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Epidemiology of Fingertip Injuries at South Central Hospital Petróleos Mexicanos "Pemex" with a Review of the Literature

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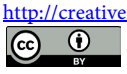


Abstract

Background: The hand is an essential component for performing our daily tasks; as a result, injuries to the fingertip are frequently seen. Accurate evaluation and treatment of fingertip injuries are essential to avoiding long-term disability, job loss and psychological issues. No matter the injury classification system, maintaining finger length, regaining sensation, and improving appearance are the three main objectives of treatment. The objective of this research was to outline the epidemiology of fingertip injuries treated between 2021 and 2022 at a highly specialized referral hospital in Mexico City. Methodology: This investigation is cross-sectional, retrospective, and observational. From January 2021 to December 2022, 60 patients with a diagnosis of fingertip injury from the South Central Hospital "Pemex" were included. The descriptive statistical analysis was performed using SPSS29. Results: 60 patients were included, 27 (45%) were women and 33 (55%) were men. Allen's classification was able to classify only 19 patients, of which 18 (94.7%) had a type 1 classification and one (5.26%) had a type 2 classification. 10% of patients experienced complications, which included 2 patients with surgical site infections (3.3%), 3 patients with persistent pain (5%), and 1 patient (1.6%) with graft rejection. Conclusions: There are currently insufficient epidemiological data on hand and wrist injuries and its effects on labor in Mexico. Fingertip injuries require particular care in order to prevent complications and long-term damage. The creation of national registries could help with the creation of reference manuals for the care of hand and wrist injuries in our nation.

Keywords

Fingertip, Fingertip Injuries, Epidemiology

1. Introduction

Epidemiology

The hand constitutes a fundamental element for carrying out our daily activities, which is why it is constantly exposed to aggression of all kinds. It is therefore common to observe injuries to the distal portion of the fingers [1]. These types of accidents are not usually life-threatening; however, accurate evaluation and treatment are vital as they can prevent long-term disability, job loss, psychological problems, and even social isolation [2] [3]. The objective of the treatment is to achieve the greatest possible length of the finger in order to achieve a stable, non-painful covering tissue that allows for the maintenance of joint function and an aesthetic appearance [4].

A fingertip injury is defined as an injury that occurs distally to the insertion of the flexor and extensor tendons in the distal phalanx [5]. Today, they represent a large percentage of emergencies that are attended daily by the Plastic and Reconstructive Surgery service [6] [7]. When these lesions are characterized as complex, in addition to the skin defect, there is involvement of vascular, nervous, bone and/or tendon structures [8].

The International Labor Organization estimates that hand injuries account for approximately two million victims per year worldwide [2]. The prevalence of this disease varies between 0.33% and 11% per 100 workers per year [4]. The Occupational Safety and Health Administration reports an annual incidence of 400,000 hand injuries in the United States [2]. In contrast, the Mexican Social Security Institute reported 113,511 hand injuries in 2011, which represents 26.9% of all work accidents in Mexico [4]. The Zone I of the fingertip is described as having the highest frequency of hand injuries [9].

Despite this, it is well-known that a significant portion of Pemex workforce engages in manual labor, which poses a risk of fingertip injuries. Considering that many of these injuries are treated at first- and second-level units throughout the country, only those that were treated at our institution will be referred to in this manuscript. The objective of this study was to describe the epidemiology of fingertip injuries treated at a highly specialized referral center in Mexico City between 2021 and 2022.

2. Anatomy

2.1. Anatomy of the Fingertip

When discussing the correct execution for hand surgery, it is recommended to have an exact knowledge of physiology, anatomy, biomechanics, and various surgical techniques [6]. The fingertip encompasses the anatomical region be-

tween the pulp and the nail bed (**Figure 1(a)**), extending distally to the insertion of the flexor and extensor tendons in the distal phalanx [10]. Among the adult population, it measures an average of three to four centimeters long and 1.5 to 2.5 centimeters wide, with a discrimination of two points less than four millimeters (**Figure 1(b)**, **Figure 1(c)**) [11].

2.2. Irrigation and Innervation

The artery supply for this region is provided by the network of terminal branches of the digital arteries, which are located around the distal interphalangeal (DIP) joint and the proximal half of the distal phalanges (**Figure 2**). The main veins draining the fingertip form a net-like structure on the back of the finger. The digital arteries do not have concomitant veins, but there is a venous plexus surrounding each artery in the subcutaneous tissue. Therefore, any flap based on a digital artery should include at least two to four mm of surrounding subcutaneous tissue.

The digital nerves, however, leave the terminal branches and form a transverse arch in the palmar subcutaneous tissue of the fingertip [12] (**Figure 3**).

2.3. Tendons

Flexor tendons attach to the lateral ridges (palmar plates) of the proximal and middle phalanx of the digital joints. Verdan performed the division of the flexor system, describing horizontal zones with respect to the tendinous structures (**Figure 4**) [13].

The extensor tendons have been traditionally classified into 8 anatomical zones. Zones 1, 3, 5 and 7 (odd) are located on the joints, while zones 2, 4, 6 and 8 are located on the bony references of the middle phalanges, proximal phalanx, metacarpal, radius and distal ulna respectively (**Figure 5**) [1].

2.4. Bones

The distal phalanx forms the bony structure, which is formed by the diaphysis with a palmar concavity and ends in a distal tuberosity. A proximal and a distal segment can be distinguished by the fibrous skeleton that establishes it [14] (**Figure 6**).

The distal portion of the soft tissue is divided into radial distributed fibrous septa that insert into the deep face of the dermis and periosteum, constituting pyramid-shaped compartments of celluloid adipose tissue [14] (**Figure 7**).

2.5. Nail Anatomy

The dorsal portion of the distal phalanx contains a laminar surface of flattened cells (the nail) arranged in layers. This structure rests on the nail bed, which is made up of the germinal matrix (middle part of the nail), the sterile matrix (ventral part of the nail), which is what determines nail adhesion, and the dorsal roof of the nail fold (dorsal part of the nail). The lunula is the whitish area found in the proximal part of the nail, corresponding to the area where the cell nuclei

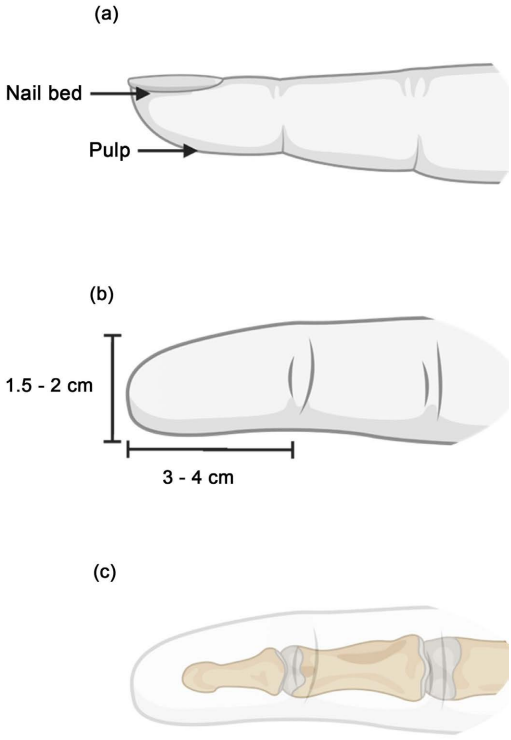


Figure 1. Fingertip structure viewed from the volar and lateral views and bone structure of the distal phalanx viewed from the volar view. "*Created with BioRender.com*".

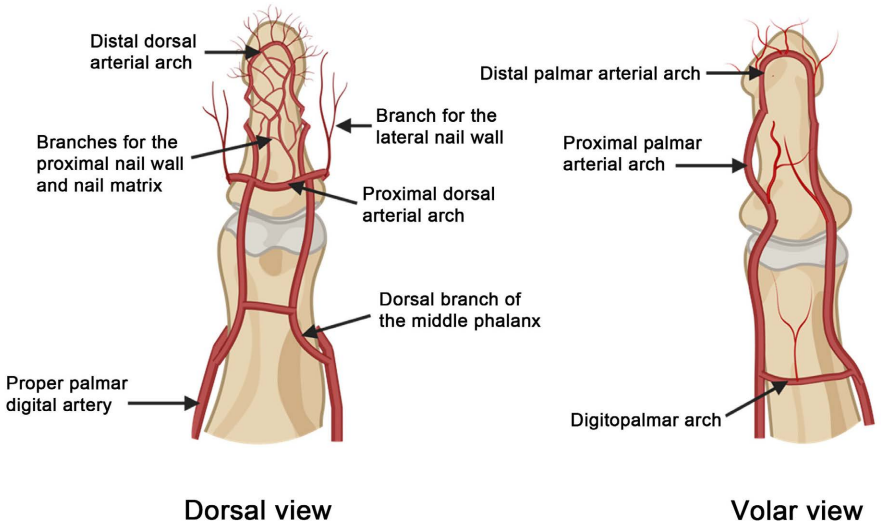


Figure 2. Diagram of the irrigation of the distal phalanx. "*Created with BioRender.com*".

within the nail plate have degenerated. The nail is surrounded by a structure called the hyponychium, which is located immediately below the distal edge of the nail. It is a keratinous plug that will cover the junction of the protruding nail plate, the distal margin of the sterile matrix, and the skin of the fingertip. However, the perionychium is the skin that will surround the nail and that will fold over its proximal and lateral edges [1].

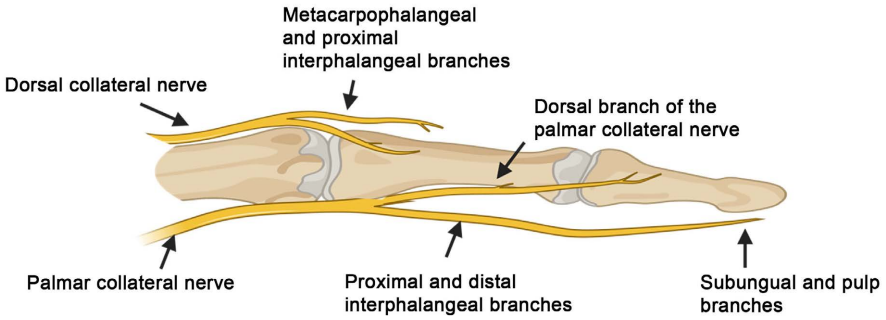


Figure 3. Diagram of the innervation of the distal phalanx. "*Created with BioRender.com*".

Zone I	Deep flexor segment that goes from the insertion of the superficial flexor on the middle phalanx, to the insertion of the deep flexor on the base of the distal phalanx
Zone II	From the distal palmar flexion crease to the insertion of the superficial flexor
Zone III	From the distal edge of the flexor retinaculum to the distal palmar crease
Zone IV	Zone under the flexor retinaculum
Zone V	Zone between the myotendinous junction and the upper edge of the flexor retinaculum

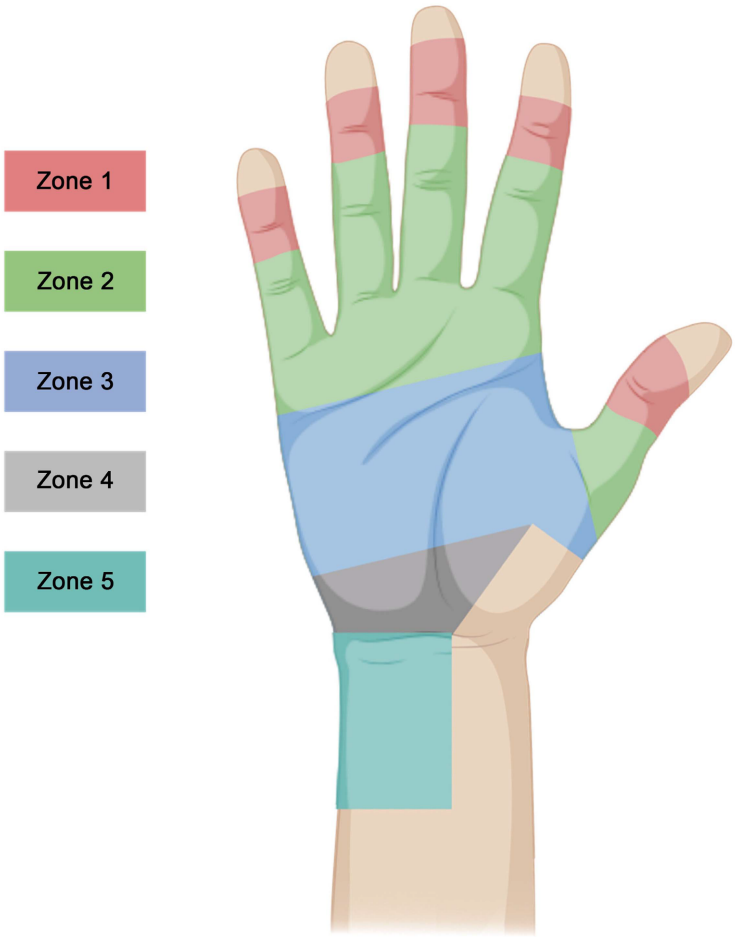


Figure 4. Graphic representation of flexor zones. "*Created with BioRender.com*".

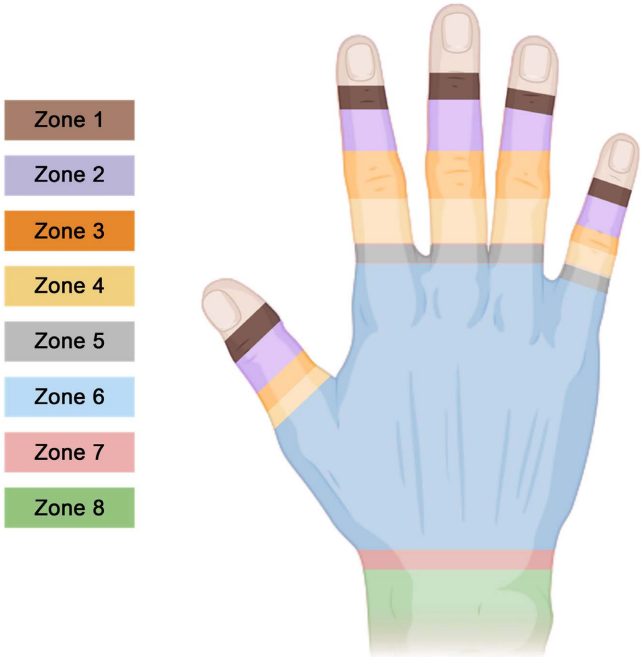


Figure 5. Graphic representation of extensor zones. "*Created with BioRender.com*".

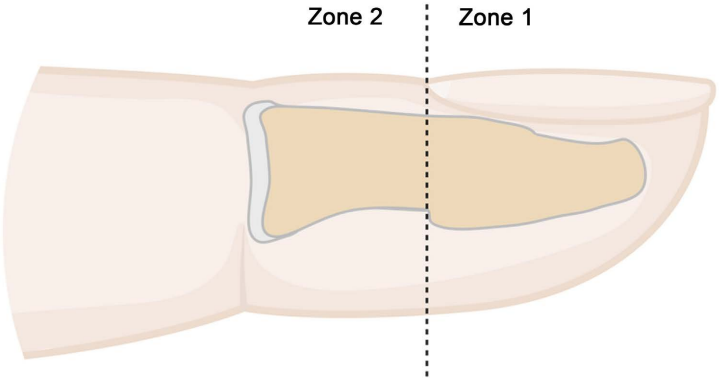


Figure 6. Bone anatomy of the distal phalanx: Zone 1, distal segment. Zone 2, proximal segment. "*Created with BioRender.com*".

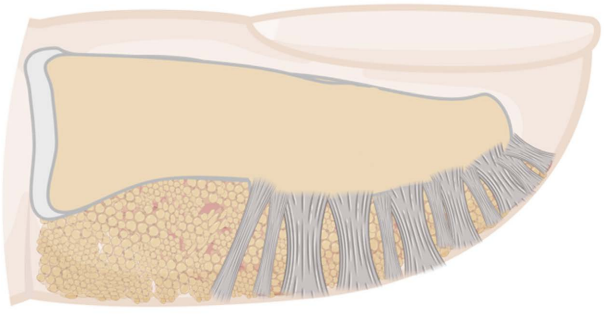


Figure 7. Schematic of a longitudinal section through the distal phalanx with exposure of the cutaneous ligaments on the pulp of the finger, which extend from the skin. "*Created with BioRender.com*".

The importance of the nail lies in the fact that it supports the pulp, contributes to sensitivity, allows fine motor skills, and helps to improve the appearance of the finger. When the nail bed is injured, a subungual hematoma can develop, with or without fractures of the distal phalanx. A radiological study is indicated because there is generally a history of local trauma. If subungual hematomas are present, they should be decompressed. Treatment consists of three principles: remove the nail if the hematoma is very extensive (more than 50%), repair the nail bed, and repair the nail [1]. The average daily growth rate of the nail following an injury is 0.1 mm, with a goal of complete restoration within 70 to 140 days. The average duration of restoration is 100 days (**Figure 8**).

2.6. Classification of Digital Tip Injuries

The classification of the lesions can be made based on the loss of soft tissue without bone exposure in: <50% of the distal phalanx and >50% with bone exposure, with the presence of the lesion in the nail bed, fractures (distal third, medial, and proximal); and direction of amputation.

The Allen and Duatel classification identifies lesions in four zones according to their extension (**Figure 9**). This classification identifies zones ranging from distal to proximal:

- Zone I: distal amputation, without finding the exposed phalanx, only includes skin and subcutaneous tissue.
- Zone II: passes through the nail bed, but an adequate length is maintained to allow adequate growth of the nail.
- Zone III: the level of the lesion is close to the proximal nail fold. If the nail bed is preserved at this level, the "parrot beak" phenomenon will occur.
- Zone IV: amputation proximal to the interphalangeal line, zone in which venous anastomosis is viable as well as reimplantation.

Based on the type of injury presented, we can choose an adequate coverage method [10].

The Tamai classification, which has been modified by Ishikawa, is another classification available in the current literature. Tamai divides digital tip amputations into two zones based on their degree of distalness. Zone I extend from the nail base to the distal interphalangeal joint, while zone II extends from the nail base to the distal interphalangeal joint. This classification was modified by Ishikawa *et al.*, who added four subzones: subzone I which extends from the distal end of the nail to the midpoint of the nail, subzone II which extends from the base of the nail to the midpoint of the nail; subzone III, which extends from the midpoint of the distance between the nail base and the interphalangeal joint; and subzone IV, which extends from the interphalangeal joint to the midpoint [10] (**Figure 10**).

The Tang divisions for the lesion of the digital tip are used to describe the involvement of bony and soft structures and the direction of the lesion [8]. The zones are classified as follows: Zones 1A, B and C are based on the existing zoning of the flexor tendon. Zone 0 is the tip distal to the insertion of the digital

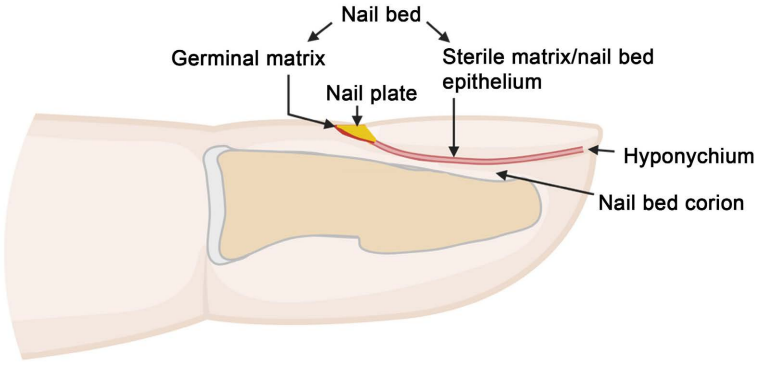


Figure 8. Anatomy of the nail. "*Created with BioRender.com*".

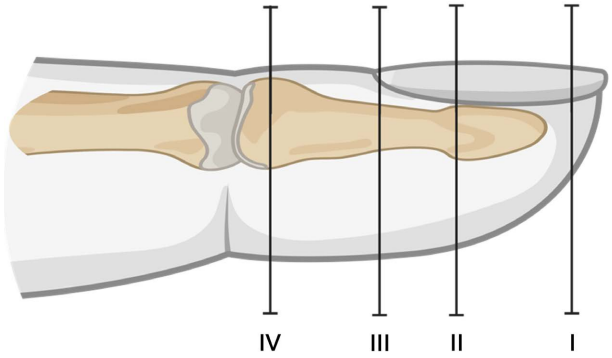


Figure 9. Allen and Duatel classification for digital tip injury. "*Created with BioRender.com*".

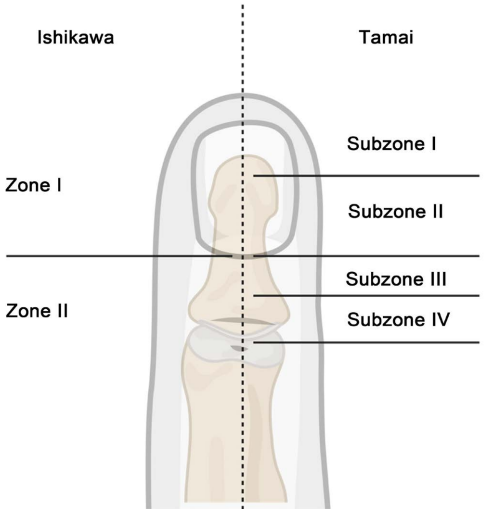


Figure 10. Digital tip lesion classification by Tamai modified by Ishikawa. "*Created with BioRender.com*".

flexor tendon, which is divided into zone 0A (intact nail root) and 0B (absent nail root). The right panel presents a classification of lesions based on their structure and obliquity. An injury to the tip of a finger, for example, may be classified as a "zone 0B-C injury" when it causes loss of the nail root and is

transversal [10] (**Figure 11**).

Regardless of the classification system, the essential goals of repair include: Maintaining finger length, restoring sensation and appearance. A further goal is to restore active range of motion in the distal joint [12].

3. Methodology

This is an observational, retrospective, cross-sectional, analytical and descriptive study. The source population consisted of all patients with a diagnosis of fingertip injury who had been treated in the department of plastic and reconstructive surgery of our institution between January 2021 to December 2022. The inclusion criteria were defined as follows: patients with a diagnosis of fingertip injury between 2021 and 2022, who underwent immediate postoperative clinical follow-up, and who had a complete clinical record. Patients who did not have complete clinical information in their files were excluded. Between 2021 and 2022, through a non-probabilistic convenience sampling, 70 patients were initially obtained, who had been treated for fingertip injury in our institution. 10 patients were excluded from the study because they did not receive post-surgical follow-up. The study enrolled a total of 60 participants. The primary objective of this study was to outline the epidemiology of fingertip injuries treated between 2021 and 2022 at a highly specialized referral hospital in Mexico City.

For nominal variables, a frequency analysis was performed. Kolmogorov-Smirnov normality tests were applied, and then mean and deviation were used to describe normally distributed numerical variables and median and range to describe non-normally distributed numerical variables.

The descriptive statistical analysis was performed using SPSS29. The article was written based on the STROBE guidelines for observational reports. A search for articles was carried out in PubMed, Cochrane Library, Google Scholar, and a synthesis of current knowledge.

4. Results

During the study period, 60 patients with a diagnosis of fingertip injury were identified, of which 27 (45%) were women and 33 (55%) were men. Average age was 45.5 years, with a range between 5 and 86 years. The majority of lesions occurred on the left hand, accounting for 71.6% of the cases. The most affected finger was the index finger, accounting for 31.6%, followed by the thumb and ring finger. The pulp was the most common lesion in more than half of the cases, representing 73.3%. 83.3% of injuries occurred at the home, followed by injuries at work or while commuting to work (8.3% and 8.3%, respectively). Most of the injuries were treated with only primary closure. The characteristics of the injuries are outlined in **Table 1**.

Regarding the frequency of Allen's classification, information could only be obtained from 19 patients (31.6%), 18 (94.7%) were classified as type 1 and one patient (5.26%) was classified as type 2 (**Graphic 1**).

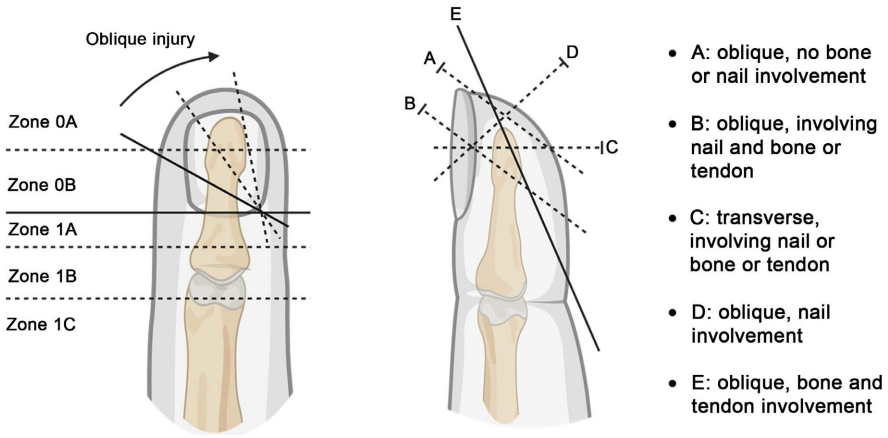


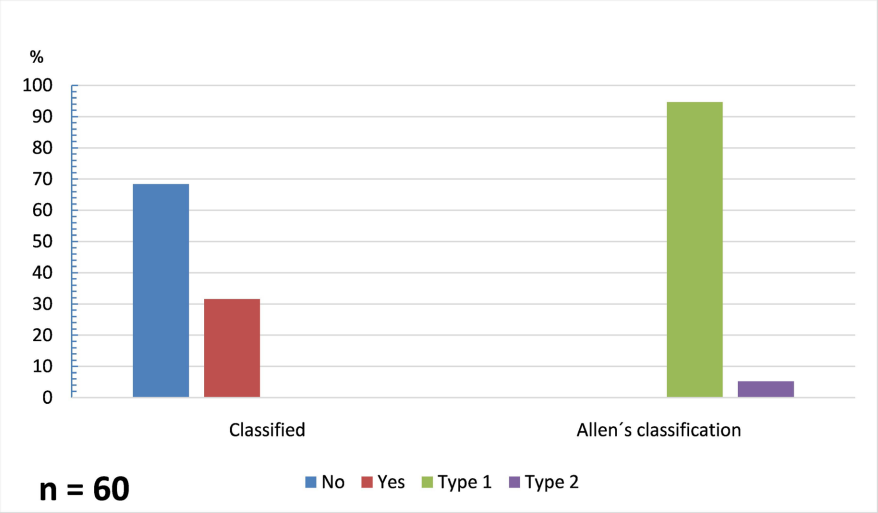
Figure 11. Tang classification. "*Created with BioRender.com*".

Table 1. Characteristics of fingertip injuries.

	n	%
Laterality of Lesion		
Right	17	28.3
Left	43	71.6
Affected Finger		
Index	19	31.6
Thumb	16	26.6
Ring	13	21.6
Middle	12	20
Little	8	13.3
Types of Injury		
Amputation	2	3.3
Nail Matrix Injury	7	11.6
Nail Matrix + Pulp Injury	6	10
Phalanx Fracture	1	1.6
Fingertip + Vascular injury	1	1.6
Pulp Injury	44	73.3
Incident Location		
Work-related	5	8.3
Traffic Accident	5	8.3
Home	50	83.3
Procedures Performed		
Amputation	2	3.6
Flaps	2	3.6
Primary Closure	36	65.4
Nail Bed Splint	3	5.4
Foreign Body Removal	3	5.4

Continued

Conservative Management	9	16.3
Full-thickness Graft	1	1.8
Secondary Intention Closure	1	1.8
Reimplantation	1	1.8
Hematoma Drain	4	7.2
Microsurgical Repair	1	1.8



Graphic 1. Representation of patients who could be included in Allen's classification and the distribution of lesions classified as type 1 and type 2.

Despite this, the average duration of incapacity for work for 28 active workforce members was 5.5 days. Complications included 1 patient (1.6%) with graft rejection, 3 patients (5%) with residual pain, and 2 patients with surgical site infection (3.3%), for a total of 10% transient complications. Therefore, 90% of the patients (n = 55) were not presented with any type of complication.

5. Discussion

Hand injuries account for a large percentage of emergency department injuries worldwide. Although there is limited information on the epidemiology of these pathologies in the Mexican population, Pacheco *et al.* reported a total of 6106 cases of hand trauma in a 3-year period, representing 67.4% of all reported emergencies [2].

Digital tip injuries, including nail bed injuries, are a major public health issue and are common in the emergency room. Economically active age groups are especially vulnerable, which has a significant impact on the development of society [15].

In December 2004, within the "Lomas Verdes" High Specialty Medical Unit, 59 injured fingers were found in 57 patients, 44 of them men. In this descriptive study, 95% of patients presented with fingertip injury, 72.9% nail injury, and

40.7% phalanx affection [16]. A study conducted at the "Luis Guillermo Ibarra" National Rehabilitation Institute described the epidemiology of hand and wrist injuries treated during 2015, where 48 cases of digital tip injury (2.2%) were found [17]. The López Mateos Medical Center, a hospital of the State of Mexico Health Institute (ISEM), found that men between the ages of 20 and 29 were the most affected by hand injuries. The frequency of injuries to the right hand was higher (54% of all cases) [18].

Telich-Tarriba J. *et al.* carried out a five-year sociodemographic description of the patients treated for fingertip injury in a tertiary referral center in Mexico; included 1265 patients, of whom 75% were male. At presentation, the mean age was 20.5 years old. Furthermore, the most affected age group was children under 15 years of age (46.7%). The most frequently injured fingers were the third (27.2%) and second (25.8%), with no predominance of laterality [7] unlike our study where we observed a higher incidence in the second finger followed by the thumb and ring finger in that order with a predilection for the left hand. Furthermore, Telich-Tarriba J. *et al.* found that the percentage of patients with single-digit lesions was 87%. The most common type of injury was fingertip amputation (49%), followed by simple fingertip lacerations (45%), and nail bed injuries (5.6%). The severity of the lesions was higher than that found in our study, where the majority of lesions presented only lesions of the pulp (73.3%), requiring primary closure. As in our study, most of them required surgical management (95.8%) [7], which highlights the importance of plastic and reconstructive surgery for the management of this type of lesions. That the majority of events occurred at home (83.3%) and a minority occurred at work (8.9%). This may be due to the protective equipment used by the workers at the company. As reported in other series, most of our patients were men (55%) and only 16.3% were managed conservatively. Among those who required some type of intervention, 90% did not present any complications. The prevalence of hand injuries was higher in the left hand (71.6%), with greater involvement of the index finger (31.6%). The reporting and classification of these lesions was not uniform, and information was only obtained from 19 patients, a third of the sample. Therefore, we believe it is essential to achieve internal consensus in order to unify classification criteria. This, however, did not affect the management or evolution of our patients.

As reported in the literature, the incidence of nail bed injuries is higher in young men, who are the most vulnerable population [15]. For this reason, multiple studies have attempted to establish the direct and indirect costs of hand and wrist injuries throughout the world [19] [20]. Robinson *et al.* conducted a systematic review in 2015 and found that the average cost per case of all hand injuries was $6951 dollars [19]. This is another reason to provide adequate care, treatment, and timely rehabilitation for these pathologies.

Our study is limited by the fact that it is not possible to conduct a random sample, which could lead to biases.

6. Conclusion

Hand and wrist injuries are one of the most common pathologies in our country. Currently, there is no sufficient epidemiological data on this type of injuries in Mexico, regarding its labor repercussions. Fingertip injuries, however, require specialized treatment in order to avoid complications and permanent disability. On the other hand, fingertip injuries need to receive specialized treatment to avoid complications and permanent disability. Furthermore, the establishment of national registries could assist in the development of reference guides for the treatment of the hand and wrist injuries in our country.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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