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(REVIEW ARTICLE)

Epidemiology, classification, etiology, complications, and treatments of finger traumatic amputation: A literature review

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Abstract

Traumatic finger amputation is a significant medical and functional challenge with varied etiologies, ranging from workplace injuries to recreational accidents. While classification systems like Pulp, Nail, and Bone (PNB) have enhanced injury assessment, the management and outcomes of such injuries remain highly variable. This review aims to provide a comprehensive overview of the epidemiology, classification, etiology, complications, and management strategies for traumatic finger amputations. Relevant literature was identified through a systematic search of databases including PubMed, Scopus, and Google Scholar. Studies were selected based on their focus on traumatic finger amputation, including epidemiology, classification systems, mechanisms of injury, complications, and treatment approaches. The review reveals that traumatic finger amputations are most common among young males and are often associated with machinery and traffic accidents. The PNB classification system offers a detailed framework for evaluating injuries, complementing traditional systems. Complications such as arterial insufficiency, neuroma formation, and cold intolerance are frequently reported. Treatment options, primarily replantation and stump plasty, depend on the severity of tissue damage and patient-specific factors. Effective management of traumatic finger amputations requires a combination of surgical expertise and long-term rehabilitation to address functional and psychosocial challenges. Future research should focus on improving surgical techniques, advancing prosthetic designs, and standardizing treatment protocols to enhance patient outcomes.

Keywords: Traumatic finger amputation; PNB Classification; Crushing Injury; Stump plasty; Finger Replantation

1. Introduction

Traumatic finger amputation is a condition in which part or all of a finger is lost due to trauma [1]. This condition can have significant consequences for patients, impacting biological, psychological, and social aspects of their lives. Biologically, complications such as delayed wound healing, stimulus intolerance, infections, and joint contractures are common [2]. Patients often experience impaired finger functionality, including difficulties in gripping and reduced sensory perception, which significantly impact their daily activities [3]. On a psychological and social level, traumatic finger amputation can cause distress due to societal stigma and its effect on body aesthetics, ultimately reducing the patient's quality of life [4].

The global burden of finger amputation trauma is reflected in Disability-Adjusted Life Years (DALY), as evidenced by a study in South Korea, which showed an increase in DALY related to upper limb amputations, including hand and finger

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amputations, from 43.00 units per million in 2004 to a peak of 56.05 per million in 2007 before declining [5]. This trend illustrates the profound burden traumatic amputations place on individuals, affecting their overall well-being.

Epidemiological data further highlight the significance of this condition. The global incidence of hand and wrist fractures is approximately 179 per 100,000 people, while rarer injuries, such as finger fractures, occur at an incidence rate of 24–56 per 100,000 people. Case incidence varies across regions, with East Asia—particularly China and North Korea—showing a significant increase in cases. In contrast, Indonesia is among the countries with a lower reported incidence of finger amputation trauma, alongside Timor Leste, Laos, Mauritius, and the Philippines [6].

This study aims to provide a comprehensive overview of epidemiology, classification, etiology, complications, and treatment of finger traumatic amputation. Furthermore, this study can guide future research, inform clinical practices, and enhance understanding of preventing, managing, and treating finger traumatic amputation.

2. Review Content

2.1. Definition and Epidemiology

Traumatic finger amputation refers to the loss of one or more fingers due to external trauma or injury, which can occur through various mechanisms such as motor vehicle accidents, farming activities, tool usage, or burns. This type of injury is predominantly seen in young adult males, although it can affect individuals of all ages and genders. The severity of the tissue damage typically determines the classification of traumatic amputations, with the mechanisms of trauma varying widely [7].

A descriptive study conducted in 2020 estimated that approximately 57.7 million people worldwide suffer from amputations resulting from trauma. Among these, 19.6% of the cases involved unilateral hand amputations, and 19.1% involved bilateral hand amputations. Falling was identified as the most common cause of traumatic amputations, followed by traffic accidents and mechanical trauma. Additionally, amputations resulting from conflict and terrorism have been reported [8].

Regional prevalence data from the Global Burden of Disease (GBD) indicate that East Asia has the highest number of traumatic amputations, with 11.2 million cases, followed by South Asia at 9.7 million. However, when considering the prevalence ratio per 100,000 people, Central Europe, Australasia, and Eastern Europe report the highest rates, with 2478, 2200, and 2096 cases per 100000 people, respectively. Despite these high prevalence ratios, these regions contribute a relatively small proportion to the global total prevalence of traumatic amputations [8].

A retrospective study conducted at Nancy University Hospital in France between 2017 and 2018 revealed that over 500,000 individuals visited the hand emergency clinic annually, with an average of 5,500 cases per year. Of the 2,247 hand amputations reported, 1,715 were traumatic amputations, and 532 were non-traumatic [9].

In the United States, a study covering the period from 2010 to 2019 found that finger amputations accounted for approximately 234,304 cases in emergency departments. The majority of these patients were male (79%), with the most common causes being chainsaws and other machinery, followed by accidents involving doors and lawnmowers. The incidence of finger amputations demonstrated a bimodal distribution, with the highest rates observed in children aged 0-4 years, followed by a second peak in adults aged 65-74 years [10].

2.2. Classification

Traumatic finger amputation can be classified based on the zone of tissue injury, with three primary tissues assessed: pulp (soft tissue), nail, and bone (distal phalanx). This classification system is known as the Pulp, Nail, and Bone (PNB) classification. Since these three tissues may experience trauma or loss in various combinations, a three-digit classification system was developed to describe the injury accurately, based on the specific tissues involved [11].

The PNB classification system was inspired by the Tumor, Node, and Metastasis (TNM) system, which is commonly used for malignancies. The classification begins with the number 0, indicating the absence of trauma, and progresses to the highest number, which denotes complete amputation of the associated structure. The system uses abbreviations for each tissue—'P' for Pulp, 'N' for Nail, and 'B' for Bone—followed by numbers that represent the severity of the injury. [11].

2.3. Etiology

Traumatic finger amputation does not have a single specific etiology, as the term "traumatic amputation" refers to any injury or trauma that results in the loss of a body part, in this case, a finger. However, there are several potential etiologies and modes of injury that can lead to finger amputation. These include crushing injuries (such as compression or destruction), injuries sustained during play, lacerations, and injuries caused by work equipment [12].

Crushing injuries may occur when fingers are pinched by heavy objects such as doors, stones, or machinery. Play-related injuries are common in children, often occurring when fingers become trapped in objects during recreational activities. Laceration injuries can range from those caused by kitchen utensils to compression injuries from bicycle chains. Work-related injuries, particularly in industrial settings, often involve fingers being caught or pinched in equipment such as sewing machines [12].

Further data from a 2001 study in Norway, which examined 163 severe upper extremity injuries, revealed diverse injury mechanisms. Of the cases, 48 occurred at home, 18 at work, 13 due to traffic accidents, 10 on non-traffic roads, and 7 during leisure activities. Injuries also occurred in various contexts, such as sports, children's play areas, and other uncategorized locations. Items commonly associated with these injuries included knives (15 cases), glass (15 cases), saws (13 cases), machines (10 cases), and lawnmowers (1 case), among others [13].

2.4. Complications

Complications arising from traumatic finger amputations are typically categorized into early and late complications. Woo's 2015 study identified early complications such as arterial insufficiency, venous insufficiency, and infection. These issues often arise shortly after the trauma and can significantly impact the outcome of the injury if not managed promptly. On the other hand, late complications may develop over time and include cold intolerance, tendon adhesion, joint stiffness, bone malunion, and altered sensory perception [14].

Harris's 2018 study further expanded on the range of complications, identifying challenges such as soft tissue closure problems, nail deformity, neuroma formation, cosmetic deformities, scar contracture, and loss of function. Among these, issues related to soft tissue closure are the most commonly observed and may occur alone or in conjunction with other complications. These complications can complicate rehabilitation and affect both the aesthetic and functional outcomes of the injury [15].

In addition to the early and late complications already discussed, traumatic finger amputations may lead to other conditions that develop over time. These complications can significantly impact both the physical and psychological well-being of the patient. Notable complications include phantom pain, stump pain, edema, the formation of contractures, body asymmetry, skin damage, and neuroma formation [16].

2.5. Treatments

The initial management of a patient with traumatic finger amputation involves several critical steps to optimize outcomes. These include first aid, proper preservation of the amputated part, administration of tetanus vaccination to prevent complications, and the use of antibiotics in accordance with local hospital protocols. Replantation is considered only under specific conditions: the amputated finger must have been recently severed, exhibit healthy tissue, result from a sharp trauma mechanism (with a clean amputation boundary), have minimal tissue damage, and show no signs of contamination [17].

Replantation is indicated in cases such as thumb amputation, multiple finger amputations, amputations at the palm or proximal area, pediatric amputations, and situations where patient preference aligns with specialist recommendations. Conversely, contraindications include severe tissue damage, smoking, mutilation, heavy contamination, medically unfit patients, avulsion injuries, unstable mental states, and prolonged warm ischemic times [17].

- The process of replantation involves several technical steps:
- Bone fixation (with or without shortening),
- Tendon repair (both flexor and extensor),
- Nerve repair,
- Arterial anastomosis,
- Venous anastomosis (when veins are identifiable) (17).

For cases where replantation is not viable, stump plasty serves as a primary management technique. This approach begins with desensitization of the stump to reduce external stimulus sensitivity. Subsequently, the bone is shortened, and the stump is reshaped for better functionality and aesthetics. The wound is dressed with both soft (bandages) and rigid (splints) materials. If needed, prosthetic devices may be provided to assist with functional rehabilitation (18).

3. Conclusion

Traumatic finger amputation remains a challenging condition that requires careful management to optimize outcomes. This review has summarized the global prevalence, mechanisms of injury, and the role of classification systems such as the PNB system in guiding treatment decisions. Complications, both early and late, continue to pose significant challenges in patient care, emphasizing the importance of effective management. Replantation is the preferred treatment for eligible cases, although its feasibility is often limited by specific criteria. For cases where replantation is not possible, stump plasty serves as a viable alternative to restore functionality and improve quality of life. Despite advancements in surgical techniques and rehabilitation, gaps remain in understanding long-term outcomes and standardizing treatment protocols. Further research is needed to refine treatment strategies, develop innovative technologies, and address the psychological and functional impacts of traumatic finger amputation. By addressing these gaps, future studies can contribute to improving patient outcomes and advancing the field of trauma care.

Compliance with ethical standards

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Disclosure of Conflict of interest

No conflict of interest to be disclosed.

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