# Ultrasound imaging: Enhancing the diagnosis of carpal tunnel syndrome

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# Ultrasound Imaging: Enhancing the diagnosis of Carpal Tunnel Syndrome

**Abstract:** Broader adoption of ultrasound (US) imaging in carpal tunnel syndrome management enhances patient care and outcome. This case underscores the importance in diagnosing carpal tunnel syndrome, highlighting its capability to uncover hidden anomalies and assist in surgical planning.

Carpal tunnel syndrome (CTS) is a common neuropathy, that requires accurate diagnosis for effective treatment. Traditionally, the diagnosis of CTS has relied heavily on clinical history and physical examination findings, occasionally supplemented by electrodiagnostic studies e.g., electromyography (EMG) or nerve conduction velocity (NCV). However, there are limitations to this approach. Clinical symptoms can be non-specific, and physical examinations may not always be conclusive. Although electrodiagnostic studies are often considered the gold standard, they are invasive, painful, and may fail to detect early or mild cases[1, 2].

US imaging offers distinct advantages over traditional methods. Unlike EMG, it is non-invasive and readily available, providing a patient-friendly experience. The true power of US imaging lies in its ability to provide real-time visualization of the median nerve and surrounding structures, enabling clinicians to detect subtle abnormalities and potential complications that other methods might miss[3]. Furthermore, US imaging permits precise measurements to determine if a nerve is entrapped and offers detailed information about the surrounding tissues. This comprehensive capability makes US imaging a valuable tool in medical diagnostics. Lin et al. have demonstrated that the cross-sectional area (CSA) of the median nerve at the carpal tunnel inlet is particularly reliable, with a cutoff value of 9–10.5 mm² providing the highest diagnostic performance[4].

Our case involves a 66-year-old left-handed Caucasian woman who experiences pain in her left hand, loss of sensation in the radial four fingers, and extreme difficulty grasping smaller objects. She has a history of a distal radius fracture on the left side, which was treated with plate and screw osteosynthesis six years earlier. Clinical examination consisted of a positive Tinel Sign and an extreme tenderness proximal to the wrist fold.

While EMG confirmed CTS, it was the preoperative US imaging that unveiled a critical detail: a dislodged screw from a prior surgery six years earlier (Figures 1A-D). Notably, the osteosynthesis had employed an angular stable locking system, making such dislodgment unexpected. Consequently, a surgical exploration was planned. Neurolysis of the median nerve was performed, during which we discovered that the screw was in close contact with both the motor branch of the median nerve and the nerve itself. The motor branch branched off proximally to the wrist crease, entering the carpal tunnel together with the sensory branch. This screw was situated near the median nerve. Clear irritation, fibrosis and inflammation of both the thenar motor branch and the main nerve were observed (Figures 2A-C). Due to its location, proximal to the carpal tunnel, it could have gone unnoticed during a mini open carpal tunnel release and even an endoscopic carpal tunnel release, just as the screw had gone unnoticed during the clinical examination.

At the six-week post-operative clinical examination, the patient reported some residual difficulty with finger extension upon waking, which was attributed to slight persistent tenosynovitis of the flexors. The patient also noted minor residual numbness in the left second and third digits, with overall a good recovery.


*Figure 1A*

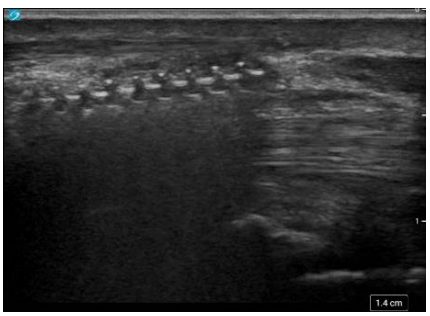


*Figure 1B*


*Figure 1C*


*Figure 1D*

*Figure 2A*

*Figure 2B*

*Figure 2C*

The benefits of incorporating US imaging in the workup of carpal tunnel syndrome extend beyond complication detection. In addition to patients with a history of distal radius fracture and osteosynthesis, where US imaging proves to be a valuable tool for identifying potential issues arising from previous procedures, US imaging holds promise for all individuals at risk of CTS. Gaining an in-depth understanding of anatomical variations, such as bifid median nerves or persistent median arteries, cannot be overstated. For instance, a meta-analysis revealed that the incidence of bifid median nerves in carpal tunnel syndrome patients is 50% higher compared to matched control subjects[5]. Similarly, Townsend et al. found that the prevalence of persistent median arteries observed in patients undergoing carpal tunnel release can be as high as 8.3%[6]. This knowledge not only guides preemptive intervention planning and retrospective evaluation of treatment outcomes but also influences the selection of interventional strategies[7]. Moreover, US imaging is useful in the overall diagnosis of carpal tunnel syndrome, offering comparable sensitivity to NCS and slightly higher specificity compared to NCS and electromyography[8]. In fact, the degree of CSA enlargement at the carpal tunnel inlet has been correlated with CTS severity, making it a critical measurement in both diagnosis and severity assessment[4].

This growing body of evidence advocating for US imaging in the workup of CTS is compelling. By embracing US imaging in preoperative assessments, particularly in complex cases or those with a surgical history, we can enhance the preoperative evaluation. In this particular case, the preoperative identification of a previously undetected dislodged screw has allowed for a more comprehensive surgical plan, preventing further nerve irritation, and leading to improved postoperative outcomes.

Furthermore, Descamps et al. demonstrated that experience in upper-limb US guided surgery significantly impacts surgical practices by increasing the adoption and application of ultrasound-guided techniques[9]. This underscores the potential benefits of developing educational programs for surgeons to improve their proficiency in conducting and interpreting US examinations in CTS cases.

In conclusion, while electrodiagnostic studies like EMG/NCV remain a valuable tool, this letter calls for expanding the diagnostic toolbox for CTS by systematically incorporating preoperative US imaging. Ultrasound's real-time visualization, improved complication detection, non-invasive character and patient-friendly approach offer significant advantages. By embracing this versatile tool, we can move towards more comprehensive preoperative evaluations, potentially mitigating complications and improving outcomes for patients with CTS.

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