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Review

Management of partial fingertip amputation in adults: Operative and non operative treatment

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ABSTRACT

Background: Hand and finger injuries account for approximately 4.8 million visits to emergency departments each year. These injuries can cause a great deal of distress for both patients and providers and are often initially encountered in urgent care clinics, community hospitals, and level one trauma centers. Tip amputation injuries vary widely in mechanism, ranging from sharp lacerations to crush injuries that present with varying degrees of contamination. The severity of damage to soft tissue, bone, arteries and nerves is dependent upon the mechanism and guides treatment decision-making. The management algorithm can oftentimes be complex, as a wide variety of providers, including orthopedists, general surgeons, plastic surgeons and emergency physicians, may care for these injuries, depending on location and local culture. We review the common mechanisms for tip amputation and the optimal treatment in adults, based on the severity of the injury, degree of wound contamination, and the facilities available to the provider.

Methods: Pubmed was searched using text words for articles related to management of fingertip injuries in adults. Bibliographies of matching articles were searched for additional relevant articles, which were then also reviewed. 107 articles were reviewed in total, and 61 were deemed relevant for inclusion. All clinical studies and reviews were included. Particular attention was paid to articles published within the past 15 years.

Results: In the United States, up to 90% of fingertip amputations are treated with non-replant techniques. In comparison, the majority of amputations in Asian countries are replanted due to moral values and importance of body integrity. Tip amputation injuries can be managed with local debridement, complex reconstruction, or simply with irrigation and application of a sterile dressing.

Conclusion: In the United States, most fingertip amputations in adults are treated with non-replant techniques. However, the precise management of a fingertip injury in adults depends on the degree of injury itself, and a number of operative and non-operative techniques may be successfully employed.

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Anatomy

The fingertip is composed of a thick layer of overlying skin, a core of pulp and bone, a protective fingernail, and branches of innervating nerves and supplying vessels. Numerous papillary ridges within the epidermis produce unique fingerprints in every individual. Multiple fibrous bands, interlaced with fat, make up the pulp and extend from the periosteum of the distal phalanx to the dermis [2]. The pulp makes up over half of the total volume of the fingertip and plays an important role in soft tissue coverage and in gripping objects [3].

Fingernails, which grow at an average rate of 0.1 millimeters per day, adorn the dorsal surface of each digit and perform a variety of functions. In addition to their cosmetic role, nails protect the dorsal surface of digits, increase the sensitivity of fingertips, and facilitate pinching and scratching [4]. Each nail is composed of an eponychium (or cuticle), paronychium, hyponychium, nail bed, nail plate, and nail root. The eponychium refers to the soft tissue at the proximal border of the nail, while the paronychium refers to the soft tissue at the lateral borders of the nail. The hyponychium is a keratinous plug located between the free distal edge of the nail and the fingertip that acts as a physical and immunological barrier to infection of the nail bed [5]. The nail bed consists of the proximal germinal matrix, which creates the keratin that composes the nail, and the distal sterile matrix, which is responsible for the nail's adherence [6]. The junction between the germinal matrix and the sterile matrix is the lunula. The nail plate is composed of a keratinous substance called onchyn, which is produced by death of the germinal matrix cells. The proximal part of the nail plate is known as the nail root [3,7].

The digital vessels and nerves arborize near the distal interphalangeal (DIP) joint. Each main palmar digital artery sends branches to the nailbed and pulp [3,8]. The superficial palmar and oblique communicant veins drain deoxygenated blood from the palmar surface of the finger [8]. The digital arteries run along the sides of each digit, while the digital veins run along the dorsal surface of each digit. Each digital nerve, derived from either the median or ulnar nerve, sends branches to the paronychium, fingertip, and pulp volar to the corresponding digital artery. Given its importance in sensation, the fingertip is richly imbued with sensory receptors [9].

Mechanism of injury

Sharp injury

Injuries inflicted by sharp objects may result in laceration or amputation. Following careful examination, simple lacerations can typically be treated with primary closure in the emergency department after all nonviable tissue and dirt has been debrided [10]. Care should be taken to protect the wound until healing has occured [11,12]. If the nail is involved in the laceration, removal of the nail plate and exploration of the nail bed for potential repair is warranted [5].

Amputations are more complex injuries often affecting the fingertip, nail bed, and the neurovascular structures [5]. There are several fingertip injury classification systems including the Fassler, Rosenthal, Allen, Tamai, Sebastin and Chung, and most recently the PNB "(P)ulp, (N)erve, (B)one" system (Table 1) [3]. Evans and Bernadis proposed the PNB system using a point system to provide a 3-digit code to better describe injury severity to the pulp, nerves, and bone. One study has successfully used this classification to guide treatment, although another found it to be too complex for everyday clinical use [13]. Described in 1983, one of the most commonly used classifications is the Rosenthal system of fingertip amputations and is based on three zones: zone I injuries are distal to the bony phalanx, zone II injuries are between the lunula and distal phalanx, and zone III injuries are proximal to the lunula [14]. Zone I injuries can generally be treated conservatively because the germinal matrix remains intact. In contrast, zone II and III injuries do not spare the germinal matrix and are thus generally managed surgically [5].

Crush injury

Crush injuries can present as open or closed and occur when compressive forces damage the fingertip [15]. While injuries to the pulp and bone may occur, they are generally self-limited and not associated with significant sequelae. Instead, the most critical consequence of crush injuries is damage to the nail bed, which can lead to altered nail growth, cosmetic deformity, and permanently decreased grip and scratch capabilities [10].

Clinicians often underestimate the severity of crush injuries and therefore delay the delivery of appropriate treatment. Therefore, it

Table 1
(P)ulp, (N)ail, and (B)one (PNB) Classification [3].

Pulp	Nail	Bone
0 No Injury	0 No Injury	0 No Injury
1 Laceration	1 Sterile matrix laceration	1 Tuft fracture
2 Crush	2 Germinal and sterile matrix laceration	2 Comminuted non-articular
3 Loss – distal transverse	3 Crush	3 Articular involvement
4 Loss – palmar oblique partial	4 Proximal nailbed dislocation	4 Displaced basal
5 Loss – dorsal oblique	5 Loss – distal third	5 Tip exposure
6 Loss – lateral	6 Loss – distal two thirds	6 Loss – distal half
7 Loss – complete	7 Loss – lateral	7 Loss – subtotal
	8 Loss – complete	8 Loss – complete

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