

# BIFID MEDIAN NERVE IN A PATIENT WITH CARPAL TUNNEL SYNDROME – CORRELATION OF CLINICAL, DIAGNOSTIC AND INTRAOPERATIVE FINDINGS: CASE REPORT AND REVIEW OF THE LITERATURE

Darija Granec<sup>1</sup>, Goran Bičanić<sup>2</sup>, Igor Borić<sup>3</sup> and Domagoj Delimar<sup>2</sup>

<sup>1</sup>Department of Orthopedic Rehabilitation, Krapinske Toplice Special Hospital for Medical Rehabilitation, Krapinske Toplice; <sup>2</sup>Department of Orthopedic Surgery, Zagreb University Hospital Center, School of Medicine University of Zagreb, Zagreb; <sup>3</sup>Department of Radiology, Sv. Katarina Special Hospital for Orthopedics, Surgery, Neurology and Physical Medicine and Rehabilitation, Zabok, Croatia

**SUMMARY** – A young patient with symptoms of median nerve compression in carpal tunnel without known risk factors is presented. Ultrasonography and magnetic resonance imaging confirmed an anatomical variation of the median nerve in carpal tunnel, described in the literature as bifid median nerve. The knowledge of the existence of bifid median nerve is important in planning surgical decompression of median nerve to avoid nerve injury or potential relapse if decompression of both branches has not been done. Carpal tunnel ultrasonography is a noninvasive, reliable and available diagnostic tool to diagnose bifid median nerve.

**Key words:** *Carpal tunnel syndrome; Bifid median nerve; Anatomical nerve variation; Ultrasonography; Magnetic resonance imaging; Surgical decompression of median nerve*

## Introduction

Carpal tunnel syndrome (CTS) is the most common nerve entrapment syndrome and it may be associated with anatomical variations of the median nerve<sup>1,2</sup>. As shown by review of the literature, variations of the median nerve in the carpal tunnel are not uncommon, but the practitioners rarely think of it in CTS diagnostic and therapeutic approach. We present a young patient with the right hand CTS and bilateral bifid median nerve, along with correlation of the clinical, electrophysiological, ultrasonography (US), magnetic resonance imaging (MRI) and intraoperative findings.

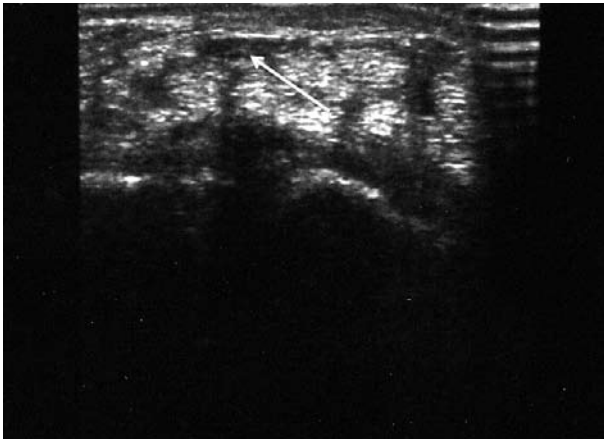
Correspondence to: *Darija Granec, MD*, Department of Orthopedic Rehabilitation, Krapinske Toplice Special Hospital for Medical Rehabilitation, Gajeva 2, HR-49217 Krapinske Toplice, Croatia

E-mail: [dgranec@gmail.com](mailto:dgranec@gmail.com)

Received November 18, 2011, accepted May 2, 2012

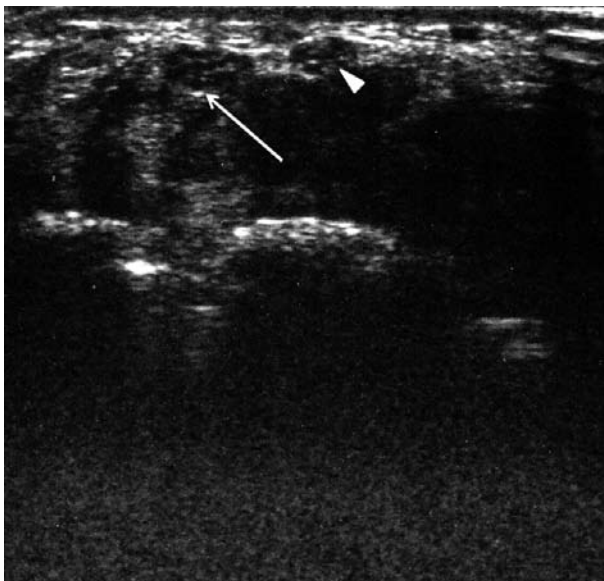
## Case Report

A 29-year-old woman presented with a one-year history of pain and tingling in the dominant right hand with significant progression of symptoms. Occasionally, she started to feel tingling in the first three fingers of the left hand. Clinical evaluation was suggestive of median nerve compression neuropathy in the right wrist. Incipient weakness of thenar muscles was noted and Phalen's sign and Tinel's sign over median nerve were positive. Electrophysiological evaluation with a Premiere plus electromyography system (Premiere plus, Medelec, UK) confirmed a mild stage of the right CTS. Electrophysiological examination results of the left hand were within the physiological range. Wrist x-ray and laboratory findings were within the normal limits. Bilateral carpal tunnel US was performed with a 12-MHz linear probe (Acuson X500, Siemens, Germany). Transverse images showed two parallel oval nerve structures in the carpal tunnel

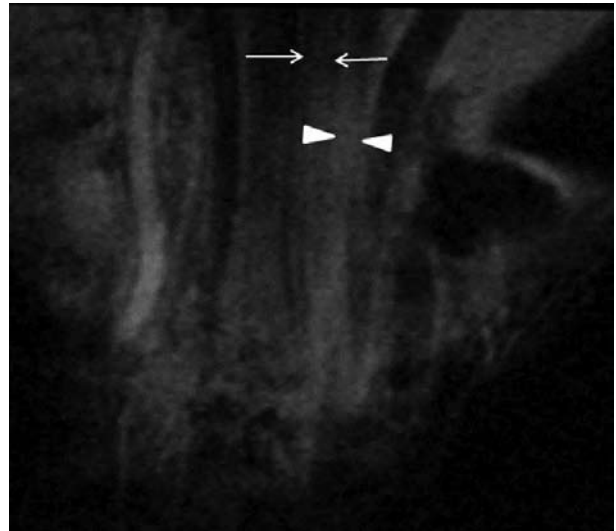


*Fig. 1. Ultrasonography of the carpal tunnel, transverse scan: normal sonography of the median nerve in the carpal tunnel (arrow).*

in both wrists. The cross-sectional area of the median nerve trunks was measured at the level of pisiform bone (Figs. 1 and 2). In the right hand, the radial trunk measured 8.84 mm<sup>2</sup> and ulnar trunk 5.93 mm<sup>2</sup>. Between these two trunks, there was a hyperechoic septum measuring 1.5 mm. The radial trunk of the bifid median nerve in the left hand measured 6.92 mm<sup>2</sup> and ulnar trunk 6.75 mm<sup>2</sup>. Both trunks in the right and left hands were abnormally hypoechoic compared

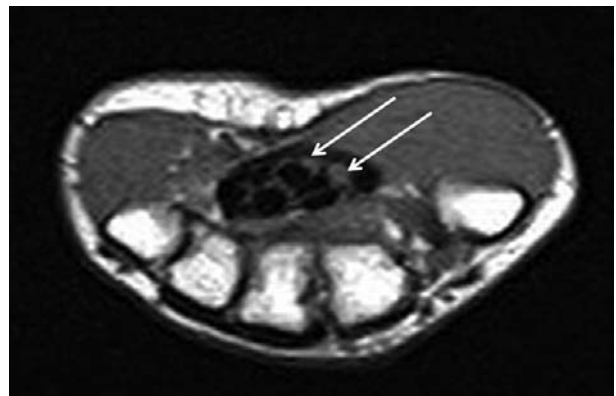


*Fig. 2. Ultrasonography of the carpal tunnel, transverse scan: bifid median nerve with a thicker radial (arrow) than ulnar branch (arrowheads).*

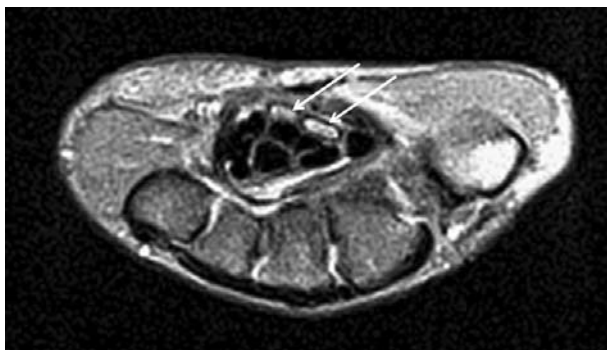


*Fig. 3. Magnetic resonance imaging of the carpal tunnel: coronal PD weighted image shows two parallel nerves (one between arrows and another one between arrowheads) in the carpal tunnel.*

with US of the normal peripheral nerve. No space-occupying lesion, such as expansive mass, accessory muscle or dislocated bone was noted in the carpal tunnel. The patient also underwent MRI (Avanto, 1.5-T magnet, Siemens, Germany) of the symptomatic right hand, which confirmed bifurcation of the median nerve by about 3 cm proximally to the carpal tunnel with a significant mark of nerve compression (Figs. 3, 4 and 5). Because of the poor therapeutic response to physical therapy, operative treatment was indicated. Intraoperatively, we found a duplicated nerve span



*Fig. 4. Magnetic resonance imaging of the carpal tunnel: axial T1 weighted image shows two neural structures (arrows) in the carpal tunnel*



*Fig. 5. Magnetic resonance imaging of the carpal tunnel: axial T2 fat suppressed weighted image shows two oval edematous neural structures (arrows) in the carpal tunnel, which are compressed with flexor retinaculum.*

(epineuria) that infiltrated the space within the two trunks of the median nerve in carpal tunnel and it was easily removed. Two months after the surgery, US of the right hand showed reduced cross-sectional nerve areas: 7.63 mm<sup>2</sup> on the radial trunk and 5.31 mm<sup>2</sup> on the ulnar trunk. There was no septum between the nerve trunks. The patient had no tingling in the right hand and reported pain only on maximal dorsiflexion of the hand and after prolonged work with the hand. She was complaining of symptoms in her left hand.

## Discussion

Carpal tunnel syndrome is the most common nerve entrapment syndrome<sup>1,2</sup>. The prevalence of CTS in the general population is from 1% to 3%, with an incidence that peaks in the late 50s, and it is three times more frequent in female than in male<sup>3-5</sup>. It is very rare in childhood and only 10% of the population with CTS are younger than 30 years<sup>6</sup>. CTS may be idiopathic or associated with other conditions such as posttraumatic disorders, expansive space-occupying formation, some systemic conditions like rheumatoid arthritis, hypothyroidism, diabetes mellitus, gout, pregnancy, and anatomical variations of the median nerve<sup>1,2,7</sup>.

Median nerve is the only nerve that passes through the carpal tunnel. It divides into several branches at the exit from the tunnel. However, variations of the median nerve in carpal tunnel are not uncommon. In 1977, Lanz<sup>8</sup> explored a series of 246 hands with diagnosed CTS and found a 12% incidence of ana-

tomical variations. He divided these variations into four groups: group 1, variations in the course of the thenar branch; group 2, accessory branches at distal carpal tunnel; group 3, high division of the median nerve (bifid median nerve); and group 4, accessory branches proximal to the carpal tunnel. Bifid median nerve is commonly associated with persistent median artery<sup>8-11</sup>. However, bifid median nerve has been described in association with an accessory muscle in some cases and in some others where both radial and ulnar branches passed through a separate compartment<sup>12-17</sup>. In our patient, US and MRI revealed bifurcation of the median nerve about 3 cm proximally to the carpal tunnel without any other associated anatomic variation or space-occupying lesion. On US, we found the hyperechoic septum that measured 1.5 mm, which was intraoperatively seen as a duplicated nerve span (epineuria) and easily removed during the operation.

In several surgical studies, the prevalence of bifid median nerve in patients with CTS ranged from 1% to 3.3%<sup>8,17,19</sup>. Recently, a higher prevalence has been reported from one MRI study (6.1%)<sup>20</sup>, and even higher prevalence from US studies (19%)<sup>21,22</sup>. There are little data on the prevalence of bifid median nerve in the general population.

How to diagnose the bifid median nerve? Carpal tunnel US has been proven to be effective in the diagnosis of CTS, relying on the measurement of the cross-section area that should be, according to several authors, greater than 9 mm<sup>2</sup> or 10 mm<sup>2</sup> at the level of the pisiform bone<sup>23-25</sup>. US is also valuable in the detection of anatomic variations of the nerve, tendons, arteriovenous malformation or expansive soft-tissue formation and bony deformation<sup>21,26,27</sup>. Based on one of the cases of bifid median nerve in a 16-year-old patient, and one bifid median nerve and one partially duplicated median nerve in 10 random cadaveric specimens, Propeck *et al.*<sup>26</sup> conclude that the established US size criteria may not be applicable in patients with bifid median nerve. Bayrak *et al.*<sup>21</sup> have published a large US study on 320 hands of 170 patients with CTS and 240 hands of 120 asymptomatic controls. The median nerve was evaluated morphologically and the cross-sectional area was measured at three levels (radial-ulnar junction, pisiform, and hook of the hamate). In 170 CTS patients, they found bifid median nerve in 32 (19%) cases, 22 of these unilateral

and 10 bilateral. They measured cross-sectional area of the radial and ulnar branches separately, and the total of these two areas yielded total cross-sectional area value. In conclusion, a cut-off value of the cross-section size in patients with bifid median nerve was 11 mm<sup>2</sup> and in nonbifid median nerve 9 mm<sup>2</sup>. In our patient, the total cross-sectional area measured preoperatively in the symptomatic right hand was 14.8 mm<sup>2</sup> and in the initially symptomatic left hand 13.7 mm<sup>2</sup>. Two months later, after surgical decompression, the total cross-sectional size of median nerve was reduced to 12.9 mm<sup>2</sup>.

MRI is a well-known and effective imaging method to evaluate disorders of the wrist and carpal tunnel with clear criteria for diagnosing CTS, which include swelling of the median nerve within and proximally to the carpal tunnel, and palmar bowing of the flexor retinaculum<sup>28,29</sup>. In their retrospective study, Pierre-Jerome *et al.*<sup>20</sup> analyzed MR wrist images of 194 patients aged 12-80 years, with various indications for MRI, to assess the prevalence of aberrant median nerve branches and persistent median artery in the carpal tunnel. There was a bifid nerve with bifurcation proximally to the carpal tunnel in 12 (6.1%) wrists and within the carpal tunnel in 36 (18%) wrists. Among these 36 wrists, the symptoms were due to trauma and inflammatory arthropathy in 15 (41.6%) cases each, while CTS was diagnosed in only two (0.5%) cases. Finally, the authors conclude that there are no reliable data on the bifid median nerve to be a primary cause of CTS. One recently published prospective US study estimating the prevalence of bifid median nerve has pointed to the same conclusion<sup>22</sup>. On wrist US, they found bifid median nerve in 18.5% of patients with CTS and 15.4% of control subjects.

Accordingly, bifid median nerve is not uncommon nerve variation in the carpal tunnel. It may aggravate CTS symptoms, but there is no reliable evidence that it is the cause of it. There is no clinical or electrophysiological possibility to detect anatomical nerve variation in CTS, so US should be employed as a noninvasive, effective and available diagnostic tool to diagnose bifid median nerve. The knowledge of morphological changes of the nerve structure in carpal tunnel is certainly a considerable fact in therapeutic approach, especially operative. In case of bifid median nerve, the surgeons must consider the possibility of coexist-

ing persistent median artery to avoid intraoperative vascular damage<sup>9,10,20</sup>. They also have to think about the ability of two nerve compartments and perform epineurectomy besides decompression of each nerve branch<sup>13,14,16</sup>. We also want to draw attention to the cases of early postoperative recurrence of CTS symptoms, i.e. to think of the possibility of the anatomical nerve variation such as bifid median nerve<sup>30,31</sup>. In conclusion, we suggest US of the carpal tunnel as a beneficial diagnostic step before operative treatment of CTS.

## References

1. PRESTON DC, SHAPIRO BE. Median neuropathy at the wrist. In: PRESTON DC, SHAPIRO BE, editors. Electromyography and neuromuscular disorders. Philadelphia: Elsevier Butterworth-Heinemann, 2005:255-79.
2. PECINA M, KRMPOTIC-NEMANIC J, MARKIEWITZ AD. Tunnel syndromes in the upper extremities. In: PECINA M, KRMPOTIC-NEMANIC J, MARKIEWITZ AD, editors. Tunnel syndromes. Peripheral compression syndromes. 3<sup>rd</sup> edn. Boca Raton: CRC Press, 2001:125-39.
3. ATROSHI I, GUMMESSON C, JOHANSSON R, ORNSTEIN E, RANSTAM J, ROSEN I. Prevalence of carpal tunnel syndrome in a general population. JAMA 1999;282:153-8.
4. KATZ JN, STIRRAT CR, LARSON MG, FOSSEL AH, EATON HM, LIANG MH. A self-administered hand symptom diagram for the diagnosis and epidemiologic study of carpal tunnel syndrome. J Rheumatol 1990;17:1495-8.
5. STEVENS JC, SUN S, BEARD CM, O'FALLON WM, KURLAND LT. Carpal tunnel syndrome in Rochester, Minnesota, 1961 to 1980. Neurology 1988;38:134-8.
6. ASHWORTH N. Carpal tunnel syndrome. Clin Evid 2004;12:1558-77.
7. JURJEVIĆ A, BRALIĆ M, ANTONČIĆ I, DUNATOV S, LEGAC M. Early onset of carpal tunnel syndrome during pregnancy: case report. Acta Clin Croat 2010;49:77-80.
8. LANZ U. Anatomical variations of the median nerve in the carpal tunnel. J Hand Surg Am 1977;2:44-53.
9. GUTOWSKI KA, OLIVIER WA, MEHRARA BJ, FRIEDMAN DW. Arteriovenous malformation of a persistent median artery with a bifurcated median nerve. Plast Reconstr Surg 2000;106:1336-9.
10. BERRY MG, VIJH V, PERCIVAL NJ. Bifid median nerve: anatomical variant at the carpal tunnel. Scand J Plast Reconstr Surg Hand Surg 2003;37:58-60.
11. TOUNTAS CP, BIHRLE DM, MacDONALD CJ, BERGMAN RA. Variations of the median nerve in the carpal canal. J Hand Surg Am 1987;12:708-12.

12. JONES DP. Bilateral palmaris profundus in association with bifid median nerve as a cause of failed carpal tunnel release. *J Hand Surg Am* 2006;31:741-3.
13. TAKAMI H, TAKAHASHI S, ANDO M. Bipartite median nerve with a double compartment within the transverse carpal canal. *Arch Orthop Trauma Surg* 2001;121:230-1.
14. SZABO RM, PETTEY J. Bilateral median nerve bifurcation with an accessory compartment within the carpal tunnel. *J Hand Surg Br* 1994;19:22-3.
15. FERNANDEZ-GARCIA S, PI-FOLGUERA, ESTALLO-MATINO F. Bifid median nerve compression due to a musculotendinous anomaly of FDS to the middle finger. *J Hand Surg Br* 1994;19:616-7.
16. AMADIO PC. Bifid median nerve with a double compartment within the transverse carpal canal. *J Hand Surg Am* 1987;12:366-8.
17. SCHULTZ RJ, ENDLER PM, HUDDLESTON HD. Anomalous median nerve and an anomalous muscle belly of the first lumbrical associated with carpal-tunnel syndrome. *J Bone Joint Surg Am* 1973;55:1744-6.
18. LINDLEY SG, KLEINERT JM. Prevalence of anatomic variations encountered in elective carpal tunnel release. *J Hand Surg Am* 2003;28:849-55.
19. AMADIO PC. Anatomic variations of the median nerve within the carpal tunnel. *Clin Anat* 1988;1:23-31.
20. PIERRE-JEROME C, SMITSON RD Jr, SHAH RK, MONCAYO V, ABDELNOOR M, TERK MR. MRI of the median nerve and median artery in the carpal tunnel: prevalence of their anatomical variations and clinical significance. *Surg Radiol Anat* 2010;32:315-22.
21. BAYRAK IK, BAYRAK AO, KALE M, TURKER H, DIREN B. Bifid median nerve in patients with carpal tunnel syndrome. *J Ultrasound Med* 2008;27:1129-36.
22. GRANATA G, CALIANDRO P, PAZZAGLIA C, *et al.* Prevalence of bifid median nerve at wrist assessed through ultrasound. *Neurol Sci* 2011;32:615-8.
23. CHEN P, MAKLAD N, REDWINE M, ZELITZ D. Dynamic high-resolution sonography of the carpal tunnel. *AJR Am J Roentgenol* 1997;168:533-7.
24. BUCHBERGER W, JUDMAIER W, BIRBAMER G, LENER M, SCHMIDAUER C. Carpal tunnel syndrome: diagnosis with high-resolution sonography. *AJR Am J Roentgenol* 1992;159:793-8.
25. AŽMAN D, BOŠNJAK J, STRINEKA M, *et al.* Median nerve imaging using high-resolution ultrasound in healthy subjects. *Acta Clin Croat* 2009;48:265-9.
26. PROPECK T, QUINN TJ, JACOBSON JA, PAULINO AF, HABRA G, DARIAN VB. Sonography and MR imaging of bifid median nerve with anatomic and histologic correlation. *AJR Am J Roentgenol* 2000;175:1721-5.
27. IANNICELLI E, CHIANTA GA, SALVINI V, ALMBERGER M, MONACELLI G, PASSARIELLO R. Evaluation of bifid median nerve with sonography and MR imaging. *J Ultrasound Med* 2000;19:481-5.
28. MONAGLE K, DAI G, CHU A, BURNHAM RS, SNYDER RE. Quantitative MR imaging of carpal tunnel syndrome. *AJR Am J Roentgenol* 1999;172:1581-6.
29. BORIĆ I, PEĆINA M, PEĆINA HI, ANTIČEVIĆ D. Magnetic resonance imaging of tunnel syndromes. *Eur Radiol* 2002;12 (Suppl 1):446.
30. AI-QATTAN MM, AI-ZAHRANI K, AI-OMAWI M. The bifid median nerve re-visited. *J Hand Surg Eur Vol* 2009;34:212-4.
31. EROL O, OZCAKAR L, KAYMAK B. Bifid median nerve revisited: imaging and clinical aspects. *Plast Reconstr Surg* 2004;113:1289-90.

### Sažetak

## PODVOJENI MEDIJANI ŽIVAC KOD BOLESNICE SA SINDROMOM KARPALNOG KANALA – KORELACIJA IZMEĐU KLINIČKOG, DIJAGNOSTIČKOG I INTRAOPERACIJSKOG NALAZA: PRIKAZ SLUČAJA I PREGLED LITERATURE

*D. Granec, G. Bičanić, I. Borić i D. Delimar*

Prikazuje se slučaj mlade bolesnice sa simptomima kompresije medijanog živca u karpalnom kanalu, a bez poznatih čimbenika rizika. Ultrazvučnom dijagnostikom i magnetskom rezonancom karpalnog kanala potvrđena je anatomska anomalija medijanog živca u literaturi opisana kao podvojeni medijani živac. Spoznaja o postojanju podvojenog medijanog živca je bitna za operacijsko liječenje kako bi se izbjegle ozljede živca ili potencijalni recidivi ako se ne bi učinila dekompresija obje grane. Ultrazvučna dijagnostika je neinvazivna, pouzdana i relativno dostupna metoda u prikazu struktura karpalnog kanala, odnosno prikaza podvojenog medijanog živca.

Ključne riječi: *Sindrom karpalnog kanala; Podvojeni medijani živac; Anatomska anomalija živca; Ultrazvuk; Magnetska rezonanca; Kirurška dekompresija medijanog živca*

