Sensation Assessment of Dorsal Digital Artery Perforator Flap In Fingertip Reconstruction
(A Prospective Study)

Thesis

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Presented By

Mostafa Kotb Abdelrazik Mohammed
(M. B., B. CH)

Under Supervision of

Prof. Dr/ Mohamed Ahmed Khalaf Allah
Prof. of General Surgery
Faculty of Medicine - Ain Shams University

Dr/ Ahmed Gamal Eldin Osman
Assistant Prof. of General Surgery
Faculty of Medicine - Ain Shams University

Dr/ Ahmed Mohamed Gad Ali
Assistant Prof. of Plastic Surgery
Faculty of Medicine - Ain Shams University

Faculty of Medicine – Ain Shams University
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INTRODUCTION

The hand is the main autologous "tool" used by primates and humans, so it is no surprise that fingertip and thumb tip injuries are the most frequently encountered injuries of the upper limb. The fingertips are the most important organs of tactile sensibility. The high density of Vater-Pacini bodies and the branches of the palmar digital nerves usually provide dynamic 2-point discrimination between 3 and 4 mm. [1]

A fingertip injury is any soft tissue, nail or bony injury distal to the insertions of the long flexor and extensor tendons of a finger or thumb.[2] The terminal branches of the main palmar digital arteries provide the fingertip with arterial blood. Venous drainage on the palmar side is provided by superficial palmar veins and oblique communicating veins. The architecture of the subcutaneous tissue and fascia of the pulp withstands substantial pressure and shear force. [1]

Hand and finger injuries can be crippling and affect all ages, the most is between the working-class adults and children. In adults, injuries are commonly due to occupational activities. In this setting, lacerations are the major type of injury, followed by crush and avulsion injuries. Most injuries tend to be single and of minor severity, and can be treated as an outpatient. However, powered machines and non-powered hand tools are more likely to result in multiple types of injuries.[3]

The National Institute for Occupational Safety and Health in the United States conducted a survey across multiple emergency departments in 1982, and estimated occupational finger injuries to account for 25.7% of its workload. 1.6% had amputations of one or more fingers. [4]

Distal replantation is the best way to restore finger length and offer the best cosmetic results. Although microsurgical developments and techniques have enabled the replantation of even extreme distal tip amputations, replantation may not be feasible for distal pulp crush injuries. Several treatment options are available, including closure with shortening, simple skin grafting, composite grafting, transposition flaps, advancement flaps, antegrade-retrograde flow flaps, perforator flaps, and free flaps. [5]

The decision to choose which method of reconstruction should be used depends on the localization, the geometry of the defect, and the exposed structures (bone, tendon, and nerve). The advantages and disadvantages of each technique depend on the difficulty and reliability of the procedure, donor site morbidity, and the recovery of sensation, all of which have to be carefully considered when choosing the best technique for the patient. [5]

The digital artery perforator flap is a vascular island flap elevated on the distal and either the radial or ulnar sides of the digit for the reconstruction of fingertip defects. The flap based

on the small perforators coming out of the digital artery at the level of the distal interphalangeal joints (DIPJ) or near the DIPJ. [6]

This flap is used to reconstruct fingertip with versatile and debatable issue for sensation restoration. It is not necessary to analyse the geometry of defects when using the DDAP flap, as it is rotated around the perforators in a propeller-like fashion and can be easily applied and rotated to all types of fingertip defects. Although all types of pulp defects have been reconstructed with the DDAP flap, coverage of the dorsal oblique defects were easier. [6]

AIM OF THE WORK

The aim of this study is to assess the restoration of sensation in dorsal digital artery perforator flap for fingertip reconstruction.

REVIEW OF LITERATURE

Anatomy

The fingertip is composed of; Skeletal elements (distal phalanx, tendons, and ligamentous structures), The nail complex or Perionychium (germinal and sterile matrices, nail plate, sheaths, and skin folds), Fibrous connective tissue network with the subcutaneous tissues, Vascular network, Nerves with end organs and The nonperionychial skin. [7] Fig. (1)

The Skeleton

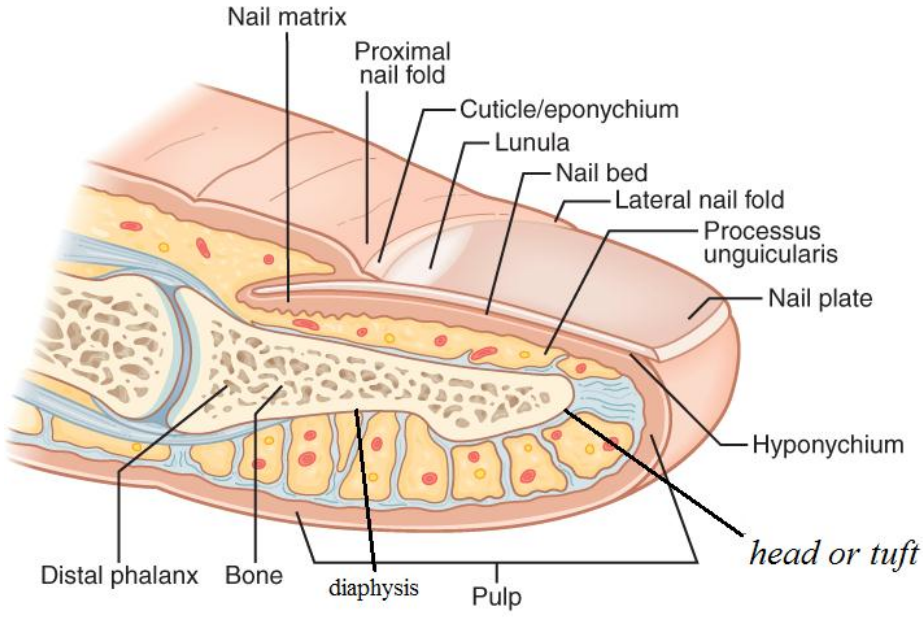

Fig. (1): Skeletal anatomy of the fingertip and distal interphalangeal joint.

The distal phalanx has; A head or tuft, A diaphysis or shaft and A base with articular surface.

The dorsal cortex of the distal diaphysis and the tuft supports the nail plate and the underlying nail matrix. The tuft is an enlarged termination of the phalanx with a “U-shaped” tuberosity called the ungula process. The roughened surface allows dense connective tissue attachments to anchor the skin and subcutis firmly to allow secure object manipulation. The nail bed also firmly adheres to this distal expansion of the phalanx. In addition, the nail matrix is firmly adhered to the more proximal aspect of the distal phalanx via fibres from the radial and ulnar collateral ligaments that serve to anchor the matrix to the base of the distal phalanx. [8]

The terminal extensor tendons have terminal insertions into the dorsal base of the distal phalanx over a somewhat narrow ridge just proximal to the epiphysis. Injuries to these tendons, the tendinous insertion, or to the dorsal base of the distal phalanx may result in "mallet deformities". On the volar aspect, the flexor digitorum superficialis tendon of the fingers and the flexor pollicis longus tendon of the thumb insert more broadly over the volar cortex with a larger footprint of tendon attachment. Likewise, injuries to the tendon, the tendon insertion, or fractures through this portion of the volar base of the distal phalanx can cause loss of flexion of the distal interphalangeal (DIP) joint of the digit which called jersey finger. [9]

The DIP joint itself is a hinged synovial joint stabilized by insertions of the proper and accessory collateral ligaments of

the DIP joint on the tubercles of the distal phalangeal base as well as a volar plate of connective tissue that spans the joint (Fig.2). The phalanx tapers at the mid diaphysis where the lateral interosseous ligaments span from the base to the more hypertrophied and roughened tuft and create a passageway for neurovascular structures on both the radial and ulnar aspects of the fingertip. The shape of the base itself helps confer close approximation and single vector motion by mirroring the bicondylar shape of the middle phalanx head with a central groove between the two concave articular recesses of the distal phalangeal base. These structures allow motion in the volar/dorsal plane while stabilizing the radial/ulnar and rotatory vectors. [10,11]

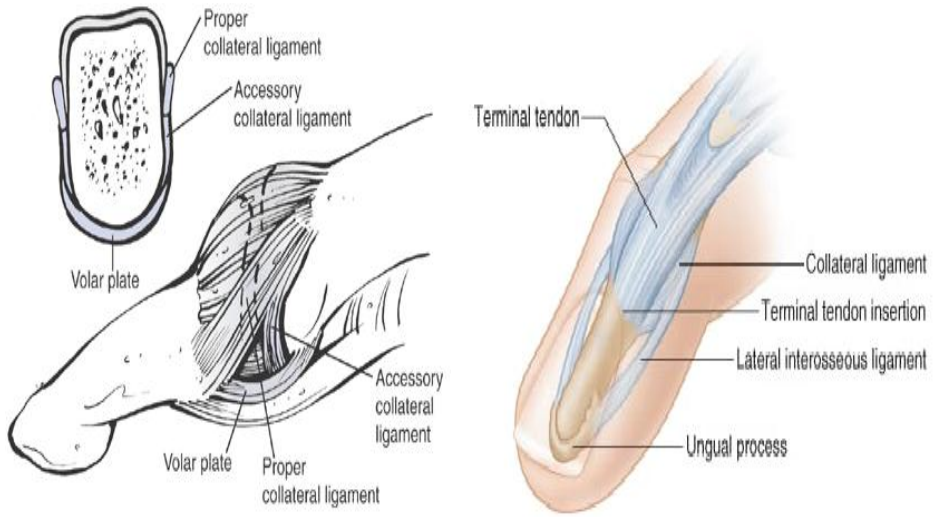

Fig. (2): Finger ligaments anatomy.

The Perionychium

The Perionychium, or nail complex, is a highly specialized structure that is critical to normal digit function. The nail complex allows for improved manipulation of small or fine objects, helps regulate perfusion, contributes to tactile sensation, protects the fingertip, and is possibly the most important structure of the fingertip in regards to aesthetics. [12]

The anatomy of the Perionychium includes; the nail bed (sterile and germinal matrices, the eponychium, the nail fold and the hyponychium. Fig. (3)

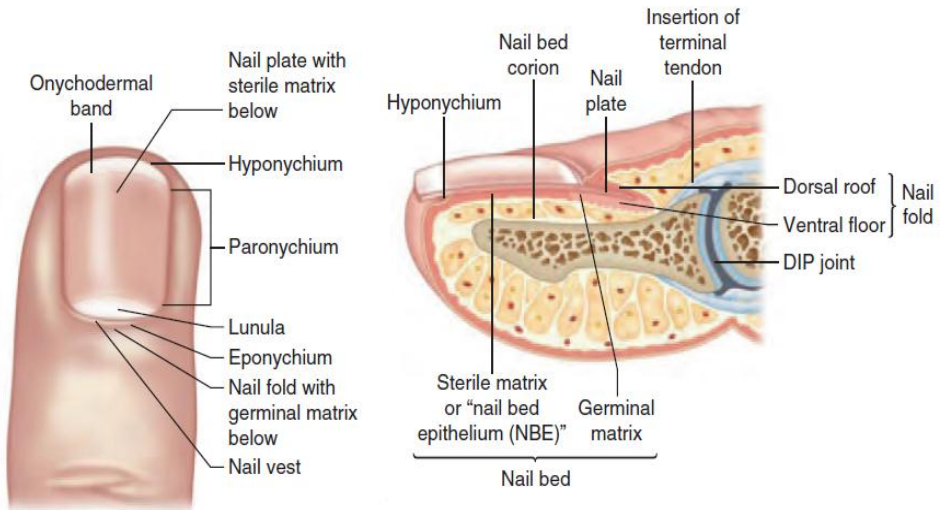

Fig. (3): Perionychial anatomy of the fingertip.

The nail plate itself is a hard, kertinaceous three-layered structure formed by contributions from multiple perionychial components which may be considered generative and supportive of the nail plate. [13]