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CASE STUDY

# The "Giant" Median Nerve, a Rare Diagnosis Presenting as Routine Carpal Tunnel Syndrome: Case Series and Literature Review

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## Abstract

Carpal tunnel syndrome is one of the most common entrapment neuropathies and is caused by median nerve compression as it traverses the carpal tunnel. Marked enlargement of the median nerve in the setting of carpal tunnel syndrome, occasionally termed "giant" median nerve, is rare in the literature and typically seen only in conditions of tumorous growth or arteritis. Here we report two cases of a giant median nerve in the setting of carpal tunnel syndrome. One patient reported classic sensory disturbances in the median nerve distribution in her right index finger and middle finger, while the second patient reported diffuse numbness and tingling in both hands. In our first patient, the right median nerve cross sectional area was measured to be 36.2 $mm^2$ via ultrasonography, and in the second patient, the left and right median nerves were measured to be 31.3 $mm^2$ and 32.4 $mm^2$ respectively. Ultrasonography was essential to diagnosis in these cases. Massive enlargement of the median nerve is likely underdiagnosed, and further imaging such as ultrasonography should be strongly considered as first-line workup in carpal tunnel syndrome to provide anatomical information, corroborate clinical findings, and facilitate pre-operative planning.

## Keywords

Median nerve, Ultrasonography, Carpal tunnel syndrome, Case report

## Introduction

Carpal tunnel syndrome (CTS) is a fairly common entrapment neuropathy caused by compression of the median nerve as it travels between the transverse carpal ligament and carpal bones of the wrist [1]. Patients usually present with characteristic sensory disturbances including pain, numbness or tingling in the median nerve distribution [1,2]. While clinical presentation may be sufficient to diagnose carpal tunnel syndrome, physical exam tests including the Phalen maneuver (sustained wrist flexion), Durkan's compression (direct compression of the carpal tunnel), and/or Tinel sign (light percussion at the flexor retinaculum) can be used to confirm the diagnosis [1,3,4]. The Boston Carpal Tunnel Syndrome Questionnaire (BCTQ) or Carpal Tunnel Syndrome scale (CTS-6) may also be used to quantify symptom severity and functional status [5,6]. Reproduction of pain or sensory disturbances in the characteristic median nerve distribution during these tests constitutes a positive test and is suggestive of carpal tunnel syndrome.

Electromyography (EMG) can be used to not only confirm impaired functionality of the median nerve but also further characterize the severity of the entrapment. For these reasons, EMG is commonly obtained prior to carpal tunnel release surgery to estimate the likelihood of restoration of functionality, as recovery of function may be limited in patients with more severe entrapment [1]. EMG has traditionally been considered the reference standard, despite lack of consensus between it and other tests [7]. Ultrasonography, which is less invasive and generally better tolerated by patients, can be used to measure cross-sectional area (CSA) of the median nerve. However, ultrasound criteria for CTS varies due to differences in measurement technique along with populations studied and presence of comorbid

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conditions (e.g. diabetes mellitus). Most commonly used is a cross sectional area > 10 $mm^2$ at the proximal tunnel which has a similar sensitivity and specificity to the CTS-6 score and EMG studies [7-11]. Furthermore, previous studies have shown ultrasonography to be at least similar to EMG in diagnostic accuracy and is the only diagnostic test of the three (CTS-6, EMG, ultrasound) that can yield anatomical data [7,12]. In addition, ultrasound can be used as a corroborative investigation to strengthen the findings of EMG and is recommended as a complement to routine clinical and neurophysiological evaluation and as the first-line imaging modality for masses of suspected nerve origin [13,14]. Furthermore, obtaining anatomical data prior to surgery would have clear implications regarding surgical planning to avoid surprises such as masses and gross enlargement upon surgical exploration.

First-line treatment for carpal tunnel syndrome is usually conservative and consists of wrist splinting and activity modification that targets reduced wrist flexion [2,3,15]. If conservative management fails, corticosteroid injections into the carpal tunnel region or a two week course of oral corticosteroids may be offered [15]. Surgical decompression can be considered in patients with refractory or severe carpal tunnel syndrome [3].

Enlarged median nerves, usually due to tumor growth, can also cause symptoms that mimic or reproduce carpal tunnel syndrome. There are reports in the literature of patients with schwannomas, neurofibromas or lipofibromatous hamartomas of the median nerve presenting with characteristic paresthesia in the median nerve distribution, and often termed the so-called "giant" median nerve [16-22]. Lipofibromatous hamartomas are fairly rare, benign peripheral nerve tumors that preferentially affect the median nerve and can present as entrapment neuropathies [20]. Schwannomas and neurofibromas are other peripheral nerve tumors that commonly affect the median nerve and can cause paresthesia and other sensory disturbances in the distribution of the median nerve [16]. Other causes of "giant" median nerve enlargement include edema and giant cell arteritis [23,24]. However, to our knowledge there are no reports of a marked enlargement or a "giant" median nerve due to cases of pure edema/swelling without tumorous change or arteritis, other than one case report of a median nerve width of 25 mm only discovered at surgery [23]. Generally, further imaging such as ultrasound, MRI and/or diagnostic testing such as EMG may be useful in identifying cases of pathological median nerve enlargement that manifest as carpal tunnel syndrome, a relatively common condition. We present three cases of two patients, one with bilateral giant median nerves and one with unilateral giant median nerve. In both cases, the giant median nerve was diagnosed by ultrasound, and so we emphasize the importance of obtaining anatomical information to complement and corroborate other clinical data during the workup of apparent carpal tunnel syndrome.

## Case Report

### Case 1

A 72-year-old female presented with chronic numbness and tingling in her right wrist and right index finger, middle finger and ring finger. Her symptoms were worse with pulling, bending or pushing motions, particularly with holding the phone or driving. Conservative management including rest, wrist braces, anti-inflammatory medications, ice and topical analgesics provided only minimal relief. Physical exam was not able for a fullness over the volar right wrist under and between the palmaris longus and the flexor carpi radialis.

Ultrasound of the volar wrist (Figure 1A) revealed significant enlargement of the median nerve to 37 $mm^2$ at the carpal tunnel region as compared to 8 $mm^2$ at the level of the pronator quadratus. There was no

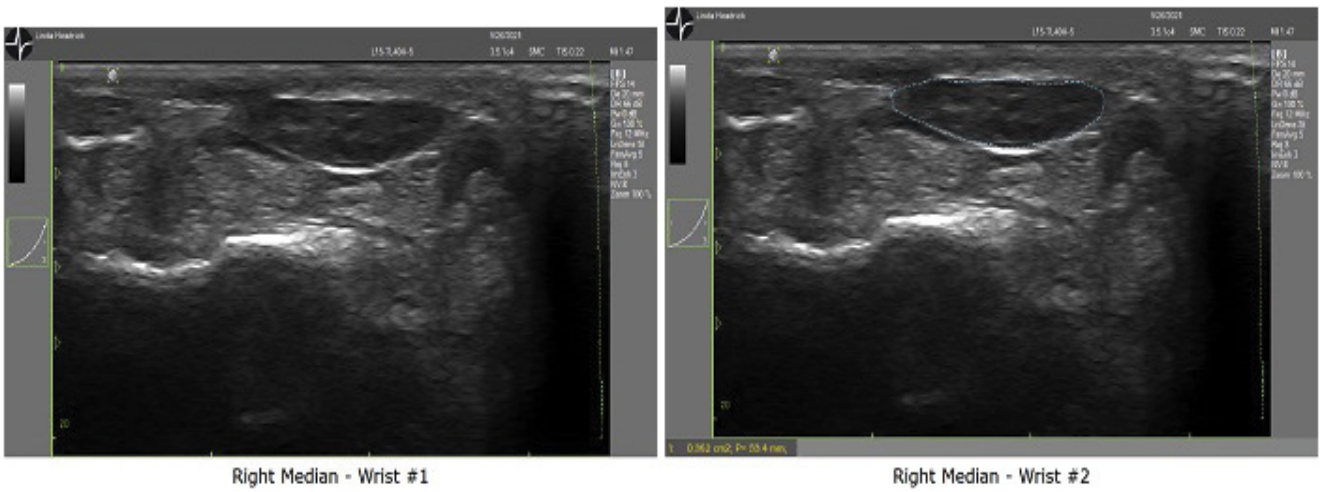


**Figure 1:** Right Median - wrist # 1, Right Median - wrist # 2.

**Table 1A:** Nerve conduction studies; anti sensory left/right comparison.

| Stim site | L Lat (ms) | R Lat (ms) | L-R Lat (ms) | L Amp (μV) | R Amp (μV) | L-R Amp (%) | Site1 | Site2 | L Vel (m/s) | R Vel (m/s) | L-R Vel (m/s) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Median Acr Palm Anti Sensory (2nd Digit) 30.5 °C** | | | | | | | | | | | |
| Wrist | 7.8 | | | 14.0 | | | Wrist | Palm | 16 | | |
| Palm | 3.4 | | | 9.0 | | | | | | | |
| **Ulnar Anti Sensory (5th Digit) 27.9 °C** | | | | | | | | | | | |
| Wrist | 3.6 | | | 55.6 | | | Wrist | 5th Digit | | | |

**Table 1B:** Motor left/right comparison.

| Stim site | L Lat (ms) | R Lat (ms) | L-R Lat (ms) | L Amp (mV) | R Amp (mV) | L-R Amp (%) | Site1 | Site2 | L Vel (m/s) | R Vel (m/s) | L-R Vel (m/s) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Median Motor (Abd Poll Brev) 27.6 °C** | | | | | | | | | | | |
| Wrist | 6.8 | | | 5.4 | | | Elbow | Wrist | 51 | | |
| Elbow | 10.9 | | | 4.3 | | | | | | | |
| **Ulnar Motor (Abd Dig Minimi) 28 °C** | | | | | | | | | | | |
| Wrist | 3.7 | | | 11.1 | | | B Elbow | Wrist | 62 | | |
| B Elbow | 6.3 | | | 11.1 | | | A Elbow | B Elbow | 56 | | |
| A Elbow | 8.1 | | | 10.6 | | | | | | | |

Doppler flow and no signs of tumor e.g. a schwannoma or peripheral nerve sheath tumor. Subsequent EMG showed severe prolonged latency and marked reduced conduction velocity of the median sensory nerve across the carpal tunnel and significantly low amplitude of the median motor nerve. The patient agreed to right wrist carpal tunnel release and exploration of the median nerve. The surgeon ordered an MRI of the right wrist which revealed significant enlargement of the median nerve immediately proximal to the carpal tunnel with no discrete mass within the nerve. She is scheduled for future carpal tunnel release surgery (Table 1A and Table 1B).

## Case 2

Our second patient is a 67-year-old female with chronic diffuse numbness and tingling in bilateral hands. Nightly wrist braces had provided only minimal symptomatic relief. Physical exam was significant for positive Tinel's and Durkan's test. EMG demonstrated severe bilateral median neuropathy with no sensory or motor response. A second lumbrical and interossei distal motor latency difference test (2L-INT DML) can be used to further characterize median mononeuropathy in patients with severe carpal tunnel syndrome to determine if there is any viable median nerve that may be amenable to surgery [25,26]. In this case, the test revealed very low amplitude and prolonged latency response of the median nerve. Ultrasound of the median nerves showed significant enlargement measuring 31.3 $mm^2$ of the left median nerve cross sectional area and 32.4 $mm^2$ of the right median nerve with no Doppler flow or masses within the median nerve appreciated (Figure 1B and Figure 1C). She underwent left and right carpal tunnel release surgery with significantly reduced numbness and tingling in both hands postoperatively (Table 2A and Table 2B, Figure 2 and Figure 3).

## Review of Literature

The PubMed database was queried with the search term "giant median nerve" and returned 215 papers. Papers originally written in a language other than English and results that only contained abstracts were excluded. Results describing non-median nerve masses such as lipomas or tenosynovial tumors causing local compression of the median nerve in the carpal tunnel were excluded. Ten case reports were ultimately identified for review. The cause of median nerve enlargement was varied. Seven of the papers described a median nerve hamartoma while one paper reported a median nerve schwannoma [16-22]. One paper described a case of edematous engorgement of

**Table 2A:** Nerve conduction studies; anti sensory left/right comparison.

| Stim site | L Lat (ms) | R Lat (ms) | L-R Lat (ms) | L Amp (μv) | R Amp (μv) | L-R Amp (μv) | Site1 | Site2 | L Vel (m/s) | R Vel (m/s) | L-R Vel (m/s) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Median Acr Palm Anti Sensory (2nd Digit) 30.5 °C** | | | | | | | | | | | |
| Wrist | | | | | | | Wrist | Palm | | | |
| Palm | | | | | | | | | | | |
| **Ulnar Anti Sensory (5th Digit) 30.5 °C** | | | | | | | | | | | |
| Wrist | 3.3 | 3.3 | 0.0 | 29.7 | 42.8 | 30.6 | Wrist | 5th Digit | | | |

**Table 2B:** Motor left/right comparison.

| Stim site | L Lat (ms) | R Lat (ms) | L-R Lat (ms) | L Amp (mV) | R Amp (mV) | L-R Amp (%) | Site1 | Site2 | L Vel (m/s) | R Vel (m/s) | L-R Vel (m/s) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Median Motor (Abd Poll Brev) 30.6 °C** | | | | | | | | | | | |
| Wrist | 13.8 | | | 0.0 | | | | | | | |
| **Ulnar Motor (Abd Dig Minimi) 30.9 °C** | | | | | | | | | | | |
| Wrist | 2.9 | 2.8 | 0.1 | 6.9 | 5.9 | 14.5 | B Elbow | Wrist | 58 | 58 | 0 |
| B Elbow | 5.9 | 5.9 | 0.0 | 6.7 | 4.6 | 31.3 | A Elbow | B Elbow | 53 | 56 | 3 |
| A Elbow | 7.8 | 7.7 | 0.1 | 6.5 | 5.5 | 15.4 | | | | | |

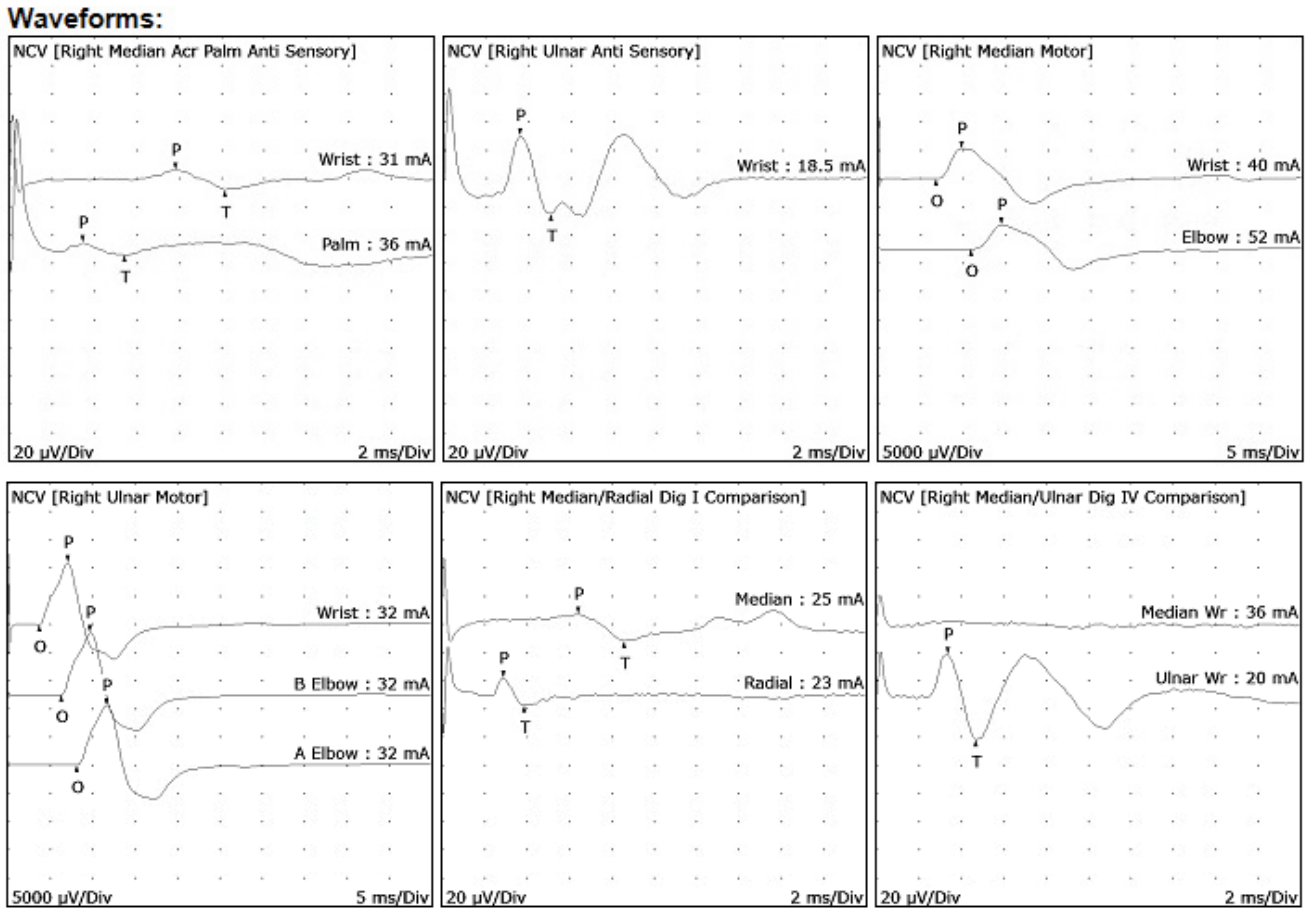


**Figure 2:** Waveforms.

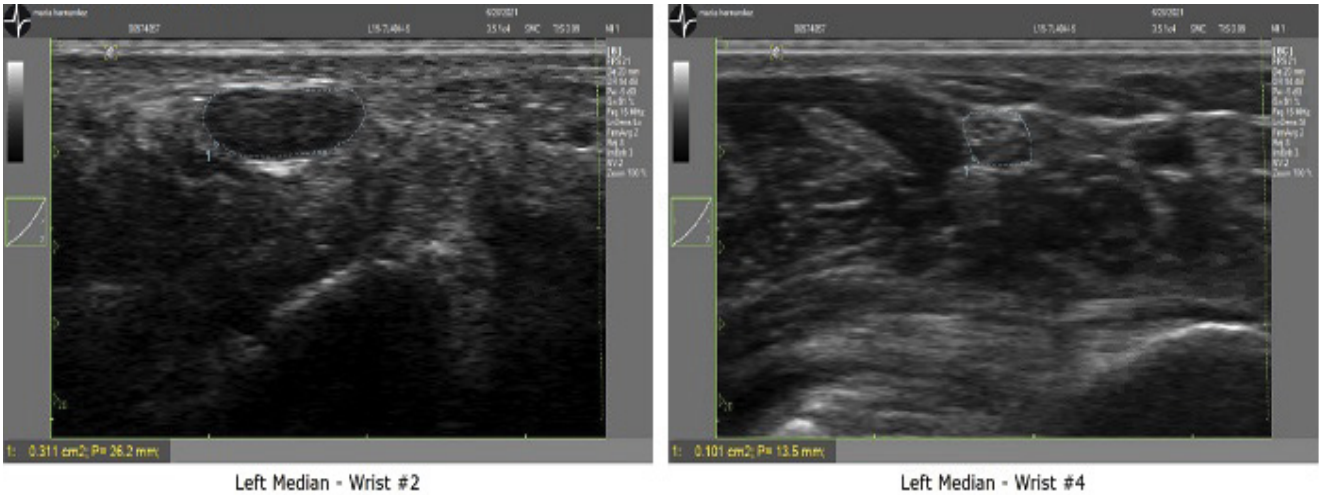


**Figure 3A:** Left Median - Wrist # 2; Left Median - Wrist # 4.

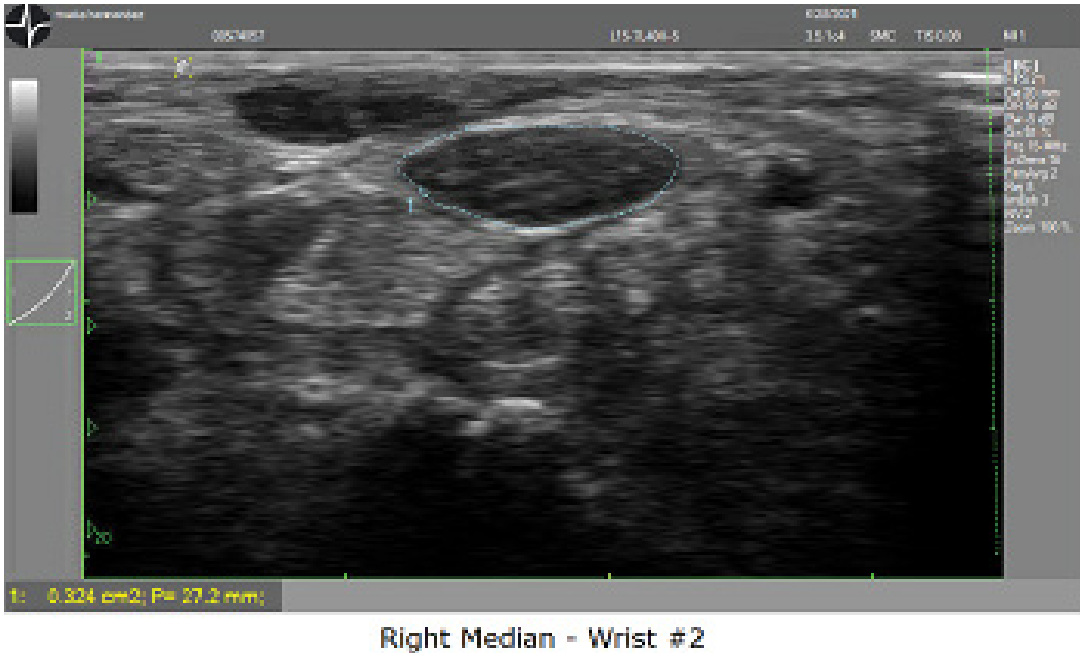


**Figure 3B:** Right Median - Wrist # 2.

the median nerve identified at surgery, measuring 25 mm in width [23]. One paper reported a case of giant cell arteritis involving the small artery of the median nerve and presented with symptoms confused with carpal tunnel syndrome [24]. Excision of the involved arterial segment resolved symptoms, but the mass was ultimately not of median nerve origin.

Of the ten cases identified, three patients were female and seven patients were male. Macrodactyly was noted in three patients [17,19,21]. Eight of the patients presented with sensory disturbances including hypoesthesia, numbness or tingling in the median nerve distribution [16,18-24]. Three patients presented with intrinsic thenar muscle weakness [20-22]. In terms of further imaging or diagnostic studies, MRI was obtained in 9/10 cases [16-23], nerve conduction studies (NCS) in 6/10 cases [18-21,23,24], ultrasound in 4/10 cases [18-21], radiographs in 4/10 cases [20,22,24], EMG in 4/10 cases [21,22,24], and fine needle aspiration cytology in 1/10 cases [16]. Surgical intervention including decompressive or debulking surgery was performed in 8/10 cases [16,17,20-24].

Few case reports measured the cross-sectional area of the enlarged median nerve. Two case reports describing hamartomas reported ultrasonographically measured cross sectional areas of 136 $mm^2$ and 190 $mm^2$ [19,21]. The patient presenting with carpal tunnel syndrome caused by edematous engorgement of the median nerve identified at surgery had a diameter of 25 $mm^2$ [23]. However, none measured cross-sectional area of the median nerve, the most common measurement in carpal tunnel syndrome [7,12]. Positive is often considered > 9 $mm^2$ and severe is often considered > 14 $mm^2$ with a sensitivity of 77% and specificity of 100%

reported [1,27,28]. In the author's experience (K.V. over 15 years in practice with extensive EMG and ultrasound experience, including ultrasound of the wrist for carpal tunnel syndrome), cross-sectional area of > 20 $mm^2$ is rarely but occasionally seen. In our case series, cross-sectional areas in the giant median nerves ranged from 31.3 $mm^2$ to 37 $mm^2$.

## Discussion

We present the first reported case series of patients presenting with "giant" median nerves in the setting of carpal tunnel syndrome, in the absence of schwannoma, hamartoma, macrodactyly, or other tumor or overt pathology.

Identifying this dramatic enlargement of the median nerve in the setting of a fairly common condition is important as it can have significant implications on management. Enlargement of the median nerve or other space-occupying lesions in the carpal tunnel may increase carpal pressures, and it is known that patients with carpal tunnel syndrome have elevated carpal canal pressures [29]. Space-occupying lesions can cause nerve compression injury when the increased carpal tunnel pressure threatens nerve viability and cause nerve ischemia and reperfusion injury [30-32].

Identification of potential masses or marked enlargement of the median nerve itself therefore is critical to provide accurate care, as continued high carpal pressures compromise nerve function and can cause cytokine-induced cell damage, IL-6 mediated fibroblast proliferation and fibrosis [32,33]. As it is demonstrated that IL-6 levels are highly elevated in carpal tunnel syndrome, avoidance of prolonged ischemia and reperfusion stress is paramount to preventing median nerve atrophy and permanent injury [23,32-34]. Fortunately, carpal tunnel release decreases the pressure not only in the carpal canal, but also in the intraneural median nerve pressure itself. Therefore prompt diagnosis and consideration of screening ultrasound is emphasized, as highlighted in this case series [29,35]. In the event of a massive or giant median nerve, excision rather than release of the flexor retinaculum can be considered [23].

Ultrasound may offer additional advantages. While routine nerve conduction studies and EMG may be positive in cases of carpal tunnel syndrome, it is well known that there may be a high false negative rate, upwards of 16-34% of the time [36]. While NCS and MRI were the two most common studies obtained in the reviewed case reports, there was one case report in which NCS and EMG studies of the median nerve were normal [24]. MRI may be used to identify focal enlargements of the median nerve, but it is expensive, has potential contraindications to use, and cannot be done same day for point-of-care service as compared to ultrasound. In addition, NCS and EMG can be uncomfortable to patients, and are considered inefficient and less cost-effective than ultrasound [37].

There are several limitations to this study. It is difficult to differentiate between general median nerve enlargement as the cause of carpal tunnel syndrome versus carpal tunnel syndrome causing edema and consequently enlargement of the median nerve. Increased pressure at the carpal tunnel can cause compressive trauma to the median nerve, resulting in increased permeability and edema [23,38]. Bilateral enlargement of the median nerves at the level of the pronator quadratus in case #2 seems to favor the former argument and suggests that enlarged median nerves can be a risk factor and certainly contribute to development of carpal tunnel syndrome. Additionally, this case series focuses on diagnosis of giant median nerves in the setting of carpal tunnel syndrome, not necessarily on treatment or surgical outcomes. Of the two cases presented in this manuscript, one patient underwent carpal tunnel release surgery, while the other patient is scheduled for future surgery. Therefore, we cannot comment on the prognosis of giant median nerves without surgical intervention. The purpose of this case series is not to comment on outcomes of carpal tunnel release surgery in patients with giant median nerves but to increase awareness of this condition and how ultrasonography can be used to facilitate diagnosis in these situations.

## Conclusion

Carpal tunnel syndrome is a common focal neuropathy of the wrist typically caused by compression of the median nerve within the carpal tunnel. Patients may present with paresthesia or other sensory disturbances in the median nerve distribution as well as weakness of the intrinsic thenar muscles. Although uncommon, enlargement of the median nerve by tumorous growth, edema, or arteritis must also be considered in the differential diagnosis. We present two rare cases of severe median nerve enlargement, the so-called "giant" median nerve with CSA greater than 30 $mm^2$. The diagnosis of carpal tunnel syndrome is usually based upon clinical presentation and EMG. However, further diagnostic imaging with ultrasound was essential in these cases to provide critical anatomical information that ultimately identified enlarged median nerves with cross sectional areas larger than those previously reported in the literature. We strongly recommend considering ultrasound as a first-line diagnostic modality in the workup of carpal tunnel syndrome.

## Author Disclosures

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