

# A systematic review of the utility of electrodiagnostic testing in carpal tunnel syndrome

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## SUMMARY

*Carpal tunnel syndrome (CTS) comprises a complex of symptoms in the hand, including pain and paresthesia and weakness of hand muscles thought to result from compression of the median nerve. Many clinicians either refer patients for electrodiagnostic studies to aid diagnosis or conduct electrodiagnostic studies, which may be useful as an aid to decisions on treatment. The aim of this systematic review is to evaluate the evidence base for the use of electrodiagnostic tests in the diagnosis and management of carpal tunnel syndrome.*

*A systematic search was undertaken for studies that included patients with clinical diagnosis of CTS who were undergoing electrodiagnostic tests and surgery, together with reported outcomes of surgery. A published systematic review found that electrodiagnosis was not a useful diagnostic test in patients with clinical signs of CTS. Seven primary studies of prognosis reporting electrodiagnosis and surgery outcomes were found; however, one of them was subsequently retracted. The remaining six were retrospective case series of poor quality. Four of these studies reported outcomes of surgery in patients with clinically identified CTS, comparing both positive or negative electrodiagnostic results. No study found any statistical difference in surgical outcome between those who were electrodiagnostic test positive and those who were negative.*

*Despite the limited quality of the evidence, in cases of clear-cut clinical CTS, electrodiagnosis is not warranted either as a diagnostic test, where clinical symptoms are well defined, or as a predictive indicator of surgical outcome. It may still be useful in cases where the clinical diagnosis is not clear.*

**Keywords:** carpal tunnel syndrome; electrodiagnosis; systematic review.

## Background

Electrodiagnostic techniques are often used in the assessment of carpal tunnel syndrome and are considered to be beneficial in the management of the condition.<sup>1</sup> Local health care commissioners have noted increased referrals for electrodiagnosis for carpal tunnel syndrome (CTS) in circumstances where there was a shortage of resources and increased waiting lists. Both GPs and surgeons have requested such tests in patients presenting with clinical signs. Although resources are in short supply and waiting lists are long, ineffective or non cost-effective technologies may still be used in the health services based on historical practice, with little evaluation.<sup>2</sup> To evaluate whether the service should be expanded or the expertise be made more widely available, a systematic review of the cost-effectiveness of electrodiagnosis in the assessment of CTS was carried out.

Carpal tunnel syndrome presents with symptoms in the hand and forearm. These include pain, paraesthesia or weakness in the regions covered by the median nerve. These symptoms are thought to result from compression of the nerve in the carpal tunnel.<sup>3</sup> CTS is more common in diabetics, rheumatoid arthritis, and pregnancy and may be associated with repetitive movements.<sup>3</sup> It is initially treated conservatively with rest and splinting<sup>3</sup> or with systemic analgesics or injected glucocorticoids.<sup>4</sup> If these fail, decompression surgery has a success rate of between 80% and 95%.<sup>5,6</sup> In 1998, approximately 30 000 admissions to NHS hospitals were for CTS (personal communication: R Wilson, 1999).

There is no 'gold standard' for CTS diagnosis;<sup>7</sup> it rests on clinical diagnosis of specified signs and symptoms and sometimes also on the results of electrodiagnostic tests.<sup>3,8,9</sup> Electrodiagnostic tests, used to aid diagnosis, include nerve conduction studies and sometimes electromyography.<sup>10</sup> Surface stimulating and recording electrodes can be used to study both motor and sensory nerves. Damaged nerves produce slower conduction velocities and smaller amplitudes.<sup>11</sup> Test conditions — for example, temperature, electrode size, distance between electrodes, and amplifier gain — need to be controlled.<sup>10</sup> Results are compared with tables of normative values but different clinicians may use different normal values.

The aim of this study is to evaluate in a systematic review the evidence base for the use of electrodiagnostic tests in the diagnosis and management of carpal tunnel syndrome in patients with clinical signs.

## Method

The first stage of the review consisted of a scoping search

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Submitted: 2 May 2001; Editor's response: 4 July 2001; final acceptance: 22 November 2001.

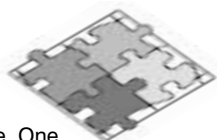
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**HOW THIS FITS IN***What do we know?*

Carpal tunnel syndrome is a common problem encountered in general practice. One choice open to GPs is to refer patients for electrodiagnostic testing prior to surgical referral.

*What does this paper add?*

This systematic review has found no evidence that electrodiagnostic tests are of use in the diagnosis or management of patients presenting with well-defined clinical signs.



concerning diagnosis of CTS. Thus the first question to be answered was: how effective is electrodiagnosis in the diagnosis of CTS?

However, a preliminary search revealed a systematic review that had assessed information on all studies in which patients were examined both clinically and with electrodiagnostic studies.<sup>10</sup> Although the specificity of electrodiagnosis for confirming clinically characterised CTS was found to be high (between 95% and 100%), so that few people without clinical CTS would have abnormal electrodiagnostic results, the sensitivity was low and very variable (between 49% and 84%), so that a substantial proportion of patients with positive clinical symptoms who would benefit from treatment would have normal electrodiagnostic results. That is, if clinical diagnosis was considered as a reference standard then there were many false negatives on electrodiagnostic tests. Thus, electrodiagnosis would not seem worthwhile to confirm the diagnosis in the majority of cases of CTS where the symptoms are well defined. However, electrodiagnosis is still recommended by guidelines in the United States<sup>12</sup> and still used in this way.

Since it appeared that the use of electrodiagnosis as a diagnostic test could not be justified on the basis of the evidence, it was necessary to consider how else electrodiagnosis could contribute to patient management, as there might be some other evidence-based use for the tests. A further question was framed: is electrodiagnosis useful as an additional tool to predict surgical outcome?

A systematic search of MEDLINE (from 1966 to December 1998), EMBASE (from 1988 to December 1998), OSHROM, and the Cochrane Library Database was carried out, to identify primary studies in the English language that included patients with suspected CTS undergoing both electrodiagnosis and surgery. Internet searches were also carried out. Further studies were sought via personal contact with electrodiagnosticians and hand surgeons and via citation checking.

The quality and findings of the papers was abstracted independently and any discrepancies were discussed and resolved. Formal data synthesis was not appropriate or valid because only poor quality case series, heterogeneous with regard to subjects and outcome measurement, were identified.

**Results**

Seven studies were identified that included patients with

suspected CTS undergoing both electrodiagnosis and surgery.<sup>5,6,13-17</sup> All were poor quality retrospective case series studies and a comprehensive retraction was found for one of these.<sup>15,18</sup> Studies were poorly designed and reported; for example, outcomes were often given only for a subset of the patients. Temperature control of tests was frequently absent. The criteria for abnormal tests varied and sometimes were derived using invalid methods. Calculations were sometimes incorrect. Several studies reported number of patients, not number of hands.<sup>13;14</sup> Clinical and physical criteria for CTS diagnosis varied and were defined only in half of the studies.<sup>5,6,17</sup>

Four studies allowed analysis.<sup>5,6,13,14</sup> Surgery was 73% to 93% effective in alleviating CTS. There were no statistically significant differences in outcome between those with positive and negative electrodiagnostic tests (Table 1), providing no support for use of electrodiagnosis as a predictive indicator of the likely success of surgical treatment of CTS.

**Discussion**

It is concluded, on the basis of a previous systematic review, that electrodiagnostic studies are not useful in the diagnosis of clear-cut cases of CTS. Additionally, electrodiagnosis test results could not be justified as providing a prognostic indicator of surgical outcome in CTS. The role of electrodiagnosis in risk management was also considered and no published justification for its use on these grounds in the United Kingdom setting could be identified. In view of the lack of evidence justifying the use of electrodiagnostic tests where there was a firm clinical diagnosis of CTS, use of electrodiagnosis in these circumstances is also not cost effective. General practitioners should curtail the use of electrodiagnosis in this context, thereby expediting appropriate surgical referrals and decreasing unnecessary expenditure.

The limitations of the published studies meant that it was not possible to assess the place of electrodiagnosis where the clinical diagnosis is not clear. High-quality studies could be designed to evaluate the predictive value of electrodiagnostic techniques before surgery, both in those cases of CTS that fully meet clinical diagnostic criteria and in those cases that do not. It could be argued that it is for the protagonists of these techniques to produce such data before support and resources are committed to their use.

The systematic review of established techniques often reveals practice based on historical tradition rather than evidence. It has been argued that such results should be published.<sup>19</sup> This review demonstrates how such negative findings might lead to improved patient management and more cost-effective care.

**References**

1. Kanaan N, Sawaya R. Carpal tunnel syndrome: modern diagnostic and management techniques. *Br J Gen Pract* 2001; **51**: 311-314.
2. Stevens A, Milne R, Lilford R, Gabbay J. Keeping pace with new technologies: systems needed to identify and evaluate them. *BMJ* 1999; **319**: 1-3.
3. Campbell W. Diagnosis and management of common compression and entrapment neuropathies. *Neurol Clin* 1997; **15**: 549-567.
4. Dammers J, Veering MM, Vermeulen M. Injection with methylprednisolone proximal to the carpal tunnel: randomised double-blind trial. *BMJ* 1999; **319**: 884-886.
5. Glowacki K, Breen C, Sachar K, Weiss A-PC. Electrodiagnostic testing and carpal tunnel release outcome. *J Hand Surg* 1996;

Table 1. Results of electrodiagnostic studies and outcomes of surgery.

Study	Patients entered: number of hands	Positive clinical diagnosis: number of hands	Underwent electrodiagnostic studies: number of hands	Electro-diagnostic results: number of hands (%)	Having surgery: number of hands	Patient-based outcomes of surgery			Relative Risk of good outcome, Pos ED versus Neg ED (95% CI)	Statistical test <sup>b</sup> (P-value)	Loss to follow-up	Side effects
						Outcome measures	Pos ED	Neg ED				
Grundberg 1983 <sup>16</sup>	292 <sup>a</sup>	292 <sup>a</sup>	292 <sup>a</sup>	Pos = 259 <sup>a</sup> (89) Neg = 33 <sup>a</sup> (11)	292 <sup>a</sup>	Cured or mild remaining symptoms No relief	NS 30	2	–	–	7 <sup>a</sup>	1? Reactive fibrosis
<sup>c</sup> Glowacki 1996 <sup>5</sup>	227	227	126	Pos = 99 (79) Neg = 27 (21)	227	Complete resolution or occasional symptoms No change or worse	92 7	25 2	1.00 (0.96–1.03)	Fisher's exact (P = 1.0)	NS	NS
Choi 1998 <sup>17</sup>	294	NS	294	Pos = 294	294	Complete resolution or mild residual symptoms Improvement but still symptomatic Unchanged or worse	242 39 13	NS	–	–	NS	Incisional pain and tenderness after 1 year = 6/294
Braun 1994 <sup>14</sup>	151 <sup>a</sup>	151 <sup>a</sup>	125 <sup>a</sup>	Pos = 75 <sup>a</sup> (60) Neg = 50 <sup>a</sup> (40)	151 <sup>a</sup>	No significant residual discomfort Persistent significant discomfort	60 <sup>a</sup> 15 <sup>a</sup>	40 <sup>a</sup> 10 <sup>a</sup>	1.00 (0.84–1.20)	$\chi^2$ Yates' correction (P = 0.82)	NS	NS
Higgs 1997 <sup>13</sup>	93 <sup>a</sup>	93 <sup>a</sup>	93 <sup>a</sup>	Sensory latency: Pos = 21 <sup>a</sup> (60) Neg = 72 <sup>a</sup> (40)	93 <sup>a</sup>	Numbness —Good —Poor  Pain —Good —Poor  Nocturnal symptoms —Good —Poor	19 <sup>a</sup> 2 <sup>a</sup>  19 <sup>a</sup> 2 <sup>a</sup>  20 <sup>a</sup> 1 <sup>a</sup>	49 <sup>a</sup> 23 <sup>a</sup>  54 <sup>a</sup> 18 <sup>a</sup>  57 <sup>a</sup> 13 <sup>a</sup>	–  1.21 (1.00–1.46)  –	$\chi^2$ Yates' correction or Fisher's exact P = 0.08 P = 0.23 P = 0.18	NS	NS
Concannon 1997 <sup>6</sup>	460	460	460	Pos = 398 <sup>a</sup> (87) Neg = 62 <sup>a</sup> (13)	460	Symptoms resolved  Symptoms not resolved	390  8	61 <sup>a</sup>  1 <sup>a</sup>	1.00 (0.89–1.13)	Fisher's exact P = 1.0	NS	Complications: Pos ED = 20 Neg ED = 3

<sup>a</sup>Number of patients. <sup>b</sup>It has been assumed that outcomes for two hands in the same patient are independent. Insufficient data were available to take any other approach. <sup>c</sup>Only positive results followed up. ED = electrodiagnosis; Pos ED = abnormal; Neg ED = normal.

- 21A:** 117-122.
6. Concannon M, Gainor B, Petroski G, Puckett C. The predictive value of electrodiagnostic studies in carpal tunnel syndrome. *Plast Reconstr Surg* 1997; **100**: 1452-1458.
  7. Rempel D, Evanoff B, Amadio P, *et al*. Consensus criteria for the classification of carpal tunnel syndrome in epidemiologic studies. *Am J Public Health* 1998; **88**: 1447-1451.
  8. Mercier L. *Practical Orthopedics*. Chicago: Year Book Medical Publishers, 1987.
  9. Harrington J, Carter J, Birrell L, Gompertz D. Surveillance case definitions for work-related upper-limb pain syndromes. *Occup Environ Med* 1998; **55**: 264-271.
  10. Jablecki C, Andary M, So Y, *et al*. Literature review of the usefulness of nerve conduction studies and electromyography for the evaluation of patients with carpal tunnel syndrome. *Muscle Nerve* 1993; **16**: 1392-1414.
  11. Cornwall, M. <http://jan.ucc.nau.edu/~cornwall/pt580/class/EDX/> (1999).
  12. American Association of Electrodiagnostic Medicine, American Academy of Neurology, American Academy of Physical Medicine and Rehabilitation. Practice parameter for electrodiagnostic studies in carpal tunnel syndrome: summary statement. *Muscle Nerve* 1993; **16**: 1390-1391.
  13. Higgs P, Edwards D, Martin D, Weeks P. Relation of pre-operative nerve conduction values to outcome in workers with surgically treated carpal tunnel syndrome. *J Hand Surg* 1997; **22A**: 216-221.
  14. Braun R, Jackson W. Electrical studies as a prognostic factor in the surgical treatment of carpal tunnel syndrome. *J Hand Surg* 1994; **19A**: 893-900.
  15. Louis D, Hankin F. Symptomatic relief following carpal tunnel decompression with normal electromyographic studies. *Orthopedics* 1987; **10**: 434-436.
  16. Grundberg A. Carpal tunnel decompression in spite of normal electromyography. *J Hand Surg* 1983; **8**: 348-349.
  17. Choi S, Ahn D. Correlation of clinical history and electrodiagnostic abnormalities with outcome after surgery for carpal tunnel syndrome. *Plast Reconst Surg* 1998; **102**: 2374-2380.
  18. Hankin F, Louis D. Retraction. *Orthopedics* 1988; **11**: 532.
  19. Alderson P, Roberts I. Should journals publish systematic reviews that find no evidence to guide practice? Examples from injury research. *BMJ* 2000; **320**: 376-377.