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# Static and Dynamic Ultrasound Evaluation of the Median Nerve Morphopathology in Carpal Tunnel Syndrome Diagnosis

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*ABSTRACT*

***Objective:*** *The current study included a total of 10 patients, both males and females, who gave their consent to participate in the study and underwent clinical and ultrasound examinations. All patients had a history of carpal tunnel symptoms like tingling, numbness, nocturnal paraesthesia and weakness of the hand (loss of pinch and grip strength) for more than 12 months.*

***Aim:*** *The aim of our study was to investigate the morphopathology of the median nerve in clinically diagnosed carpal tunnel thought static and dynamic ultrasound assessment.*

***Material and methods:*** *The present study included a small group of 10 patients aged over 18, both males and females, who had a history of carpal tunnel symptoms for over 12 months and a positive Tinel's and reverse Phalen's tests during clinical examination. Ultrasound was performed by an experienced orthopaedic surgeon with musculoskeletal ultrasound training. Ultrasound evaluation was made using a standardized method and included transverse and longitudinal static examination and dynamic examination of the median nerve in the carpal tunnel. Side-to-side evaluation was performed and differences of more than 10 mm width in the median nerve have been recorded, which was considered to be a positive test for carpal tunnel syndrome. Furthermore, the major advantage of the dynamic evaluation brought by performing the palmar hand and finger flexion test, while investigating the movement trajectory of the median nerve in the carpal tunnel, provides superior imagistic documentation of this pathology.*

***Results:*** *Dynamic evaluation of the median nerve has shown a decreased mobility of the nerve in the carpal tunnel on the side that also had an increased area value of the median nerve width. If in the asymptomatic hand at the time of dynamic evaluation, the median nerve would suddenly slide under the flexor tendons; therefore, we noted results only of a slight translational movement of the nerve in the carpal tunnel on the affected side. A side-to-side difference in the median nerve area, with values ranging between 3 mm up to 9 mm, was found in our patients. Furthermore, thenar atrophy has been discovered in patients with pre-existing carpal tunnel symptoms for more than 24 months.*

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***Conclusions:*** *The present study highlights the importance of ultrasound assessment as an accessible static and dynamic evaluation tool. Ultrasound can be used as an in-office imaging tool to complete the clinical diagnosis of carpal tunnel syndrome by studying the morphology and morphopathology of the median nerve in the carpal tunnel through a bilateral standardized examination technique.*

**Keywords**: ultrasound, dynamic ultrasound, median nerve, carpal tunnel

## ABBREVIATIONS

CTS: carpal tunnel syndrome
MN: median nerve
US: ultrasound
CT: carpal tunnel

## INTRODUCTION

Carpal tunnel syndrome (CTS) is a peripheral neuropathy of the median nerve, which is seen and treated by orthopaedic surgeons and plastic surgeons quite frequently as an in-office pathology.

Median nerve compression in the carpal tunnel, which is situated in between the carpal bones (having the lateral edges the pisiform and scaphoid bones) and the flexor retinaculum, can appear due to multiple causes – for instance, a narrow anatomical carpal tunnel or anatomical local changes such as cysts, osteophytes, tenosynovitis, hematomas (1). Median nerve neuropathy has also been seen in patients with diabetes, hypothyroidism, pregnant women and in connective tissue diseases, including rheumatoid arthritis, Sjögren's syndrome, systemic lupus erythematosus, systemic sclerosis, and vasculitis, due to the potential of these pathologies to cause various disorders of the peripheral nervous system (1, 2). We highlight the importance of taking a detailed medical history and a thorough examination to assess for an underlying primary pathology.

The aim of our study was to investigate the morphopathological changes that occur in the peripheral median nerve compression syndrome in relationship with clinical evaluation and symptom onset, using ultrasound (US) imaging. In the literature, US evaluation in CTS is reported to have a sensitivity of 77.6% and a specificity of 86.8% in providing an accurate diagnosis (1, 3).

In our practice, early diagnosis in CTS is essential to preventing permanent muscle damage and sequelae. With the evolution of US technology which is considered to be a low-cost, accurate and fast imaging tool, along with the high-resolution transducers that have enhanced the quality of images, we can easily observe the main US changes in shape, echotexture and mobility of the median nerve in the carpal tunnel T (4).

## MATERIALS AND METHODS

### Participants and study design

The present study included a total of 10 patients, males and females, who underwent clinical and ultrasound evaluation.

The following inclusion criteria were used: 1) age over 18 years; 2) a history of CTS symptoms such as tingling, numbness, nocturnal paraesthesia, and weakness of the hand (loss of pinch and grip strength) for more than 12 months; 3) positive Tinel's and reverse Phalen's tests at the time of clinical examination; and 4) nerve conduction studies that were performed on all patients.

Informed consent was obtained from all subjects who met the inclusion criteria and agreed to participate in the study.

### Assessments

*Clinical examination*

It consisted of optic visualization of both hands. In seven out of ten patients we noticed atrophy of the thenar region. All seven patients presented CTS symptoms, including nocturnal paraesthesia, loss of pinch strength, tingling, numbness in the index, middle finger, and half of the fourth finger for more than three years (36 months).

Clinical tests were also performed at the time of examination and included two provocative tests for CTS diagnosis:

- Tinel's test, where the patients place their hand and wrist on a stable surface and the examinator would tap the inside of the wrist region where the median nerve is situated; a positive result is considered if numbness or a tingling sensation appears when tapping the examined area (5);

- Reverse Phalen's test, where the patient holds his/her hands in the prayer position, with hand-wrist extension of 90 degrees.

*Ultrasound evaluation*

Ultrasound images were acquired by an experienced orthopaedic surgeon with musculoskeletal ultrasound certification using a Sono Scape S22 apparatus equipped with a 5–12 MHz linear-array transducer in B mode.

For the US imaging, the patient is seated on the examination table, facing the examinator, with the dorsal side of the wrist on a foam roll as illustrated in Figure 1.

A standardized US evaluation was performed and included transverse and longitudinal static examination and dynamic examination of the median nerve in the carpal tunnel. Side-to-side evaluation was performed and differences of more than 10 mm of median nerve width have been recorded as a positive result for CTS (Figures 2 and 3).

The median nerve area was measured in the carpal tunnel using B mode US imaging and a standard transverse view (Figure 4). A series of three consecutive measurements were performed and the mean of the values were taken into consideration and noted in the table.

The dynamic evaluation of the median nerve was performed starting from the standard transverse view of the median nerve in the carpal tunnel at the wrist level and as one hand of the examinator was still with the probe, the other hand was performing slow palmar flexion of the patient's hand. The evaluation is performed in a bilateral manner and a positive test is considered

**FIGURE 1.** Patient positioning during the ultrasound evaluation of the median nerve at the carpal tunnel region, longitudinal placement of the probe


**FIGURE 2.** Ultrasound image of the median nerve in B mode using a linear array at the carpal tunnel level; the star marking represents the median nerve longitudinal view

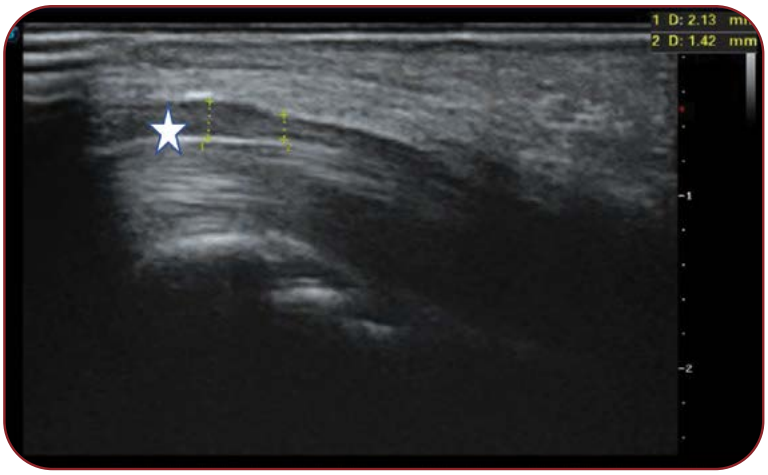


**FIGURE 3.** Ultrasound image of the median nerve in B mode using a linear array at carpal tunnel level; the star marking represents the median nerve longitudinal view. There are two different measurements marked before and at the median nerve compression site


**FIGURE 4.** Ultrasound image of the median nerve in B mode using a linear array in a transverse view at the carpal tunnel level, with the marking showing the median nerve area measurement

| PATIENT AGE AND SEX | MONTHS PASSED SINCE SIMPTOMS STARTED | JOB TYPE | THENAR ATROPHY | TINEL'S SIGN | REVERSE PHALEN'S SIGN | MEDIAN NERVE IN CARPAL TUNNEL AREA | DYNAMIC EXAMINATION OF THE MEDIAN NERVE |
|---|---|---|---|---|---|---|---|
| **55 years F** | 36 months | Sewer | + | + | + | 18 mm | + |
| **57 years M** | 40 months | Professional driver | + | + | + | 15 mm | + |
| **50 years F** | 50 months | | + | + | - | 14 mm | + |
| **47 years F** | 46 months | Hairdresser | + | + | - | 19 mm | + |
| **42 years F** | 45 months | Worker in a part factory | + | + | + | 17 mm | + |
| **44 years M** | 39 months | Nurse | + | + | + | 15 mm | + |
| **45 years F** | 48 months | Hairdresser | + | + | - | 16 mm | + |
| **35 years F** | 12 months | Software developer | - | + | + | 13.5 mm | + |
| **39 years F** | 16 months | Software developer | - | + | + | 14 mm | + |
| **41 years F** | 12 months | Human resources | - | + | + | 13 mm | + |

**TABLE 1.** Details regarding patients, and results of clinical test and ultrasound

when on the US image the median nerve does not suddenly slide under the flexor tendon. At the wrist-palmar flexion, the lack of mobility of the MN with only a small lateral translation of the nerve through this examination technique is considered a positive test for CTS.

## RESULTS

In our study group, we noticed an 80% dominance in the female sex with CTS (of all patients, eight were females and only two males).

In all ten cases, the affected hand was the dominant hand, and that was the right hand.

Exactly as expected, patients had jobs in which they overused their wrist with a high number of repetitive wrist flexions and extensions such as sewers, hairdressers or software developers, where they place their dominant hand on the mouse, etc.

Clinical test results showed that thenar atrophy was present in seven patients who had symptoms of CTS for over 36 months; thenar atrophy was directly influenced by the period of time that the median nerve has suffered a direct compression.

On Tinel's and reverse Phalen's tests, our results showed that Tinel's sign was positive in 10/10 patients, while reverse Phalen's test was positive in only seven of the ten examined patients. The three patients with a negative reverse Phalen's test had median nerve compression symptoms for more than 46 months; therefore, this might be related to the changes brought by the underlying neuropathy.

On the US nerve area measurement, we recorded median nerve measurements of the asymptomatic hand ranging between 8.5 mm up to 10 mm, while in the symptomatic hand the values varied between 13 mm and 19 mm. In the CTS, the standard limit for the median nerve area is a value of 10 mm (1, 6, 7); therefore, values above this threshold are considered positive test results.

Ultrasound dynamic sliding of the median nerve when performing a wrist-palmar flexion was positive test in all examined patients. Side-to-side differences noted a lack of mobility of the median nerve in relation to the flexor tendons. Moreover, we noted that the lack of mobility was more obvious in cases who had CTS for more than 36 months.

In our study, we did not focus on echogenicity changes of the MN in CTS, but Martinoli *et al* found that, in addition to shape changes, US scanning in a standardized manner and using a high resolution probe could identify fine echotexture changes in MN compression syndrome (4, 8).

Meanwhile, Chen *et al* found that, back in 1997, the dynamic evaluation of the median nerve was performed and reduced transverse sliding of the nerve under the retinaculum du-

ring dynamic flexion and extension of the wrist and fingers was seen as a subjective and hard to quantify sign (9). Nowadays, functional ultrasonography done by an experienced sonographer using high-resolution equipment is proved to be a useful and accurate imaging tool.

While our thenar atrophy evaluation included only clinical examination and no postoperative follow up, others like Carlos F. Fernandes *et al* evaluated the pinch and grip strength in patients with CTS preoperatively with follow-up at three and six months after surgery. In these studies, the postoperative six-month follow-up the pinch showed an improvement of strength and grip strength by 30% and 21%, respectively (10). Further discussion is to be carried out on the importance of the early treatment of the CTS before the onset of thenar atrophy.

## CONCLUSIONS

In the current study we highlight the importance of ultrasound assessment as an in-office imaging tool accessible to orthopaedic doctors with certified training. The static and dynamic ultrasound evaluation offers the tremendous value of completing the clinical diagnosis of CTS by studying the morphology and morphopathology of the median nerve in the carpal tunnel through a bilateral standardized examination technique.
There still is more to develop regarding ultrasound examination of the median nerve in CTS with regard to understanding its morphopathology and to investigating present neovascularisation with the use of Power Doppler mode and its relations to symptom onset, which can also be an interesting aspect to document in further studies due to its morphopathological importance. ❑

*Conflicts of interest: none declared.*
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# References

1. **Daniela Fodor.** *Ecografie musculoscheletala*, Vol. I. Semiologia normala si patologica a structurilor musculoscheletale, Bucuresti, 2017, pp 116-117.
2. **Inimioara Mihaela Cojocaru, Manole Cojocaru, Isabela Silosi, Camelia Doina Vrabie.** Peripheral Nervous System Manifestations in Systemic Autoimmune Diseases. *MAEDICA J Clin Med* 2014;9:289-294.
3. **Fowler JR, Gaughan JP, Ilyas AM.** The sentitivity and specificity of ultrasound for the diagnosis of carpal tunnel syndrome: a meta-analysis. *Clin Orthop Relat Res* 2011;469:1089-1094.
4. **Bianchi S, Martinoli C.** Ultrasound of the musculoskeletal system. In: *Medical radiology. Diagnostic imaging*. Springer, 2007, pp 459, 462.
5. **Phalen [sign] test 2.** Tinel [sign] test - I'll explain! (carpaltunnel-test.com)
6. **Bodner G, Gruber H, KiechlS, et al (eds).** *High resolution sonography of the peripheral nervous system*, 2nd edition, Springer, 2008.
7. **Lawande AD, Warror SS, Jashi MS.** Role of ultrasound in evaluation of peripheral nerves. *Indian J Radiol Imaging* 2014;24:254-258.
8. **Martinoli C, Serafini G, Bianchi S, et al.** Ultrasonography of peripheral nerves. *J Periph Nerve Syst* 1996;1:169-178.
9. **Chen P, Maklad N, Redwine M, et al.** Dynamic high-resolution sonography of the carpal tunnel. *AJR AM J Roentgenol* 1997;168:533-537.
10. **Fernandes CH, Meirelles LM, Neto JR, et al.** Carpal tunnel syndrome with thenar atrophy: evaluation of the pinch and grip strength in patients undergoing surgical treatment. *Hand* (N Y) 2013;8:60–63. doi: 10.1007/s11552-012-9471-8.