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Case Report

A Case Report of Carpal Tunnel Syndrome With Median Nerve Anatomical Variation in the Flexor Pollicis Longus Tendon

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ABSTRACT

Background: Carpal tunnel syndrome (CTS) is an idiopathic or secondary condition. The primary factor contributing to the development of this disorder is the alteration of the median nerve (MN). Two primary categorizations of the median nerve are recognized, referred to as the Lanz and Amadio classification. The Lanz classification is predominantly employed in the surgical literature, and the main contributing factor to CTS development has been group 3 (bifid MN). Moreover, MN's branches and connections do not align with any specific category. The MN divides into six branches beyond the carpal tunnel in standard anatomical structure. This study reports a case with CTS having anatomical MN variation in the flexor pollicis longus (FPL) tendon.

Case Presentation: The case was a 43-year-old male teacher presented with complaints of paresthesia and intermittent burning pain in his left arm and hand during the night over the past year. However, neurological examination revealed motor and sensory deficits in the patient's left hand, specifically affecting the MN. Based on the clinical examination and Phalen's test results, CTS was diagnosed. Additionally, electromyography and nerve conduction studies confirmed the diagnosis. During carpal tunnel release (CTR) surgery, the anatomical variation of the MN was observed in the FPL of the tunnel. In the carpal tunnel, the median nerve divides, while at the same time, the FPL tendon traverses the split MN.

Conclusion: The primary factor leading to CTS is the variability of the MN. Understanding the various types of median nerves contributing to CTS is crucial to reducing potential harm during CTR surgery.

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Introduction

The carpal tunnel is a canal of bone and fibrous tissue in the wrist's volar aspect. It is a protective passageway for the median nerve (MN) and nine flexor tendons. The upper boundary of the carpal tunnel is composed of the transverse carpal ligament (also known as the flexor retinaculum). In contrast, the lower boundary consists of carpal bones and flexor tendons, the flexor pollicis longus (FPL), four flexor digitorum superficialis, and four flexor digitorum profundus [1, 2]. The FPL possesses an individual synovial sheath, while the flexor digitorum superficialis and profundus share a common synovial sheath [1]. The median nerve, derived from the brachial plexus, specifically from C5 to T1, innervates the thumb, index, and middle fingers and controls wrist flexion and thumb opposition [3].

In typical anatomical anatomy, the key branches of the MN in this region include the palmar cutaneous, thenar motor, recurrent motor, and standard digital nerves.

Moreover, variations in branching configuration or supplementary branches of the MN can exist in this locality. Ultimately, an interconnection between the divisions of the median and ulnar nerves may be observed [4]. Variations in the course of the MN within the carpal tunnel and differences in its branches in the wrist and hand have been recorded [5]. An uncommon anatomical variation, known as a bifid median nerve, involves a high division of the MN before reaching the carpal tunnel and may be associated with carpal tunnel syndrome (CTS) and persistent median vessels. This unique anatomical variation is found in approximately 0.8%-2.3% of individuals with CTS [6].

CTS is a neuropathy that frequently manifests when the MN becomes entrapped in the carpal tunnel [7]. The incidence of CTS ranges from 3% to 6% in the general population. However, CTS constitutes approximately 90% of all focal entrapment neuropathy cases [8]. Acute CTS involves gradual compression of the median nerve. Most cases occur in emergency departments after sudden events, such as trauma, wrist injury, or distal radius fractures [9]. Chronic CTS is frequently observed, and its pathogenesis is categorized into four groups: Idiopathic, anatomic, systemic, and exertional [10, 11]. Variations in the MN are the main factors contributing to this condition. Understanding these anatomical differences is crucial for diagnosing and treating CTS [12, 13]. The correlation between MN variations and the development of CTS underscores the importance of personalized diagnosis and treatment plans to effectively care for those affected by this standard and potentially debilitating condition [12]. We conducted carpal tunnel release (CTR) surgery on the left hand of a 43-year-old patient who had been experiencing pain and nighttime paresthesia for one year, with a final diagnosis of CTS. During the procedure, anatomical variations of the MN in the FPL were considered.

Case Presentation

A 43-year-old male teacher presented with complaints of paresthesia and intermittent burning pain in his left arm and hand during the night over the past year. However, neurological examination revealed motor and sensory deficits in the patient's left hand, specifically affecting the median nerve. Also, the result of Phalen's test, carpal compression, and Tinel test was optimistic based on the clinical and Phalen's test results, CTS was diagnosed. Additionally, electromyography (EMG) and nerve conduction studies confirmed the diagnosis.

Based on the results of clinical and physical examinations and the EMG-NCV test, as well as the fact that non-surgical treatment in the past year did not produce positive results, the patient was advised to undergo open CTR surgery. The procedure was performed under local anesthesia, with the incision beginning at the radial edge of the hypothenar muscle and extending to the distal wrist crease, resulting in a final incision length of 4 cm. During surgery, anatomical variations in the MN were observed in the FPL.

After the incision, anatomical changes in the MN inside the carpal tunnel were observed. The MN bifurcates in the carpal tunnel, and the FPL tendon simultaneously passes through the bifurcated MN (Figure 1).

CTR was successfully performed, and the subcutaneous and skin layers were sutured conventionally. After a 4-month follow-up, a successful surgical result was observed, and CTS symptoms were completely resolved.

Discussion

CTS is a multifactorial condition characterized by nerve compression and is among the most frequently diagnosed upper-extremity disorders [14, 15]. Although CTS can occur in individuals of any age, it is most commonly observed in individuals aged 40-60 [16].

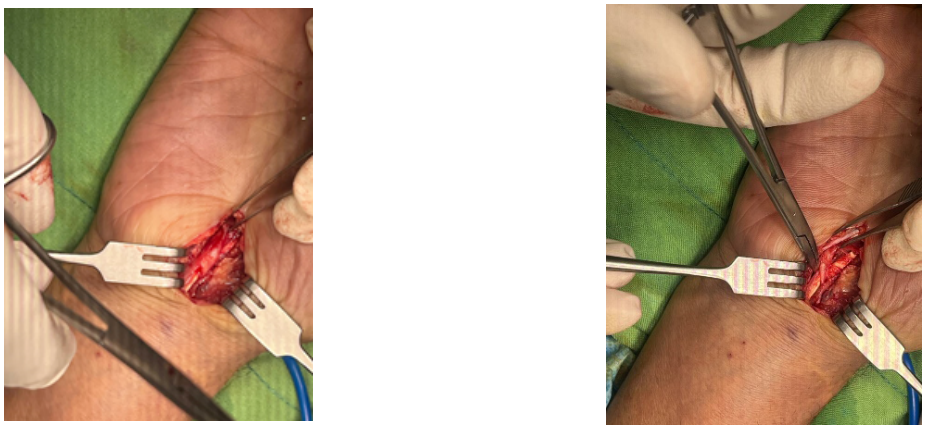

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Figure 1. The FPL tendon passes through the bifurcated MN
FPL: Flexor pollicis longus.

Some risk factors, such as hypothyroidism, diabetes mellitus, rheumatoid arthritis, tumors, trauma, pregnancy, and anatomical variation of the median nerve, predispose patients to the development of CTS [17].

Patient history plays a crucial role in diagnosing CTS, and clinical tests include the Phalen, carpal compression, and Tinel tests [18, 19]. Diagnostic methods for CTS include ultrasound, magnetic resonance imaging (MRI), and EMG-NCV, which can be used to assess the severity of the condition or provide additional information when the diagnosis is unclear [20-22].

In this case, during the initial examination, the results showed motor and sensory defects in the patient's left hand, specifically affecting the median nerve. EMG-NCV was used, and the results confirmed a diagnosis of CTS.

CTS is initially treated with conservative approaches, including wrist splints and non-steroidal anti-inflammatory drugs. If these methods are ineffective, alternative treatments, such as local corticosteroid injections or surgery, specifically CTR, may be considered. Surgery is indicated for mild CTS that does not respond to conservative treatments or for moderate-to-severe CTS accompanied by axonal loss or denervation as observed on EMG testing [23].

According to the night paresthesia and the positive results of Phalen's test and carpal compression, the Tinel test, EMG-NCV test, and open CTR surgery were used. During CTR surgery, we encountered an anatomical variation in the median nerve, which can be one of the causes of CTS. Spagnoli et.al., during CTR, identified an anatomic abnormality involving the median nerve, which was observed to bifurcate within the carpal tunnel (classified as group 3 of the Lanz classification). In addition, the radial branch of the nerve passes through its separate segment. A difference in size between the two nerve segments was observed, and the nerve was observed to travel through the carpal tunnel in the presence of a median artery [6]. Another study conducted by Park et al. reported a rare case in which an abnormal tendinous pathway of the flexor digitorum superficialis muscle is linked with a bifid MN located proximally to the flexor retinaculum at the distal wrist [24]. The bifid median nerve, a rare anomaly in which the MN divides near the carpal tunnel, occurs in approximately 2.8% of wrists.

It is often linked with other anomalies, such as persistent median artery and abnormal muscles, that cause symptoms of CTS. Bifid MN is commonly associated with CTS due to its large size. Surgeons should be aware of this variation in patients with severe unilateral CTS during CTR.

Conclusion

The incidence and severity of CTS are intricately associated with discrepancies in the morphology of the MN, primarily tasked with innervating the thumb, index, middle, and ring digits, as well as regulating specific hand musculature. Alterations in MN anatomical configuration can substantially influence the probability and advancement of CTS. Anomalies in the trajectory and ramifications of the MN may impede CTS onset. Occasionally, the nerve may traverse an atypical course, increasing susceptibility to entrapment or compression

within the carpal tunnel. These deviations contribute to the escalation of pressure on the nerve, culminating in distinctive clinical manifestations of CTS.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors' contributions

All authors contributed equally to the conception and design of the study, data collection and analysis, interception of the results and drafting of the manuscript. Each author approved the final version of the manuscript for submission.

Conflict of interest

The authors declared no conflict of interest.

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