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VASCULARIZED FLAP FROM THE METACARPAL ARTERY TO THE LITTLE FINGER, DUE TO TRAUMATIC AMPUTATION: A CASE REPORT

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Abstract
Background, Defects of the soft tissues of the fingers are rare but catastrophic entities, associated with partial amputations of traumatic origin. When talking about the creation of a vascularized flap in the hand, one must take into account the difficulty involved in carrying out carrying out one of these procedures, due to the limited availability of donor tissues in the area, in this case the rotation of the metacarpal artery of the fourth space is performed, a rare procedure not documented in the country; Presentation of the case, we have a 21-year-old female patient, of mixed race, who suffers a traumatic amputation by hydraulic press, Allen classification IV; Expected conclusions, the reader should know the alternatives that can be carried out for the creation of vascularized flaps in the hand after traumatic amputations, in addition to knowing the technique to generate an impact and it can be used in other health homes.

Keywords: Metacarpal artery, Reconstructive surgery, Vascularized flap.

Introduction

When referring to soft tissue defects of the fingers, these are described as rare but catastrophic entities, frequently associated with partial amputations of the fingers of traumatic origin, where men will have a greater risk of suffering them than women, showing a rate 6.6 times higher. Being a common reason for consultation in the area of traumatology, therefore, it is essential to know the various techniques that are available for their repair, in this case the flap with the dorsal metacarpal artery. (1)

When talking about performing a vascularized flap in the hand, it is necessary to take into account the difficulty of carrying out one of these procedures, due to the scarce availability of donor tissues in the area. In addition to the anatomical and functional complexity that is related to the hand, due to the fact that it allows patients to interact with the environment, and due to its function, a greater risk of injury (2) (3)

It should be kept in mind that the objective of these reconstructive hand surgeries is to achieve the restoration of functionality, accompanied by an aesthetic component within the appearance for the final result achieving well-being for the patient, due to the involvement of psychological and social components. The complexity of hand injuries lies in the fact that a simple trauma such as a laceration

may require complex reconstruction. Deep lesions, where the tendon or bone is involved, present a challenge for the physician at the time of resolution of the condition (3) (4) (5) (2)

For these procedures, it is necessary to perform vascularized flaps, for a correct restoration after the injury. In the case of performing procedures such as skin grafts or closure by second intention, it can generate limitations in functionality, according to Zyluk et al (7). They conducted a study in Poland where they evaluated the long-term results, at more than 3.7 years in patients with soft tissue defects inside the hand, who underwent groin flaps, where it was found that all procedures found scarring, however, in 26% of the cases complications were found. showing slight pain when moving the hand (6) (5) . (7)

Jiayu et al (8). A study was conducted in China, where nine patients with palmar hand defect underwent a sensory flap of the middle plantar artery, where it was found that 8 of the flaps survived completely showing repair of the defect and a recovery of sensitivity, while 1 presented ischemic skin necrosis. Taking into account the limitations and difficulty involved in performing this reconstructive hand surgery, this report is made in order to compare the clinical case with the published scientific literature of similar cases, which will demonstrate the specialness of the case. (8)

Several techniques have been described, in terms of hand reconstruction surgery; which are used depending on the size and location of the defect, allowing the surgeon to resort to classic procedures; which have been developed since 1950 by Hilgenfelt and have been perfected over the years. (9)

However, as mentioned in the problem statement, defects in the soft tissues of the hand represent a challenge because of the complexity that symbolizes the restoration of the functionality and aesthetics of the hand. For this reason, the search for new techniques that allow alternatives to reconstructive surgeries continues, based on the specific characteristics of each patient; For this reason, both the report and the analysis of this clinical case are relevant, which will allow us to extend the knowledge about the different reconstructive techniques, and variations in them, providing a wider therapeutic range for the resolution of these conditions. (10)

Hand vascularization is a complex system of blood vessels that originate from both the radial artery (RA) and the ulnar artery (AC) (11). The radial artery originates in the brachial artery, specifically in its lateral bifurcation, being one of the smallest terminal branches. Its point of origin is in the ulnar fossa, approximately 2.2 centimeters below the transverse crease of the elbow and at the height of the radial neck. It is then located in the lateral intermuscular septum of the forearm. It initially descends obliquely until it reaches the lower end of the radius, and then surrounds the carpal joint laterally and reaches the interosseous space of the metacarpal. Finally, it inserts into the deep part of the palm, where it connects to the ulnar artery and gives rise to the deep palmar arch (9)

The radial artery also emits several collateral branches, including the radial recurrent artery, which originates at the end of the radial artery and ascends to join the deep brachial artery, supplying branches to the surrounding muscles. Another important branch is the palmar branch of the carpal bone, which starts from the RA at the lower border of the pronator quadratus muscle, crosses transversely inwards, and joins the AC branch (9,11)

In addition, the radial artery emits a superficial palmar branch that surrounds the radiocarpal joint and joins the AC, giving rise to the superficial palmar arch. The main artery of the thumb comes from the deep RA and runs down the first metacarpal bone and the first phalanx of the thumb (11).

As for AC, it originates in the brachial artery (AB) and is the larger, medial branch of the two branches. It is located in the medial region of the forearm, specifically in the fossa of the elbow, and extends to the palmar area of the hand, giving rise to the superficial palmar arch. The ulnar artery emits several collateral branches, including the recurrent ulnar artery, which bifurcates into two branches, one anterior and one posterior. The anterior ascends through the medial bicipital sulcus to anastomose with a branch of the AB. The posterior one has an oblique trajectory and is anastomosed with other branches of the CA (12).

Another important branch of CA is the common interosseous artery, which can arise directly from the AC on its posterior aspect, and is divided into an anterior and posterior branch. The anterior ramus descends vertically into the forearm, while the posterior ramus has a downward path toward the wrist. In addition, the ulnar artery emits dorsal and palmar branches of the carpus, which anastomose with

the RA branches and form the deep palmar arch. An anastomotic branch also originates with the deep palmar arch that connects the superficial palmar arch with the deep palmar arch (9,11,13,14).
These arteries and their branches provide a vital blood supply to the hand and its structures. The flexion areas in the hand work through the extrinsic flexor tendons, which are wrapped in fibrous sheaths and employ a pulley system to guide the tendon system along the joint series. Gliding processes operate according to the specific anatomical region (11,12). The flexion zones in the hand operate thanks to the extrinsic flexor tendons that are lined by fibrous structures, and use a pulley system to direct the tendons along the various joints. The sliding action of these tendons varies depending on the particular anatomical region in which they are located (11).
The pulley system of both the triphalangeal fingers and the thumb is made up of the carpal tunnel, the flexor tendon tunnel and the digital fibrous sheaths. Referring to carpal tunnel, the flexors of the triphalangeal fingers remain retained in the middle of the carpal bone, from where they will start to go to the corresponding fingers. It is important to note that the unciform process serves as a reflection zone for the medial tendons when flexion of the fingers and wrist. When approaching the radius area, the flexor pollicis longus from its tendon, takes place and rests against the bony walls of both the scaphoid and the trapezius bone, providing as a friction zone. (12) (11,12)
The flexor tendon tunnel is located in the metacarpal area in relation to the triphalangeal fingers, this allows the flexor tendons to be located. The digital fibrous sheaths extend from their origin in the head of the metacarpals to the base of the distal phalanges. There are 5 annular pulleys, fundamental because their function is to prevent palmar dislocation that give the fibrous sheath the possibility of accommodating to digital flexion, which, in turn, favors the approximation of the annular pulleys to each other. (11) (11,12)
The flexor system is divided into horizontal zones, which are based on the area of tendon injury and the surrounding areas; there are several division zones according to their location, either at the level of the triphalangeal fingers or on the thumb; In the triphalangeal fingers there are 5 division zones: Zone 1 includes the section of the deep flexor that begins at the bottom of the superficial flexor and extends to the tip of the phalanx. Zone 2 is composed from its origin in the distal palmar fold of flexion to where it connects to the superficial flexor. Both flexors share a space surrounded by a fibrous structure that Bunnel has called "no man's land." Zone 3 extends from its beginning at the lower end of the flexor retinaculum to the distal palmar fold. Zone 4 is located below the retinaculum flexor. Finally, zone 5 is located between the muscular and tendon junction, until it reaches the superior border of the flexor retinaculum. (11)
In the same way, in the thumb we find 5 division zones; Zone 1 consists of the final portion of the oblique pulley. In zone 2, we find a segment that extends from the upper end of the pulley to its lower end. Zone 3 is located at the thenar eminence, between the lower end of the flexor retinaculum and the upper end of the pulley. Zones 4 and 5 are comparable to those of the fingers with three phalanges mentioned above. . (11,13)

The extensor system of the fingers is made up of a network of interconnected tendon and aponeurotic fibers, which is located at the top of the hand. This extensor system involves both the extensor tendons that come from outside the hand and the tendons of the intrinsic muscles of the hand. . Since 1983, a classification system has been established to assess injuries to the hand, wrist and forearm, consisting of 8 zones. Subsequently, a ninth zone was added to address injuries to the extensor muscles in the middle and proximal third of the forearm (12,14). (13–15)
Zone 1 refers to the joint at the end of the fingers; Zone 2 encompasses the middle part of the finger; Zone 3 is located at the joint closest to the hand; Zone 4 comprises the top of the finger; Zone 5 refers to the joint between the fingers and palms of the hand; Zone 6 corresponds to the metacarpal bone; Zone 7 is located below the extensor retinaculum; Zone 8 encompasses the lower third of the forearm; and zone 9 by the middle and proximal third of the forearm. When talking about the extensor areas of the thumb, 5 zones are described; T1 zone formed by the interphalangeal joint; Zone 2 by the proximal phalanx; Zone 3 by the metacarpophalangeal joint; Zone 4 by the metacarpal; Zone 5 under the extensor retinaculum . (14) (14)

Methodology

The case of a 21-year-old female patient who underwent a vascularized metacarpal artery flap on the little finger of the left hand due to traumatic amputation will be developed. Who went to a health center in the city of Cuenca, also making a comparison with other investigations similar to the present one. In order to discuss the case, exhaustive searches will be carried out in databases using keywords in both English and Spanish such as: "Vascularized flap in hand"; "Hand Reconstruction"; "Hand flap." In the same way, thanks to bibliographic descriptors and general databases.

Eligibility Criteria

A search will be carried out, including original articles, case reports and published trials related to Vascularized Hand Flaps.

Sources of Information

Data bases such as PubMed, Science Direct, Scopus, Web od Science will be used.

Results

A 21-year-old female patient, mestizo, Catholic, from and resident in Cuenca, with no history of importance, went to the emergency room of the hospital due to the fact that approximately 4 hours ago she presented a traumatic amputation of the little finger of the left hand in a hydraulic machine for the manufacture of clay material with complete loss of a finger amputated in said device; He reported pain 10/10 according to VAS in the area of trauma.

Physical examination of the left hand showed amputation of the distal phalanx of the little finger of the left hand, grade IV according to Allen's classification, and the lesion was found proximal to the proximal interphalangeal line, with active bleeding and bone exposure of the middle phalanx in the diaphysis; And according to the "Tic-Tac-Toe" classification at 3,2,3.

Table 1: Allen's Classification (16)

Allen's Classification	
Zone	**Description**
Type 1	Distal amputation, not phalanx involvement, affects only skin and subcutaneous cellular tissue.
Type 2	Amputation involves the nail bed.
Type 3	Amputation compromises the proximity of the proximal nail groove and matrix area.
Type 4	Amputation involves the area proximal to the interphalangeal line

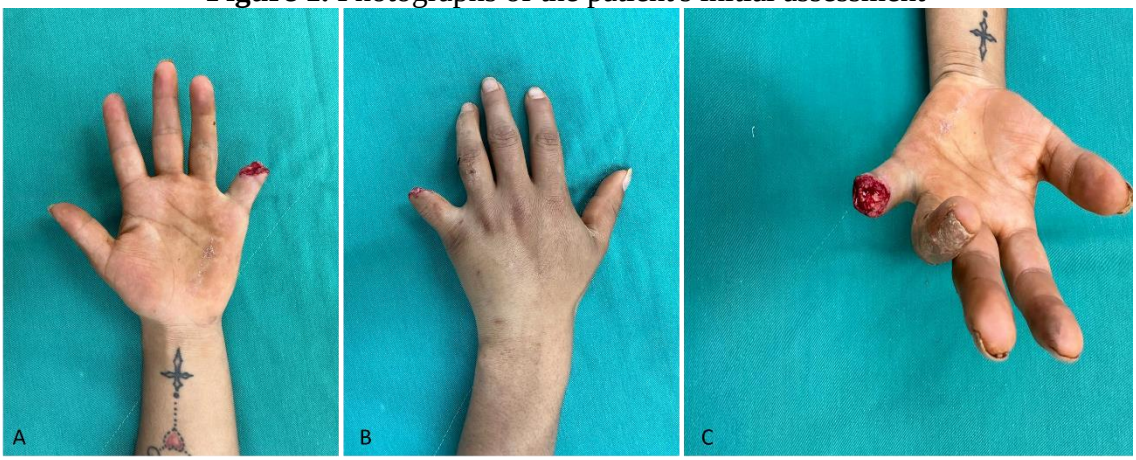
Source: Daniel Castanier.

Table 2: "TIC-TAC-TOE" Classification (17)

Tic-tac-toe classification	
Zone	**Description**
1	Thumb phalanges
2	Phalanges of the index and middle fingers
3	Phalanges of the ring and little fingers
4	Metacarpal of the thumb
5	Metacarpal of the index and middle fingers
6	Metacarpal of the ring and little finger
7	Scaphoid, trapezius, and trapezoid bones
8	Large and semilunar bones
9	Hook, pisiform and pyramidal bones
ROW	DESCRIPTION
Distal	Zones 1, 2 & 3 / Phalanxes
Central	Zones 4, 5 and 6/ Metacarpals
Proximal	Zones 7, 8 & 9 Wrist
COLUMN	**DESCRIPTION**
Radial	Zones 1, 4 and 7
Central	Zones 2, 5 and 8
Ulnar	Zones 3, 6 and 9

Source: Daniel Castanier.

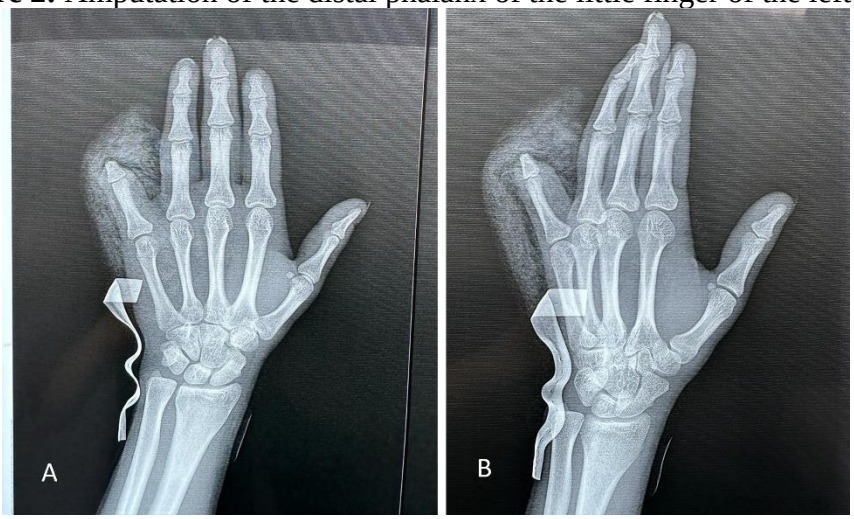
Figure 1. Photographs of the patient's initial assessment



Note. *Image A: Flying view of traumatic pinky finger amputation Allen IV classification*. Image B: dorsal view / Image C: axial view**. Source:** Gustavo Cordero.

Upon arrival, the patient underwent an anteroposterior and oblique x-ray of the hand, which showed amputation of the distal phalanx of the little finger of the left hand.

Figure 2: Amputation of the distal phalanx of the little finger of the left hand



Note. Image A: Left-hand AP X-ray / Image B: Left-hand oblique X-ray**. Source:** Gustavo Cordero

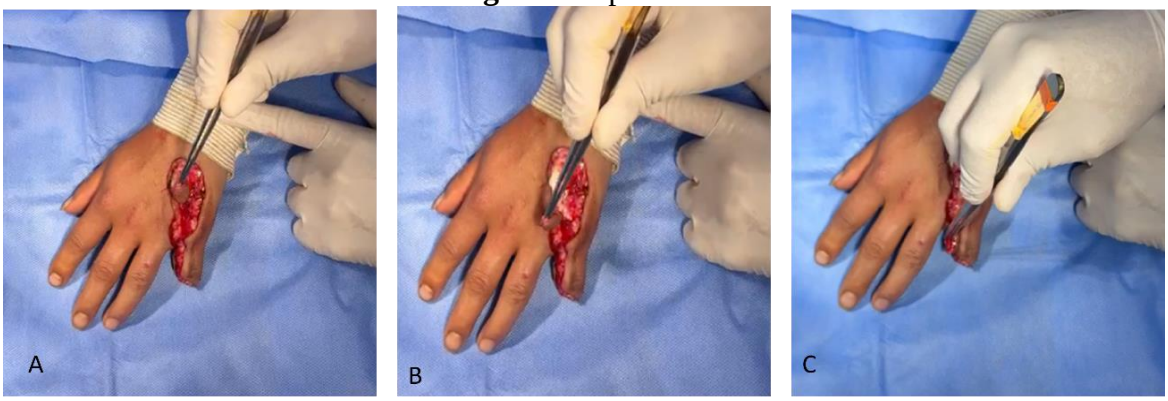
Antibiotic therapy, dual regimen therapy with ceftriaxone and metronidazole, parenteral fluid 1 gram intravenously, was initiated, and rotation of the pedunculated fasciocutaneous flap from the fourth intermetacarpal space to the little finger was planned. By means of WALANT-type regional anesthesia applied by a surgeon who performs a procedure; and under asepsis and antisepsis standards in the operating room, surgical washing is performed with 3 liters of saline solution and 4% chlorhexidine surgical soap. A skin defect of 12 mm x 12 mm was measured; to then measure the length from the donor site to the recipient site for proper pedicle collection; and finally, to mark the approach of the donor site and the recipient site with the measures described.

Figure 3. Dorsal Approach Planning for Flap Rotation

Source: Gustavo Cordero

Skin dissection was performed and a fasciocutaneous flap was taken with deepening to the pedicle; and rotation from donor site to recipient site is executed; To finally close with 4/0 nylon suture, leaving an oblique scar which allows the flexion and extension of the skin and avoids retractable scar. Once the procedure is completed, capillary filling verification is carried out at the donor site; The procedure is hassle-free.

Figure 4. Operation



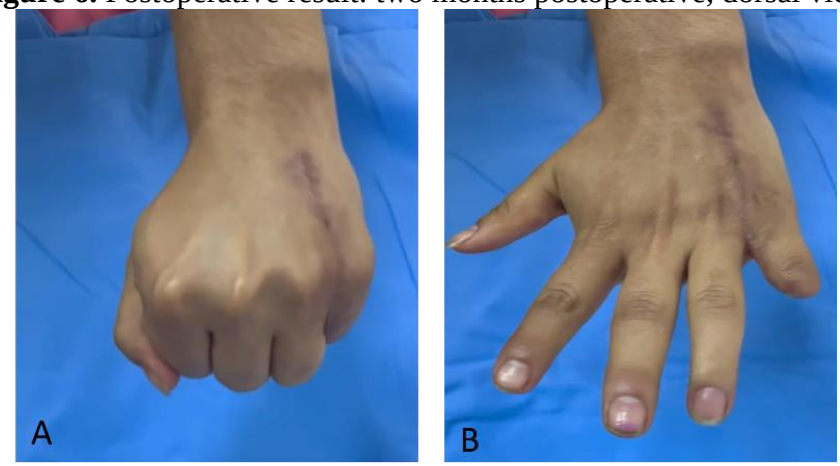
Note. Image A: Flap elevation/ Image B: flap transfer Image C: Verification of the pedicle distal. **Source:** Gustavo Cordero

Figure 5. Photographs of the final result of the surgical intervention

Note. A: Fly photo of the immediate postoperative hand, Image B: Dorsal photo of the immediate postoperative hand. Source: Gustavo Cordero

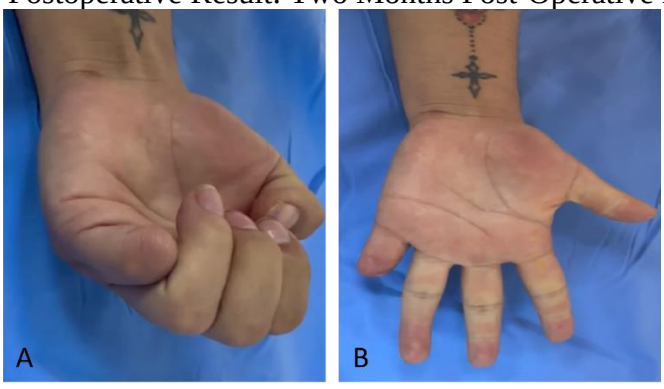
Postoperatively, enoxaparin was administered intradermal parenteral liquid 60 mg, and a new dose of ceftriaxone and metronidazole was received; Patient is discharged hours after surgery and is sent with antibiotic therapy based on cephalexin and metronidazole for 7 days; in addition to enoxaparin for two days and oral solid acetylsalicylic acid 100 mg for 30 days to prevent clots and pedicle collapse, which could lead to flap death. Once discharged, stitches are removed 20 days after the procedure; The patient was monitored weekly by outpatient clinic for two months, where there was evidence of no adverse effects, adequate flap tolerance, scar without retraction or functional limitation, complete metacarpophalangeal and proximal interphalangeal flexion, and complete metacarpophalangeal and proximal interphalangeal extension.

Figure 6. Postoperative result: two months postoperative, dorsal view



Note. Image A: Complete metacarpophalangeal and proximal interphalangeal flexion. Image B: Complete proximal metacarpophalangeal and interphalangeal extension. **Source:** Gustavo Cordero

Figure 6. Postoperative Result: Two Months Post-Operative Fly View



Source: Image A: complete metacarpophalangeal and proximal interphalangeal flexion. **Image B:** Complete proximal metacarpophalangeal and interphalangeal extension. **Source:** Gustavo Cordero

Discussion

The pediculated fasciocutaneous flap of the fourth intermetacarpal space to the little finger, represents a feasible alternative, which provides a therapeutic option to the surgeon for the management of finger amputations, offering an excellent coverage option, offering as advantages the maximum preservation of the length of the finger, maintaining the proximal interphalangeal joint of the little finger that benefits the coupling of the prosthesis, and therefore, improves the aesthetics of the patient.

This type of procedure in our environment represents a challenge due to the conditions that occur in the different medical centers in the area, showing limitations such as the absence of medical instruments for microsurgery, in this case the use of portable microscope, and the lack of a specialist in hand surgery and microsurgery.

In 2019, Gonzalez et al . They published a review in which they report 4 clinical cases in which PAMD is used as a surgical technique, a procedure similar to the one performed in our case, and results are obtained an adequate use of the technique where there are no adverse effects, good clinical evolution, adequate sensitivity and appropriate mobility. (18)

In a case report published in 2022 by Torre-Leon et al . A patient with 90% loss of the nail bed and bone exposure was approached and reconstructed using a vascularized flap of the first metacarpal artery, resulting in the absence of adverse effects and adequate sensitivity and mobility in the patient. (19)

In 2021, in a study published by Posso et al. We report 7 clinical cases in which the use of the perforating flap of the second metacarpal artery is used as a technique, where in only one of the procedures a partial necrosis of 40% is presented as a complication, who is followed up for 3 months and the defect is corrected. The other cases show no adverse effects in addition to adequate mobility and sensitivity. (20)

In a study published in Colombia in 2014 by Galan et al . We report 4 clinical cases in which the use of the CerfVolant flap of the first dorsal metacarpal artery is used as a surgical technique, where no adverse effects are reported and refer to being the first case in which the use of this technique is reported to cover highly complex defects. (21)

In a study published in 2021 by Hernández et al . A series of 6 cases of wounds with loss of substance is reported, who showed amputations at the level of zone II and III, where homodigital flaps were performed at reverse flow, observing the absence of complications at 6 months and preserved mobility. (22)

Another therapeutic option is the use of free flaps, but these are a procedure with greater adverse effects. In a study published in Spain in 2017 by Villanueva et al . A total of 49 cases are reported, in which the use of free flaps is used as a surgical technique, and they report that 100% of the flaps presented survival and an adequate degree of satisfaction from the aesthetic point of view; however, in cases in which reconstructions with vascularized joints and corticoperiosteal flaps were used, secondary tenoarthrolysis had to be operated on again; and when addressing the donor areas as complications, it was presented that 5 patients showed transient paresthesias in the area and 3 patients needed periodic dressings in the area. In the study, they conclude that the use of free flaps shows a better result because healthy areas of the hand are not sacrificed as local flaps do. (23)

The present work attempts to provide evidence about the clinical utility of the use of the pedunculated fasciocutaneous flap of the fourth intermetacarpal space to the little finger, when compared with similar literature, evidencing adequate results with the use of this technique, where the few adverse effects it presents are demonstrated, and it is left as a question why, despite the good results that have been obtained, the use of the palazzo de la carpal, has been used as a question of why, despite the good results that have been obtained, the use of the palazzo fasciocutaneous flap has been used in the past.

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