td>
</tr>
<tr>
<td>1955</td>
<td>Moberg</td>
<td>Neurovascular Island Flap</td>
</tr>
<tr>
<td>1968</td>
<td>Cobbett</td>
<td>Great Toe to Hand</td>
</tr>
<tr>
<td>1969</td>
<td>Matev</td>
<td>Metacarpal Lengthening</td>
</tr>
<tr>
<td>1980</td>
<td>Morrison</td>
<td>Wrap-Around Flap</td>
</tr>
<tr>
<td>1980</td>
<td>Leung</td>
<td>Second Toe Transfer</td>
</tr>
</tbody>
</table>

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**Figure 1** Areas of thumb loss: distal third, middle third, and proximal third. The middle third is subdivided into (A) proximal and (B) distal. (Reproduced with permission from: Kleinman WB, Strickland JW: Thumb reconstruction. In: Green DP, Hotchkiss RN, Pederson WC (eds): *Green’s Operative Hand Surgery* (3rd ed). Philadelphia: Churchill Livingston, 1999, p. 2096.)
cicular sensory soft tissue, or it may be used in conjunction with other methods as a means of restoring sensa-

**Middle-Third Amputations**

Amputations at this level tend to be accompanied by signi-

**Toe-to-Thumb Transfers**

As our ability to perform microvascular procedure has

**Z-Plasty Procedures**

Z-plasty procedures are used to deepen the webspace be-

**Table 2** Soft Tissue Treatment Options

<table>
<thead>
<tr>
<th>Treatment Options</th>
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<tbody>
<tr>
<td>Open Treatment</td>
</tr>
<tr>
<td>Skin Graft</td>
</tr>
<tr>
<td>V-Y Advancement Flap</td>
</tr>
<tr>
<td>Palmar Advancement Flap (Moberg)</td>
</tr>
<tr>
<td>Cross Finger Flap</td>
</tr>
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</table>

**Amputations Through the Proximal Third of the First Ray**

Options are more limited when injury is at this level. When the CMC is intact, options include toe-to-thumb transfers and pollicization of either an injured or uninjured digit. When the CMC joint is destroyed, probably the only good option for reconstruction is pollicization...
of the adjacent digit. The index finger is the most commonly pollicized digit for thumb reconstruction.

In a study that compared the functional results of toe-to-thumb transfers and pollicization, Michon and colleagues\(^{11}\) concluded the following:

1. For thumb amputation without injuries to the other fingers, either procedure is applicable. Pollicization returns better discriminative sensation and fine motor control, whereas toe transfer establishes better strength.

2. When other digits are amputated or mutilated, toe transfers are preferable in an effort to maximize strength.

3. For the metacarpal hand, transfer of one or more toes is the only technique capable of restoring function.

**Summary**

Many options exist for the management of post-traumatic thumb reconstruction. While the single most important factor for determining the most appropriate procedure is the level of the amputation, many other factors must be considered including patient considerations regarding function and cosmesis as well as the nature of the injury and the expertise of the surgeon. Patients must be included in the decision-making process and their needs and expectations must be clearly defined and addressed. The patient who is most concerned with cosmesis rather than function is more likely to be satisfied with a prosthesis than with even the most cutting-edge surgical procedure.

**References**