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INCIDENCE AND NATURAL HISTORY OF TOUCH ALLODYNIA AFTER OPEN CARPAL TUNNEL RELEASE

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Abstract. Open surgical decompression is believed to be a safe treatment with few complications. However, it was our subjective impression that its morbidity had been underestimated. Fifty one consecutive patients with carpal tunnel syndrome were evaluated prospectively for three years after operation. Twenty one patients (41%) experienced allodynia of the operated hand at one month after surgery, 13 (25%) at three months, and three (6%) at 12 months. These were confirmed by significantly lowered pressure-pain thresholds over both the thenar and hypothenar eminences ($p < 0.005$). During the first month after operation all patients were relieved of nocturnal pain, and all clinical signs had disappeared at three months in all 51 patients. Our results confirm that open carpal tunnel decompression has a high success rate, but highlights a previously underestimated morbidity of postoperative allodynia.

Key words: carpal tunnel syndrome, open decompression, postoperative allodynia.

Pain after injuries to the upper extremities is a serious therapeutic problem and often causes a lot of discomfort (20). It is not known why lesions to the upper extremities, and in particular the hands, often result in prolonged pain which sometimes becomes permanent. Few experimental studies on post-traumatic pain of the human hand have been reported, though several have been conducted in animals (1, 8, 10, 12, 18).

Carpal tunnel syndrome is the most common peripheral entrapment neuropathy with an incidence of 1%–2% (9, 17). Open surgical treatment of entrapment neuropathy of the median nerve by division of the carpal ligament is one of the most common operations done on human hands (6, 14). The technique is standardised (6), excellent results have been reported, and complications are thought to be few and rare (3). However, in our practice we had developed an increasing suspicion that the procedure might have a higher morbidity than previously thought, and we knew of no other study that had evaluated the incidence and the natural history of post-traumatic allodynia after a sharp lesion to a human hand. The purpose of this study was therefore to evaluate patients who had had the carpal ligament released for carpal tunnel syndrome and follow them up for three years with measurements of touch allodynia over the thenar and the hypothenar eminences.

METHODS

This study was approved by the ethics committee for human research at the University Hospital of Linköping, and informed consent was obtained from each patient.

Criteria for inclusion in the study

The diagnosis of carpal tunnel syndrome was made on the basis of pain, numbness, paraesthesiae, and weakness in the distribution of the median nerve at the wrist (3). The Tinel and Phalen provocative test was used in the diagnosis (7). When the clinical diagnosis was doubtful electrophysiological confirmation as described by Stevens was used (16). Patients with other neurological or degenerative diseases were excluded from the study.

During a three month period 1990/91, 51 patients were included in the study. There were 23 men and 28 women, and their ages ranged from 23 to 77 years. Twenty normal controls, 10 of each sex, served as reference. Their ages ranged from 20 to 62 years.

Assessment of touch allodynia

Subjective. A questionnaire was used to evaluate the patients' perception of allodynia after surgery (yes/no).

Objective. The method for measuring touch allodynia in this study was based on the definition of touch

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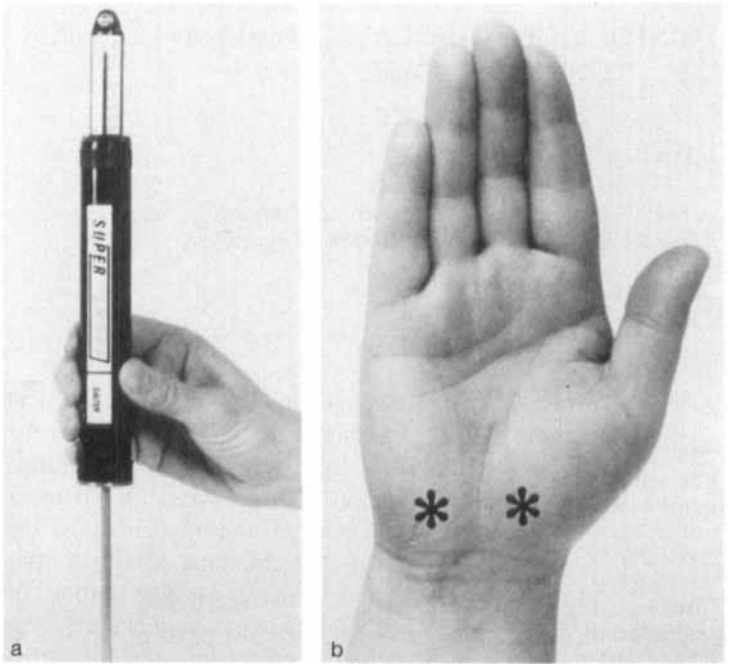

Fig. 1. (*a*) The featherweight instrument used for measurement of pain thresholds, and (*b*) the location of the two test points in the palm of the hand, one on the thenar eminence and one on the hypothenar eminence, marked by a *.

allodynia, in which a stimuli that normally did not cause pain now did, according to the International Association for the Study of Pain (13). In this study it was done by creating a reference series from 20 normal control subjects who were measured for pressures that generated a pain level 5 on a scale 0–10, with 10 being unbearable. Semmes-Weinstein monofilaments are normally used for measurements of perceived mechanical stimulation (2). However, the steps between the pressure generated by different monofilaments are logarithmic, which makes direct comparisons difficult. Furthermore, the pressure generated changes with the state of the hairs (4). As we wanted to test gradual changes in touch allodynia in this study, a new instrument was constructed (Fig. 1*a*). It is a featherweight instrument with a flat, rounded foot plate (diameter 7 mm). This flat knob is pressed against the point of interest, and the pressure generated is directly recorded from the scale which ranges from 0–50 N (0 to 500 g). Our instrument can measure a linear change, and do so at higher thresholds than the monofilaments.

Two test points were chosen, one on the thenar eminence and one on the hypothenar eminence (Fig. 1*b*). The flat knob of the instrument was pressed against these points, three times in each place with a resting period of 30 seconds. With an increasing pressure starting from 0 g, the patient was instructed to indicate when the pain reached a value of 5 on a scale from 0–10, with 10 being unbearable. In this way the lowest pressure which initiated pain over the thenar and hypothenar eminences was recorded. The mean value of the three measurements was used for further evaluation. The results were compared statistically using a software computer package (InStat™ 2.02A, GraphPad Software, USA) with the Wilcoxon test, a non-parametric test which makes no assumption of the scatter of the data. A probability of less than 0.005 was accepted as significant.

RESULTS

General

All 51 patients completed the study. At the one

Table I. *Incidence of subjective allodynia after open carpal tunnel release in 51 patients*

Subjective allodynia	Thenar eminence	Hypothenar eminence
At one month		
Yes	21	21
No	30	30
At three months		
Yes	13	13
No	38	38
At 12 months		
Yes	3	3
No	48	48
At three years		
Yes	3	3
No	48	48

Table II. *Mean (SD) thresholds (N) in the "Yes" and "No" groups of patients with subjective allodynia after operation from Table I (1N = 100 g)*

Time of measurement	Thenar eminence	*p* value*	Hypothenar eminence	*p* value*
At one month				
"Yes" group	12 (9.8)	0.001	9 (4.0)	0.001
"No" group	28 (10.3)	0.001	28 (10.3)	0.002
At three months				
"Yes" group	16 (8.3)	0.001	16 (7.1)	0.001
"No" group	24 (10.0)	0.001	24 (11.0)	0.002
At 12 months				
"Yes" group	18 (3.9)	0.001	17 (2.5)	0.001
"No" group	35 (8.1)	0.3	35 (6.3)	0.4
At three years				
"Yes" group	32 (11.3)	0.5	32 (11.7)	0.8
"No" group	33 (9.4)	0.2	33 (7.9)	0.2
Control values	39 (2.2)		38 (3.7)	

month follow up all patients where free from nocturnal pain and at three months all patients were free from clinical signs of median nerve entrapment, indicating a success rate of 100%.

Touch allodynia

Patients with subjective postoperative touch allodynia are shown in Table I. Measurements of pain-generating pressures and *p* values of the statistical analysis between the control group and the patients operated on are shown in Table II.

DISCUSSION

Postoperative touch allodynia outside the surgical area was described as disturbing by 41% of the patients one month after operation and by a quarter three months after operation (Table I). Interestingly, significantly lowered touch thresholds ($p = 0.001$, Table II) were found both in the thenar and hypothenar area not only by those in the group who expressed discomfort but also by those in the group who had no subjective discomfort. It is likely that the impression of discomfort by the individual patient was related to the specific demands on the operated hand and the patients' ability to adapt to the allodynia. This observation underlines the importance of objective measurements of pain thresholds compared with questionnaires for the evaluation of allodynia.

In three of the 51 cases, discomforting allodynia and significantly ($p = 0.001$) lowered touch thresholds were present one year after operation over both the thenar and hypothenar regions. At three years after the operation, the patients still experienced discomfort although the thresholds were no longer significantly lowered. None of these patients had signs of injured peripheral nerves which could have led to formation of a painful neurone, nor were any other complications recorded for these patients. It is therefore of interest to discuss why such prolonged allodynia can develop, as this has attracted little attention in published reports about the outcome after open treatment of carpal tunnel syndrome. While primary hyperalgesia (in the area of tissue damage) is thought to be caused by peripheral sensitisation of nociceptive endings (15), mechanisms underlying secondary hyperalgesia or pain outside the zone of injury (as seen by the allodynia over the eminences in this study) are less certain (11). Animal and human experimental studies using chemical dermal pain inductors have indicated that the secondary hyperalgesia is best explained by reversible changes in the central processing of low threshold mechanoreceptive input (1, 8, 10, 12, 18). These studies, however, are all based on

minor pain initiating injury from which the patient was freed after a few hours, and secondary hyperalgesia rarely lasted more than an hour. Other studies have evaluated patients with hand amputations or "pure" nerve injuries, long after the initial injury (5, 19). Allodynia in the intermediate period as described in this study has not previously been reported.

Before operation none of the patients had allodynia over or around the area to be incised, and after the operation the wound was protected from pressure by a bulky soft dressing and plaster of Paris cast for two weeks. When the dressings were removed all wounds had healed well with no signs of infection or haematoma then or later. To ensure relief of primary touch allodynia, the patients were not tested mechanically for another two weeks. At one month after operation none of the patients complained of unprovoked pain in the scar or the palm in general. All patients were free of nocturnal pain and 92% were free from all signs of median nerve entrapment. However, 41% expressed "soreness" in their hands and both the groups had significantly decreased mechanoreceptor-pain thresholds over both the thenar and the hypothenar eminences compared with the control series ($p = 0.001$, Table II). None of the patients had loss of sensation or other signs of peripheral nerve injury. The high incidence of post-traumatic allodynia is surprising as we are not aware of any previous reports on this subject after open treatment of carpal tunnel syndrome. However, as the touch allodynia reported by all our patients developed in regions innervated by the median and ulnar nerves, we do not think that the development of the allodynia was related to the preceding median nerve entrapment; none of these patients had touch allodynia before operation.

Previous human studies on low-threshold mechanoreceptor allodynia after injections of capsaicin intradermally, showed an incidence of allodynia of 100% after 15 minutes, which reduced to 0 after two hours (18). It is therefore possible that the incidence found by us one month after operation may be even higher nearer the time of decompression. Future studies may elucidate this question. As touch allodynia after chemical tissue damage by injection of capsaicin intradermally has disappeared after a few hours, it is suggested that the persistence of post-traumatic touch allodynia is related to the extent of initial tissue damage. This may explain why in our study we found allodynia in areas innervated by both the median and ulnar nerves and supports the view that the allodynia was not caused by the decompression of the median nerve. Three months after operation all patients were free of signs of carpal tunnel syndrome, but a quarter had persistent subjective discomfort over both the thenar and the hypothenar eminences. The mean thresholds had increased but they were significantly lower in both groups compared with the controls ($p = 0.002$, Table II). None of the previous studies on traumatic touch allodynia have evaluated the hands of patients earlier than six months after the initial injury (5).

Twelve months after operation, three patients (6%) still had discomfort and significantly abnormally low mechanoreceptor-pain thresholds over both the thenar and the hypothenar eminences compared with controls ($p = 0.001$, Table II); however, at three years the thresholds had returned to the normal range. Our results after this reproducible injury to the hand that did not damage nerves, confirm those of previous studies of touch allodynia after chemical tissue damage; after both injuries the lowered thresholds increase and return to the normal range with time (18). It therefore seems reasonable to suggest that the touch allodynia observed after open median nerve decompression may be explained by reversible changes in the central processing of the low threshold mechanoreceptive input from the skin (1, 8, 10–12, 18). Our results differ from those after injuries to larger nerve structures where thresholds for vibration-generating pain stay permanently below the normal range (19).

The key findings in the present study were that open division of the carpal ligament and the overlying skin causes touch allodynia in the whole group of patients and discomfort in 41% of these one month after operation. A quarter of all patients operated on had persistent discomfort more than three months after operation and 6% developed discomfort for more than one year. We think that the discomfort of the

allodynia is related to the physical demands on the operated hand, as the whole group of patients operated on had significantly lowered touch thresholds more than three month afterwards. These findings emphasise the possible value of first attempting conservative treatment of patients with carpal tunnel syndrome before operating on them. Future studies may show whether an endoscopic method may prevent the significant lowering of the touch thresholds after operation.

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