Electrodiagnosis of Carpal Tunnel Syndrome

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KEYWORDS

• Carpal tunnel syndrome • Electrodiagnosis • Combined Sensory Index
• Nerve conduction study

KEY POINTS

- Carpal tunnel syndrome (CTS) will likely continue to be a common problem encountered by the electrodiagnostician, given recent evidence suggesting an increasing incidence of the condition.
- New modalities, such as MRI and ultrasound, are being applied to CTS and can potentially add important information about the anatomy and morphology of the carpal tunnel, median nerve, and surrounding tissue.
- Although CTS is a condition that is relatively easy to recognize, investigations to improve early CTS detection and treatment outcomes are warranted.

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common and the best studied of all focal neuropathies.[1,2] CTS has provided an unmatched teaching and learning experience for generations of students, physicians, and scholars involved in patient care and electrodiagnostic testing (EDX). The EDX methodology for evaluating CTS has served as an example for the study of all focal neuropathies.[3,4]

It is estimated that one in five patients presenting with upper limb pain, numbness, tingling, and weakness have the diagnosis of CTS. CTS also accounts for 90% of all known compression or entrapment neuropathies.[5,6] A search on PubMed using the phrase "carpal tunnel syndrome" yields more than 7000 articles published in the English language literature alone in the new millennium, 2000 of which have been published since the beginning of this decade. This ongoing scholarly interest in CTS holds promise for further refinements to the diagnosis and treatment of the

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disorder and, it is hoped, will lead to effective ways to prevent this common human ailment.

Recent epidemiologic studies suggest the number of people afflicted by CTS is substantial in US and European populations.[7–11] The prevalence of self-reported CTS in the US adult population has been estimated to be as high as 5%.[12] New demographic data indicate an increasing trend.

CTS was initially defined as a clinical disorder diagnosed by pattern recognition of patients presenting with similar symptoms and careful clinical examination. Rudimentary EDX for CTS began in the mid-1950s[13] and continued to develop throughout subsequent decades. EDX has been regarded as an objective, reliable, and valid test for CTS. More recent advancements in technology have brought EDX to a level of performance and reliability unavailable to earlier clinicians. There have also been improvements in the speed in which the study can be conducted and comfort afforded to the patient.

This article discusses the historical aspects related to the understanding of CTS and its diagnosis, highlighting observations about this disease that have yet to be challenged. This is followed by a discussion regarding the use of EDX as a diagnostic tool for CTS, as well as the author's approach to making the diagnosis of CTS. Finally, conclusions about future directions in the diagnosis, treatment and research of this disorder are presented.

HISTORICAL ASPECTS OF CTS

Descriptions of CTS by surgeons treating traumatic upper limb injuries date back to at least the mid-1800s.[14] Brain's[15] 1947 landmark publication in the *Lancet* reported spontaneous CTS and summarized earlier published cases from 1909 to 1945. The term acroparesthesias, coined by Ormerod in 1833 to describe paresthesias in the extremities, was later used to refer to the nighttime burning and pins-and-needles sensation in the fingers of middle-aged women. Acroparesthesias in the median nerve distribution continue to be useful in evaluating CTS. Another feature noted in the early history of CTS was that of thenar eminence atrophy and hand weakness. However, an understanding that the sensory and motor symptoms were caused by a single median nerve lesion at the wrist was not appreciated until many years after the first clinical descriptions of the disease. Eventually the hypotheses that thenar neuritis, brachial plexus lesions, or an extra cervical rib could cause CTS were refuted, and focal median nerve compression at the carpal tunnel (CT) was identified as the sole cause for both the sensory and motor deficits.

The term carpal tunnel syndrome was said to appear in print for the first time in a paper published by Kremer and colleagues[16] in 1933. George Phalen, an American orthopedic surgeon at the Cleveland Clinic, was credited with popularizing the use of the contemporary term beginning in the 1950s.[17–20] Besides using the Tinel test to help support the diagnosis of CTS, Phalen also gave us the wrist flexion test that carries his name. Both the Tinel and Phalen tests have been widely used in clinical practice and for research. However, the lack of an agreed on standard method contribute to the variable sensitivity and specificity of the tests.[21]

Many risk factors for CTS have been recognized early on such as pregnancy, space-occupying tumor, trauma (especially crush injuries), and work activities. The long list of known CTS risk factors includes age, rheumatoid arthritis, diabetes, hypothyroidism, obesity, square-shaped wrist, and many others. These risks can be divided into intrinsic (ie, genetic, biologic) and extrinsic (ie, environmental, activity-related) factors.