CORPUS PUBLISHERS

International Journal of Orthopedics and Sports Medicine (IJOSM)

ISSN: 2833-8375

Volume 6 Issue 1, 2025

Article Information

Received date : February 28, 2025

Published date: March 27, 2025

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DOI: 10.54026/IJOSM/1016

Keywords

Carpal tunnel; Muscles fiber's; Nerve; Pathology; Carpal bones

Case Series

Presence of Muscle Fiber's in the Carpal Tunnel

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Abstract

Background: Carpal tunnel syndrome is a very common pathology. The global incidence is 3.9%, and in Mexico, it affects 3.4% of women and 0.6% of men. Although the standard approach for carpal tunnel release is described without traversing muscle fibers, these are common, and their exact origin is unknown.

Methods: This retrospective study analysed clinical records of patients undergoing open carpal tunnel release. Conservative treatments and other surgical procedures were excluded. The presence of anomalous muscle fibers over, under, or through the transverse carpal ligament was assessed.

Results: Out of 23 hands from 19 patients, 69.6% presented anomalous muscle fibers. They were classified into large and small muscles, with 56.3% corresponding to large muscles. Although no anatomical variations of the motor branch of the median nerve were found, they were not intentionally sought.

Conclusion: The presence of anomalous muscle fibers in the carpal tunnel is common in the studied population, exceeding international rates. Although no correlation with anatomical variations of the motor branch of the median nerve was found in this study, the relationship between these fibers and variants has been documented previously. Caution is emphasized during tunnel release to prevent injuries to the motor branch of the median nerve in the presence of such fibers. Specific clinical implications are still unknown. The need for more extensive studies is suggested to better understand the role of these fibers in median nerve compression.

Introduction

Carpal tunnel syndrome (CTS) is defined as a compressive pathology of the median nerve at the level of the carpal tunnel, making it the most common site of nerve compression in the upper extremity [1]. It is estimated that 3.9% of the general population is affected by this condition [2]. In Mexico, the incidence is 99 per 100,000 people per year, with a prevalence of 3.4% in women and 0.6% in men [3]. The carpal tunnel is formed by the carpal bones at its floor and radial and ulnar walls, and by the transverse carpal ligament at its roof. Its contents include the tendons of 4 superficial flexors, 4 deep flexors, 1 flexor pollicis longus, and the median nerve, with the latter being the most superficial structure, located immediately below the transverse carpal ligament, palmar to the flexor tendons.

When the fingers are flexed, there is an anterior movement within the carpal tunnel, generating a compressive force between the tendons and the transverse carpal ligament [4]. It is estimated that this compressive force can be similar to the force exerted by the flexor tendons on the fingers [4,5]. This supports the hypothesis that daily activities cause tenosynovitis, which plays a significant role in the pathophysiology of carpal tunnel syndrome, although its exact etiology remains unknown [4]. The standard approach for open carpal tunnel release begins at the Kaplan line proximally, with an incision made between the thenar and hypothenar muscles, without crossing muscle fibers. However, the presence of muscle fibers crossing the carpal tunnel is not uncommon. Various reports have described muscle fibers located above, though, or below the transverse carpal ligament [6-9].

Despite its high incidence, the presence of these muscle fibers is considered anomalous. The origin and insertion of these muscle fibers have not been clearly established, as the surgical approach is typically small and does not allow direct visualization of the entire muscle. Theories about their origin include the thenar muscles, hypothenar muscles, hypertrophied palmaris brevis, and abductor digiti minimi longus [8,10,11]. In 2005, Tuncali, et al. suggested the possibility of these fibers originating from epiblastic cell migration from the pronator quadratus due to their transverse orientation [7]. Ragoowansi et al. even named this variant the "transverse carpal muscle" or "musculus transversus carpi" [9]. In 2010, Hollevoet et al. conducted a cadaveric study on these abnormal supra-, trans-, or infraligamentary fibers to determine their origin. Dissections were performed on 103 cadaveric hands, reporting the following origins: ulnar extension of the thenar muscles: 29, radial extension of the hypothenar muscles: 3, union of the thenar and hypothenar muscles above the transverse carpal ligament: 11, palmaris brevis: 5, and aberrant abductor digiti minimi longus :3. The origin of the remaining muscles studied was not reported in the original article [10].

The incidence of these anomalous muscle fibers varies widely depending on the author and population studied. Reported percentages range from 11% to 66% in European, American, Asian, and Arab populations, with the largest study by Green and Morgan analyzing 1,011 hands and reporting a 28% incidence [1,6,10-13]. To the authors' knowledge, there are no reports on the incidence of these muscle fibers in the Mexican population. According to Poisel's classification, there are 3 variants of the thenar motor branch of the median nerve:

a. Extraligamentary [normal];
b. Subligamentary;
c. Transligamentary [11].

Lanz expanded Poisel's classification into 4 groups:

i. Variations in the course of a single motor branch [consistent with Poisel's classification].
ii. Accessory branches distal to the carpal tunnel.
iii. High divisions of the median nerve.
iv. Accessory branches proximal to the carpal tunnel [11,14].

Studies have demonstrated a strong association between the presence of muscle fibers above, below, or through the transverse carpal ligament and anatomical variations of the thenar motor branch of the median nerve. This association ranges from 18.2% to 92% [1,11,13].

Objectives

To determine the incidence of anomalous muscle fibers above, below, or through the transverse carpal ligament in patients undergoing open carpal tunnel release and to compare the findings with global reports.

Materials and Methods

A retrospective observational study was conducted based on clinical records of patients who underwent surgical treatment for open carpal tunnel release. All accessible clinical records were analysed for the presence or absence of muscle fibers above, below, or through the transverse carpal ligament. This allowed for the determination of the incidence of these anomalous muscle fibers in the studied population (Figure1-4).

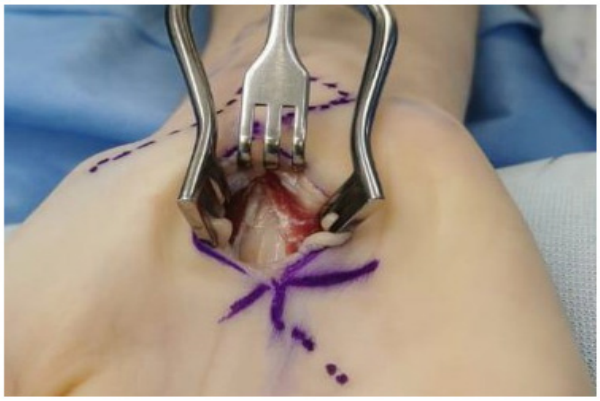

Figure 1: Voluminous anomalous muscle fibers in an 11-year-old patient.

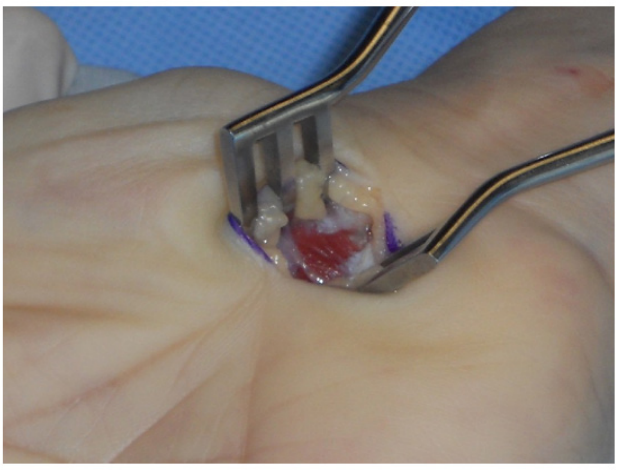

Figure 2: Transversal muscle fibers.

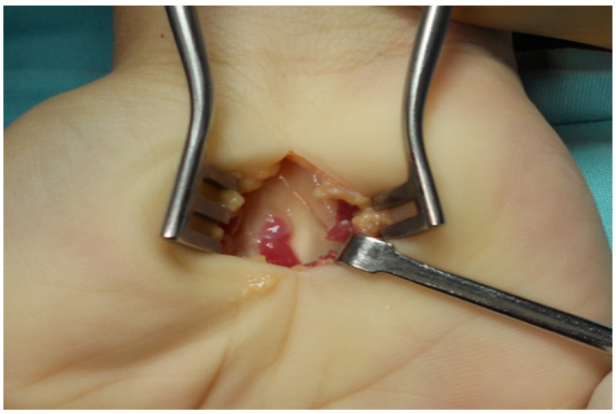

Figure 3: Transversal muscle fibers deep to palmar aponeurosis.

Figure 4: Muscle fibers located deep to the transverse carpal ligament, in close association with the median nerve.

Results

A total of 23 hands from 19 patients were analysed, revealing 16 anomalous muscles with fibers transversely crossing the classic Kaplan approach. This corresponds to 69.6%, a percentage higher than reported in consulted studies. The findings were classified into small and large muscles, with 9 out of 16 being large muscles [56.3%].

Discussion

Carpal tunnel syndrome is a highly prevalent condition in our population and worldwide. As such, it has been extensively studied, leading to various treatment approaches ranging from conservative management and injections to surgical techniques, with endoscopic release gaining popularity in recent years and open release following Kaplan's cardinal points remaining common. The classic open release approach does not account for these transverse muscle fibers, which are considered anomalous or aberrant. However, their presence is highly frequent, with

global literature reporting incidences ranging from 11% to 66% [1,6,10-13]. This is particularly significant given the strong association between these muscle fibers and anatomical variations of the median nerve's motor branch, as described by Poisel [11,14]. Therefore, the presence of muscle fibers during open carpal tunnel release should alert the surgeon to proceed cautiously to avoid inadvertent injury to the median nerve's motor branch.

Notably, among the 19 hands with anomalous muscle fibers in this study, no anatomical variations of the motor branch were found. However, the motor branch was not intentionally sought for documentation, as this would require more extensive dissection than necessary for carpal tunnel release. The only anatomical variant found was a bifid median nerve in one patient who also had anomalous muscle fibers. Despite their high prevalence, the clinical implications of these muscle fibers in the carpal tunnel remain unknown. The authors believe that higher-quality studies are needed to determine whether these fibers contribute to median nerve compression at the carpal tunnel. This study included an 11-year-old patient with classic symptoms of carpal tunnel syndrome. This condition is extremely rare in pediatric patients without anatomical abnormalities (e.g., persistent median artery [1] or other pathologies such as mucopolysaccharidoses) [2]. This patient, aside from carpal tunnel syndrome, is otherwise healthy. After failed conservative treatment, open release was performed, revealing only the presence of voluminous anomalous muscle fibers as the anatomical abnormality.

Conclusion

The presence of anomalous muscle fibers in the carpal tunnel is common in the studied population, exceeding international rates. Although no correlation with anatomical variations of the motor branch of the median nerve was found in this study, the relationship between these fibers and variants has been documented previously. Caution is emphasized during tunnel release to prevent injuries to the motor branch of the median nerve in the presence of such fibers. Specific clinical implications are still unknown. The need for more extensive studies is suggested to better understand the role of these fibers in median nerve compression.

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