Turk J Phys Med Rehab 2026;72(x):i-iv
DOI: 10.5606/tftrd.2026.16727
Available online at www.turkishjournalpmr.com

Case Report

A rare case of trifid median nerve with persistent median artery and vein in carpal tunnel syndrome

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ABSTRACT

The trifid median nerve is an anatomical variation that is rarely observed in the general population. With variations, persistent median artery and persistent median vein may also be encountered. These variations are detected incidentally during diagnostic evaluations. In our case, a trifid median nerve was found in a 64-year-old female who was diagnosed with bilateral carpal tunnel syndrome as a result of electroneuromyography results and clinical evaluation. Identification of variations of the median nerve prior to injection and surgical intervention is important to reduce the risk of complications.

Keywords: Anatomical variations, carpal tunnel syndrome, median nerves, ultrasonography.

Median nerve variations are thought to be one of the risk factors for carpal tunnel syndrome (CTS). Lanz[1] described anatomical variations of the median nerve, but this classification does not include the trifid median nerve. There are few cases of ultrasonography (USG), magnetic resonance imaging, or intraoperative detection of trifid median nerve in the literature.[2,3] Persistent median artery (PMA) and persistent median vein (PMV) may sometimes accompany the median nerve.[4]

Median nerve hydrodissection with 5% dextrose is a method used in the treatment of CTS.[5] It is very important to determine the variations of the anatomical median nerve and vascular structures to prevent injuries that may occur during injection and surgery.[3] Herein, we presented a rare case of trifid median nerve with PMA and PMV, whose findings were supported by ultrasonographic imaging. To the best of our knowledge, this case represents the first reported instance of a trifid median nerve accompanied by a PMA and a PMV in the context of CTS.

CASE REPORT

A 64-year-old female presented with complaints of chronic pain and numbness in the first and second fingers for about 10 years. On physical examination, the patient had normal range of motion and no motor deficit. Phalen and Tinel tests were positive. There was no history of hypothyroidism, diabetes, or cancer. Written informed consent was obtained from patient.

Electroneuromyography findings indicated a mild prolongation of latency (3.7 msec) and a reduced amplitude of median sensory conduction (2 μV). Additionally, a significant mild of conduction velocity (31.9 m/sec) was observed. Median motor nerve conduction, with a wrist-to-abductor pollicis brevis latency of 3.1 msec, was within normal limits. When assessed alongside the clinical symptoms, these electroneuromyography findings suggested a diagnosis of moderate CTS.

Following the diagnosis, the patient was advised to use a nighttime wrist splint. However, due to

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Received: April 13, 2025 **Accepted:** April 26, 2025 **Published online:** December 15, 2025

Cite this article as: Mehpare Özer B, Çelikyay F, Kılıç EB, Dal Erdoğan S. A rare case of trifid median nerve with persistent median artery and vein in carpal tunnel syndrome. Turk J Phys Med Rehab 2026;72(x):i-iv. doi: 10.5606/tftrd.2026.16727.

persistent pain despite conservative treatment, a 10-day paraffin wax therapy, median nerve and flexor tendon gliding, as well as stretching and strengthening exercises were initiated. As the symptoms continued, and the patient had no prior injection treatment, USG-guided hydrodissection of the median nerve with 5% dextrose was planned.

Ultrasonography examination was performed using a Samsung V8 ultrasound device (Samsung Medison, Seoul, South Korea) with a 2-14 MHz linear probe. At the proximal level of the pronator quadratus muscle, the median nerve was observed as a single branch, but distally, it divided into two branches. At the level of the carpal tunnel proximal margin and throughout the tunnel, the median nerve was visualized as three distinct branches (Figure 1). At the carpal tunnel level, the nerve branches measured 0.03, 0.03, and 0.06 cm^2, starting from the ulnar side. Additionally, color Doppler USG revealed a PMA and a PMV accompanying the median nerve (Figure 2). The diameters of both the PMA and PMV were measured at 1 mm. The PMV appeared compressed under pressure but showed no thrombus formation. Doppler USG confirmed arterial flow in the PMA without any pathological findings. For the injection procedure, the median nerve was identified at the entrance of the carpal tunnel. To separate the median nerve from the transverse carpal ligament, 3 mL of 5% dextrose was injected via an ulnar approach. Additionally, to separate the median nerve

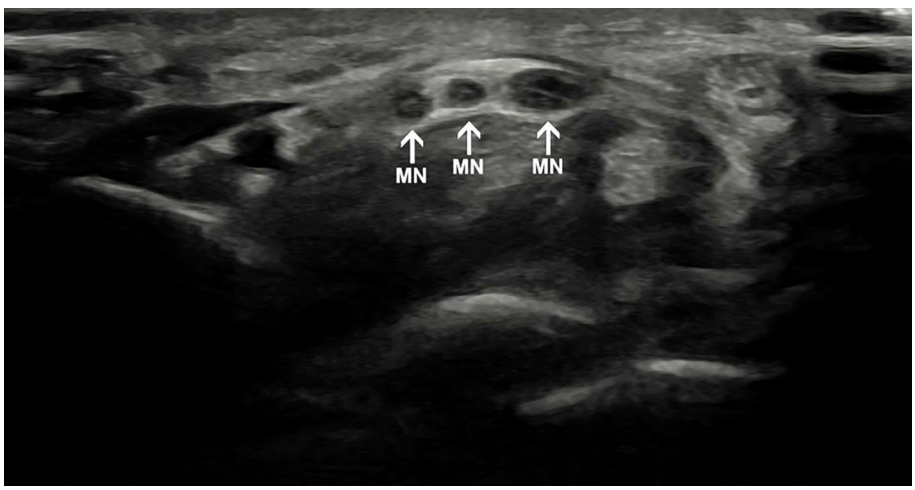

Figure 1. Ultrasound image showing a trifid median nerve (white arrow).

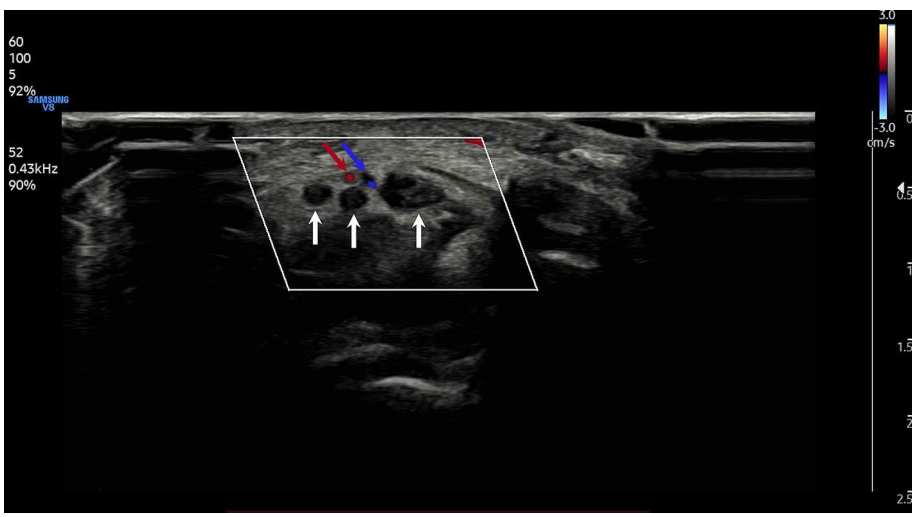

Figure 2. A PMA (red arrow) and a PMV (blue arrow) accompanying a trifid median nerve (white arrows) within the carpal tunnel.

PMA: Persistent median artery; PMV: Persistent median vein.

from the underlying flexor tendons, an additional 2 mL of 5% dextrose was injected.

The patient was scheduled for follow-up visits at the first and sixth months after the procedure. However, the patient reported no reduction in symptoms. Corticosteroid injection was recommended, but the patient declined. Instead, home exercises were prescribed, and the patient was placed under follow-up.

DISCUSSION

To the best of our knowledge, this case represents the first reported instance of a trifid median nerve accompanied by a PMA and a PMV in the context of CTS. Carpal tunnel syndrome is a common neuropathy resulting from compression of the median nerve within the carpal tunnel. Although its exact etiology remains unclear, CTS has been associated with various medical conditions, including trauma, rheumatoid arthritis, ganglion cysts, tumors, and pregnancy.[6] Some studies suggest that a bifid or trifid median nerve, when accompanied by PMA, may contribute to the development of CTS. However, other research does not support this association.[2-4] Some studies suggest that the trifid median nerve, having a larger cross-sectional area within the carpal tunnel compared to single-branch median nerves, may increase the risk of developing CTS.[7]

Typically, the median nerve divides into its branches distal to the carpal tunnel. However, proximal branching or division within the tunnel is considered an anatomical variation.[3] Lanz[1] categorized median nerve variations into four groups: *(i)* variations in the course of the thenar branch; *(ii)* accessory branches of the median nerve in the distal carpal tunnel; *(iii)* high-level division of the median nerve; *(iv)* accessory branches proximal to the carpal tunnel. According to Lanz's classification, a bifid median nerve falls under the third group; however, a trifid median nerve is not included in this categorization.

The trifid median nerve is an extremely rare anatomical variation, with only a limited number of cases reported in the literature. In their 2017 study, Billakota and Hobson-Webb[8] ultrasonographically evaluated 1,425 cases, identifying a bifid median nerve in 4.6% of cases and a trifid median nerve in only 0.14% of cases. Studies on the trifid median nerve reported in the literature used USG,[2,7,8] magnetic resonance imaging,[2,3] or intraoperative findings.[2]

The median nerve may be accompanied by a PMA and a PMV.[4,9] The PMA originates from the axial artery during the embryonic period and typically regresses by the end of the second month. However, in some individuals, this regression does not occur. Studies on the prevalence of PMA have reported varying rates: Townsend et al.[10] found a prevalence of 8.3%, Osiak et al.[11] reported 2.8%, and Chen et al.[4] identified 7.5%. When the diameter of the PMA ranges between 1 and 1.5 mm, it is typically asymptomatic. There is no direct evidence suggesting that PMA alone causes CTS. Pathologies that cause a diameter increase of 3 mm or more in the PMA (e.g., calcific plaque, thrombus, and aneurysm) constitute a risk factor for CTS.[11] The PMA accompanying the bifid median nerve may be located between the median nerve branches or lateral to the ulnar branch during its course. Knowing this course of the PMA before injection and surgery guides clinicians to avoid complications.[4]

There are studies showing the presence of one or two PMVs accompanying PMA.[4,9] The presence of a PMV has been detected more frequently in recent years due to technological advances in ultrasound devices and probes. Applying less pressure during USG facilitates the detection of PMVs, as the walls of these venous structures are thin and can be easily compressed.[4]

The efficacy of 5% dextrose injection in patients diagnosed with mild to moderate CTS is well supported in the literature. Hydrodissection with dextrose facilitates the separation of the nerve from surrounding tissues by reducing adhesions and chronic damage through its mechanical effect. This method also enhances blood flow, thereby improving the nerve's regenerative capacity.[12] However, there is no consensus in the literature regarding the optimal volume for hydrodissection with 5% dextrose. In one study, patients with mild to moderate CTS were divided into two groups: one group received 5 mL of 5% dextrose, while the other group received 3 mL of triamcinolone and 2 mL of saline. At the six-month follow-up, clinical improvement in the dextrose group was found to be significantly greater than in the corticosteroid-treated group.[13,14]

Musculoskeletal USG is the primary imaging modality for investigating, diagnosing, and monitoring peripheral nerve pathologies. Compared

to other imaging techniques, USG is a rapid, cost-effective, noninvasive, and dynamic method. Preoperative and preinjection USG can effectively identify median nerve variations and the presence of accompanying PMA and PMV.[15]

This study has certain limitations, as it is based on a single case report. Further research is needed to investigate the prevalence of trifid median nerve, PMA, and PMV, as well as their potential association with CTS. Future studies on such anatomical variations will provide valuable insights into understanding these pathologies.

In conclusion, recognizing anatomical variations of the median nerve and vascular structures such as PMA and PMV that may accompany the nerve is of great importance for clinicians and surgeons. Preoperative and preinjection awareness of these structures can help prevent iatrogenic injuries and complications.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Performed the ultrasonographic examinations: B.M.Ö., F.Ç.; Conducted the physical examinations of the patients: E.B.K., S.D.E. All authors contributed to the conceptualization and design of the study, participated in the data interpretation, and were involved in the preparation and revision of the manuscript draft.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

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