

SENSORY FUNCTION AFTER MEDIAN NERVE DECOMPRESSION IN CARPAL TUNNEL SYNDROME

Preoperative vs postoperative findings

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The sensory recovery was monitored for up to 1 year after decompression of the median nerve in 69 patients with carpal tunnel syndrome. Special attention was paid to the rate of recovery, the importance of constant or intermittent numbness or paraesthesiae preoperatively and the influence of gender.

Most patients with numbness/paraesthesiae and those with abnormal two-point discrimination recovered within 10 days. Perception of touch and vibration recovered within 3 weeks in most patients but those with abnormal nerve conduction/sensory amplitude recovered slowly during follow-up.

After 1 year patients with intermittent preoperative symptoms were significantly more likely to achieve normal nerve conduction and perception of touch. Women were more likely to achieve normal nerve conduction and perception of touch. A comparison of recovery between matched men and women with identical preoperative status showed no significant difference.

The results indicate the importance of early treatment of carpal tunnel syndrome.

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Carpal tunnel syndrome (CTS) is the most common type of nerve entrapment, frequently resulting in impaired hand function and decreased work capacity. The pathophysiology of CTS shows an association between the stage of the disease and intraneural microvascular dysfunction and nerve fibre injury. The character of numbness and paraesthesiae reflects the severity of the carpal tunnel syndrome. Intermittent symptoms indicate the presence of vascular changes whereas constant symptoms reflect intraneural changes such as an intraneural oedema, myelin changes or axonal degeneration (Dawson, 1993; Lundborg, 1988; Lundborg and Dahlin, 1994).

Carpal tunnel release is a successful procedure in most patients with CTS (Brown et al, 1993; Dawson, 1993; Kulick et al, 1986; Szabo et al, 1984). Following decompression patients rapidly improve with a maximal relief of paraesthesiae at 3 weeks, followed by a slower recovery in motor function (Brown et al, 1993). A gradual improvement in ability to perform activities of daily living has been observed over a follow-up period of 2 years (Katz et al, 1995). These results are in accordance with an earlier report of variations in the rate of recovery depending on the severity of CTS and the pathophysiological mechanisms (Lundborg and Dahlin, 1994).

Kaplan et al (1990) reported that various predictive factors such as constant paraesthesiae, age, duration of symptoms, stenosing flexor tenosynovitis, thenar atrophy, abnormality of two-point discrimination (2-PD) and a positive Phalen test may affect the outcome of non-surgical treatment of CTS.

The present study was designed to monitor the recovery of sensory functions up to 1 year after median nerve decompression. Special attention was paid to the significance of constant or intermittent symptoms preoperatively and to the influence of gender.

PATIENTS AND METHODS

Patients

This prospective consecutive study included all patients referred between March 1992 and April 1994, with clinical symptoms and signs of CTS. These included intermittent or constant numbness or paraesthesiae correlating to the anatomical distribution of the median nerve in the hand, positive Tinel and/or Phalen provocative tests, and in advanced cases pain and muscle weakness (Dawson, 1993; Gellman et al, 1986; Omer, 1992). The diagnosis was confirmed by neurophysiological examination (fractionated sensory nerve conduction velocity over the carpal tunnel, sensory nerve action potential from thumb and long finger and motor conduction time) (Rosén, 1993). Patients exposed to handheld vibrating tools or suffering from diabetes, rheumatoid arthritis, cervical radiculopathy or conditions causing pain or neuropathy in the hand were excluded. Patients with previous carpal tunnel release were also excluded.

One hundred and two patients were initially included in the study. However, 33 patients did not attend all follow-up visits, 31 of whom did not attend the 1 year follow-up. The test results of these patients up to 84 days follow-up were compared with those of the 69 patients who completed the study. There were no significant differences between the two groups of patients (Mann-Whitney U-test). The proportion of patients with intermittent or constant preoperative symptoms, those who had been treated by endoscopic or open surgical technique, and of gender were also equal. The mean age was slightly but not significantly (*t*-test) lower than in the group which completed the whole study (45 vs 50 years). The group of 69 remaining patients (71 hands) was therefore considered representative of the original consecutive patients and will be presented in detail.

The group of 69 patients included 51 women and 18 men. Among the women with a mean age of 50 years (range 27–82 years), there were 23 manual workers, 14 non-manual workers, four housewives, one student and nine retired persons. Among the men with a mean age of 54 years (range 24–81 years), there were nine manual workers, five non-manual workers, and four retired persons.

Preoperatively 41 patients (32 women, nine men) had intermittent numbness/paraesthesiae, and 30 patients (21 women, nine men) had constant numbness/paraesthesiae.

Thirty-six hands were operated on by the conventional open technique and 35 by endoscopic release using one-portal (Chow, 1990) or two-portal technique (Agee et al, 1992).

Assessment

The patients were examined preoperatively and at 10, 21, 42, 84 and 365 days postoperatively. The degree of numbness/paraesthesiae was estimated by the patients at all test occasions and Semmes-Weinstein monofilament test and 2-PD test were also done at all follow-up visits. Tactilemetry was done preoperatively and at 21, 42, 84 and 365 days postoperatively, and neurophysiological assessment was performed preoperatively and at 84 and 365 days postoperatively.

The assessments included:

- The patient's estimation of perceived numbness/paraesthesiae graded from 1 to 3 (1=none, 2=intermittent, 3=constant)
- Static two-point discrimination test (s2-PD) was performed according to Moberg (1990), using a Discriminator™. Correct response below 6 mm (≤ 5 mm) was considered normal
- Perception of touch/pressure with Semmes-Weinstein monofilament test (minikit) was done at the tips of the thumb, index and long finger (Bell-Krotoski, 1990). The lightest monofilament perceived by the digit with the worst sensibility was recorded
- Vibrotactile sense within multiple frequencies ranging from 8 to 500 Hz was assessed by tactilemetry (Lundborg et al, 1986). The Sensibility Index (SI) was used as a measurement, $SI \geq 0.8$ being considered normal (Lundborg et al, 1992)
- Fractionated sensory nerve conduction was measured over the carpal tunnel using surface electrodes and antidromic stimulation (Rosén, 1993). Nerve conduction velocity ≥ 46 m/s was considered normal (Rosén et al, 1993)
- Sensory amplitude on stimulation of thumb and long finger were recorded at the wrist. Since sensory amplitude is influenced by age (Sundkvist et al) the difference between measured and expected amplitude was calculated. Z-scores were calculated, values exceeding minus 1.64 were within the normal one-sided interval (95% confidence interval).

Statistical analyses

Logistic regression was used to investigate the influence of two specific factors; preoperative status (i.e. intermittent or constant numbness/paraesthesiae), and gender on the outcome at the 1 year follow-up.

A binary assessment of outcome, normal or abnormal, was used in the calculation of logistic regression. The results were expressed as the probability of those with preoperatively intermittent symptoms, and of women to achieve normal test results at the 1-year follow-up, compared with those with constant symptoms, and men respectively. The probability may be quantified as the odds ratio, reflecting the possibility of an association of two variables in the occurrence of a given event (Afifi and Clark, 1986).

Men had obviously worse preoperative results than women, so matched pairs of the two groups were compared for two selected sensory functions (nerve conduction velocity and Semmes-Weinstein monofilament test) preoperatively and at the 1 year follow-up. The difference in preoperative status and at the 1 year follow-up was calculated for men and women separately with the Wilcoxon signed rank test. The Mann-Whitney U-test was used for comparison between men and women at the 1 year follow-up. *P*-values < 0.05 were considered significant.

RESULTS

Rate and course of recovery of sensory functions

The course of recovery of various sensory symptoms followed different patterns (Fig 1). Forty four of 71 patients reported a complete relief of subjective symptoms at the 10 day follow-up, with a maximum at the 21 day follow-up. Similarly, most patients with abnormal 2-PD recovered within 10 days. Perception of touch and vibration recovered within 3 weeks in a majority of the patients while those with abnormal nerve conduction and sensory amplitude continued to recover slowly during the period of follow-up (Fig 1).

Influence of preoperative status and gender on recovery

Logistic regression at the 1 year follow-up showed that patients with preoperative intermittent numbness/paraesthesiae had a significantly higher probability (odds ratio with 95% confidence interval exceeding 1) of achieving normal velocity of nerve conduction velocity compared with those with preoperative constant numbness/paraesthesiae ($P = 0.01$) (Table 1). Patients with intermittent preoperative symptoms were also more likely to obtain normal perception of touch compared with those with constant preoperative symptoms ($P = 0.04$) (Table 1). The female group were more likely than men to obtain normal nerve conduction as well as sensory amplitude ($P = 0.01$ and 0.02) (Table 2). The comparison of improvement, between matched men and women with identical preoperative symptoms, in nerve

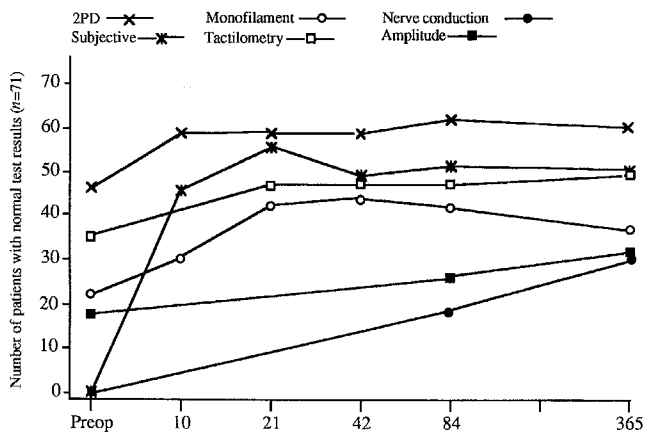


Fig 1 Number of patients with normal test results at different intervals after surgery ($n=71$).

conduction ($n=14$) and the Semmes–Weinstein monofilament test ($n=12$), showed that the velocity of nerve conduction improved significantly from preoperatively to the 1 year follow-up ($P=0.001$ and 0.003), and the results of Semmes–Weinstein monofilament test also improved significantly both for women and men ($P = 0.03$ and 0.01). In addition, no significant difference in the results

of nerve conduction and perception of touch was found between the two matched groups of men and women at the 1 year follow-up ($P = 0.07$ and 0.7) (Fig 2).

DISCUSSION

The results show a better sensory recovery in CTS-patients with intermittent preoperative numbness/ paraesthesiae compared with those with constant symptoms.

A different rate of recovery in the various sensory functions was observed after decompression. The majority of patients with numbness/paraesthesiae had rapid relief after decompression of the median nerve. These clinical observations may reflect a rapid improvement in intraneural microcirculation (Lundborg and Dahlin, 1994). 2-PD is a composite function based on peripheral as well as central nervous components with emphasis on the central nervous system (Moberg, 1962). In accordance with our findings, it has been shown by others that 2-PD may be normal in CTS (Gelberman et al, 1983; Gellman et al, 1986; Katz et al, 1995; Szabo et al, 1984). Even when sensory amplitude and nerve conduction velocity is much impaired, 2-PD is usually one of the last sensory functions to show impairment in median nerve compression lesions (Gelberman et al, 1983). The very slow recovery of nerve conduction and sensory amplitude

Table 1—The probability (expressed as odds ratio with 95% confidence interval) of achieving normal sensory function at 1 year for patients with intermittent preoperative symptoms ($n=41$), compared with patients with constant preoperative symptoms ($n=30$). (Normal test results in brackets).

Factor	Odds ratio	95% CI	P-value
Subjective (No numbness/paraesthesiae)	1.7	0.6–4.9	0.3
2-PD (≤ 5 mm)	1.7	0.4–6.2	0.4
Semmes–Weinstein monofilaments (No. 2.83)	2.8	1.1–7.8	0.04
Tactilometry ($SI \geq 0.80$)	1.1	0.4–3.0	0.9
Nerve conduction (≥ 46 m/s)	4.0	1.3–12.3	0.01
Amplitude (thumb)	1.4	0.5–4.1	0.5
Amplitude (long finger)			
(Z-score > -1.64 , after correcting raw data for age)			
	1.6	0.5–4.9	0.4

Table 2—The probability (expressed as odds ratio with 95% confidence interval) for women ($n=53$) to achieve normal sensory function at 1 year compared with men ($n=18$). (Normal test results as in Table 1).

Factor	Odds ratio	95% CI	P-value
Subjective	1.2	0.4–3.8	0.8
2-PD	1.7	0.4–6.9	0.4
Semmes–Weinstein monofilaments	2.7	0.8–8.5	0.1
Tactilometry	1.3	0.4–4.3	0.6
Nerve conduction	6.3	1.5–26.8	0.01
Amplitude (thumb)	4.4	1.4–14.4	0.01
Amplitude (long finger)	11.9	1.4–100	0.02

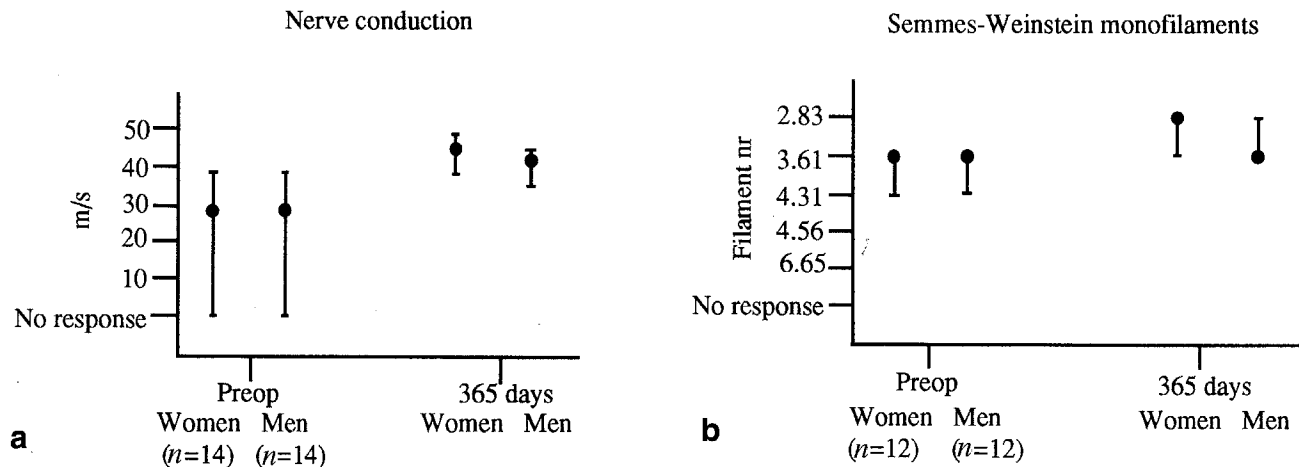


Fig 2 Results of (a) nerve conduction and (b) Semmes-Weinstein monofilament test 1 year after surgery in matched groups of men and women with identical preoperative findings. No significant differences between men and women were found. The values are given as median with interquartile range.

may reflect local demyelination and perhaps degeneration of nerve fibres (Lundborg and Dahlin, 1994), but with enough functioning axons to allow relief of numbness and normalization of 2-PD. The patients in this study had a great variation in preoperative neurophysiological results and the possibility of critical levels for sensory nerve conduction within the abnormal range should be further investigated.

The inferior outcome of surgical decompression in patients with constant preoperative symptoms may be explained by the more severe nerve lesion before treatment. Constant symptoms may reflect the presence of myelin changes and axonal degeneration, lesions that may require months or years to recover. Following axonal degeneration complete recovery may not even be possible (Lundborg and Dahlin, 1994).

Our results indicate that men have an inferior recovery from sensory disturbances after median nerve decompression. This could possibly be a result of a more severe trauma to the median nerve. Men are more often exposed to harder manual work such as repetitive and forceful gripping (Hagberg et al, 1992). CTS in males might also be related to other syndromes with a different pathophysiology (Pelmear and Taylor, 1994; Strömberg et al, 1996), such as HAVS (hand-arm-vibration syndrome) due to unconscious exposure to vibration during a long working life. When performing a matched analysis however, there were no significant differences between results from men and women at the 1 year follow-up. These results indicate that gender as such is not a prognostic factor for outcome after decompression in CTS.

The number of drop-outs at the 1 year follow-up might be a confounding factor for the results. Therefore statistical comparisons between the 31 drop-outs and the

69 patients that completed the study were performed. As the test results up to 84 days after surgery did not differ between the two groups of patients we assumed that the patients who completed the study were representative of all patients who initially took part in the study. However, other factors that may influence the outcome are the effects of surgical technique, occupational and leisure activities and working conditions as well as the duration of symptoms and the age of the patient.

The poorer outcome in patients with constant preoperative symptoms and in men after surgical decompression is an argument for early intervention by prevention and treatment of CTS before constant sensory disturbances are established.

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