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Anatomic Distribution of Sensory Symptoms in the Hand and Their Relation to Neck Pain, Psychosocial Variables, and Occupational Activities

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To explore whether different distributions of numbness and tingling in the hand can be usefully distinguished in epidemiologic studies of disorders such as carpal tunnel syndrome, the authors used a postal questionnaire, an interview, and a physical examination to collect information about risk factors, symptoms, and signs from a general population sample of 2,142 adults in Southampton, England, during 1998–2000. The authors distinguished six distributions of numbness and tingling and compared their associations with other clinical findings and with known risk factors for upper limb disorders. Distinctive relations were found for symptoms that involved most of the palmar surface of the first three digits but not the dorsum of the hand or the little finger. Such symptoms were more often associated with positive Phalen's and Tinel's tests and, unlike other categories of sensory disturbance, were not related to neck pain or restriction of neck movement. They also differed in showing no association with lower vitality or poorer mental health but an association with repeated wrist and finger movements at work. These findings suggest that, in the classification of numbness and tingling of the hand, it may be useful to distinguish symptoms that involve most of the sensory distribution of the median nerve but not other parts of the hand.

carpal tunnel syndrome; diagnosis; paresthesia

Numbness or tingling in the hand is a common symptom. Often it is thought to result from impingement of one or more nerve roots in the neck as a consequence of cervical spondylosis. However, it can also arise from peripheral neuropathies, including nerve entrapment at various sites in the arm. In particular, sensory symptoms in the hand are an important feature of carpal tunnel syndrome, which is caused by compression of the median nerve in the carpal tunnel at the wrist.

In theory, the anatomic distribution of numbness and tingling in the hand should provide a useful pointer to the underlying pathology. For example, symptoms associated with carpal tunnel syndrome would be expected to occur in the sensory distribution of the median nerve (i.e., on the palmar surfaces of the thumb, index finger, middle finger and medial part of the ring finger, and in the medial palm). In practice, however, the distinction may not be clear-cut. Thus, sensory disturbance that is limited to the palmar surface of the index finger might be attributable to either carpal tunnel syndrome or impingement of the C7 nerve root. Moreover, recall of the exact distribution of symptoms may not always be reliable.

Despite these limitations, if the reported anatomic pattern of numbness and tingling discriminates sufficiently between two or more underlying pathologies in the neck or arm, this could be useful in the design of epidemiologic surveys. For example, the distribution of symptoms might be used as a criterion in the selection of subsets of subjects for clinical investigations, such as nerve conduction studies, where these were not practical in a full study sample.

To explore the potential for such discrimination, we have examined the patterns of numbness and tingling in the hand that were reported in a survey of adults from the general population and compared their associations with neck pain, psychosocial variables, and occupational activities.

MATERIALS AND METHODS

During 1998–2000, a postal questionnaire was mailed to all but 156 of the 9,852 men and women aged 25–64 years who were registered with two general practices in Southampton, England. The 156 were excluded because their doctors considered that approach would be inappropriate or distressing (e.g., because of ongoing illness or

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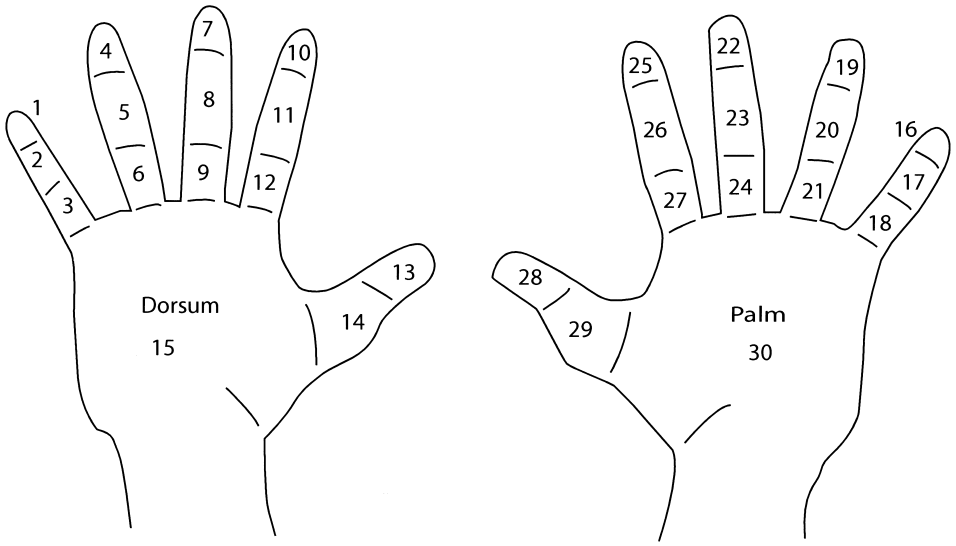

FIGURE 1. Anatomic distribution of numbness and tingling in the hand: classification in cross-sectional survey, Southampton, England, 1998–2000. The occurrence of numbness and/or tingling during the past 7 days was determined for each of the 30 numbered regions in the diagram. The pattern of symptoms in each hand was then classified according to the regions that were symptomatic: median, any of regions 22–29 ± any of regions 19–21 or region 30 but no others; nonmedian, any of regions 1–18 but no others; all fingers, all of regions 1–12 and 16–27 ± others; mixed, other combinations of regions.

recent bereavement). In Britain, virtually everyone is registered with a National Health Service general practitioner, and practice lists therefore provide a good sampling frame for the general population.

Among other things, the questionnaire asked about demographic details, physical activities in the subject's current job, and the occurrence of pain in the neck or arm and of numbness or tingling in the hand during the past 7 days. It also included sections from the Medical Outcomes Study 36-item Short-Form Health Survey (SF-36) relating to vitality and mental health (1).

Completed questionnaires were returned by 6,038 (62 percent) of the subjects mailed, of whom 3,152 (52 percent) reported pain or sensory symptoms in the arm or neck. Subsequently, all of the symptomatic responders were invited to undergo interview and physical examination, together with a random sample of 489 men and women who had no symptoms. In total, 2,145 (59 percent) agreed (1,960 (62 percent) of those with symptoms and 185 (38 percent) of those who were asymptomatic).

The interviews and examinations were carried out by four trained research nurses and a research physiotherapist, at a median interval of 37 days (range, 0–398 days; 90 percent within 108 days) after return of the initial questionnaire. At the interview, subjects were again asked about recent symptoms in their neck and arm. In particular, a note was made of whether, during the past 7 days, they had experienced numbness or tingling, lasting at least 3 minutes, in any of the regions of the hand depicted in figure 1.

The physical examination followed a standardized protocol and included, among many other components, the performance of Tinel's and Phalen's tests in each hand and assessment of the range of active movement in the neck. Tinel's and Phalen's tests are often used by clinicians in the diagnosis of carpal tunnel syndrome. Tinel's test entails percussing with a tendon hammer over the flexor retinaculum at the wrist. In Phalen's test, the subject is asked to rest both elbows on a table, with forearms vertical, and allow the hands to assume a posture of marked wrist flexion, maintained for a minute. The tests were counted as positive if they provoked pain or sensory symptoms in the thumb, index finger, middle finger, or medial palmar surface of the hand. Neck movements were measured in three planes—rotation with a modified neck goniometer and flexion/extension and lateral flexion with a plurimeter.

Statistical analysis was based on 854 men and 1,288 women (three subjects were excluded because of missing information on the distribution of numbness and tingling in the hands). Symptoms were classified according to the history elicited at interview (by the time of interview, 606 subjects who reported symptoms in response to the postal questionnaire had become asymptomatic, and 27 who previously were symptom free had developed symptoms), and the algorithm described in figure 1 was used to distinguish different anatomic patterns of numbness and tingling in the hands. Mental health, vitality, and occupational activities were derived from the postal questionnaire. Associations between hand symptoms and other variables were examined by log-logistic regression and summarized by prevalence ratios with 95 percent confidence intervals.

Ethical approval for the study was obtained from the Southampton and Southwest Hampshire Research Ethics Committee.

RESULTS

The median age of the 2,142 participants when they were examined was 49.2 years (interquartile range, 39.6–56.8

TABLE 1. Frequency and interrelation of patterns of numbness and/or tingling in the right and left hands, Southampton, England, 1998–2000

Distribution in the left hand	Distribution in the right hand						Total
	Extensive median	Limited median	Nonmedian	All fingers	Mixed	No numbness or tingling	
Extensive median	9	1	0	1	1	6	18
Limited median	0	11	0	0	2	14	27
Nonmedian	1	0	46	1	3	47	98
All fingers	1	0	2	92	6	30	131
Mixed	0	2	2	5	146	47	202
No numbness or tingling	5	17	44	29	79	1,492	1,666
Total	16	31	94	128	237	1,636	2,142

years). A total of 993 were in nonmanual occupations, 569 held manual jobs, and 533 were not currently employed. The remaining 27 subjects were in paid work, but their occupations could not be classified.

At the time of interview and examination, numbness or tingling was reported to have occurred during the past 7 days in 982 of 4,284 hands. These included 92 hands in which the symptoms were restricted to the median nerve distribution, and within this subset, the extent to which the palmar surfaces of the thumb, index finger, and middle finger were involved showed a distinctive pattern. Most often, symptoms affected from one to three of regions 22–29 in figure 1 (52 hands) or 6–8 regions (34 hands). Therefore, in subsequent analyses, a distinction was drawn between "extensive median" symptoms that involved at least six of regions 22–29 and "limited median" symptoms that were confined to between one and five of these regions.

Table 1 summarizes the frequency with which different anatomic distributions of numbness and tingling were reported in each hand. Overall, the most common patterns were "mixed" (10.2 percent of hands) and "all fingers" (6.0 percent). In comparison, extensive median symptoms were rare (0.8 percent). Both Phalen's and Tinel's tests were positive most often in hands with extensive median symptoms (59 percent and 18 percent, respectively), whereas the prevalence of positive tests in hands with limited median symptoms (29 percent and 7 percent) was lower than in hands with numbness or tingling in other distributions (i.e., nonmedian, all fingers, and mixed) (36 percent and 10 percent).

Among the 2,142 subjects who underwent examination, 318 reported symptoms in only one hand. Where both hands were symptomatic (332 subjects), the pattern of involvement on each side was usually the same (304 subjects, 92 percent). On the basis of their symptoms in each hand, subjects were classified as described in table 2. Within the study sample, the prevalence of specific anatomic patterns of numbness and tingling was generally similar in men and women, although, if anything, symptoms in a median distribution tended to be more common among men (data not shown). The prevalence of all patterns of symptoms increased with age, apart from "nonmedian in both hands or nonmedian in one hand with no numbness or tingling in the other."

Table 3 shows the frequency of recent neck pain and of neck pain with restriction of neck movement, according to

TABLE 2. Classification of subjects according to anatomic distribution of numbness and tingling in the hands, Southampton, England, 1998–2000

Distribution of numbness and/or tingling	<45 years		≥45 years		All ages	
	No.	%	No.	%	No.	%
Extensive median in one or both hands	6	0.7	19	1.4	25	1.2
Limited median in one or both hands but no extensive median	8	1.0	38	2.9	46	2.1
Nonmedian in both hands or nonmedian in one hand and no numbness or tingling in the other	55	6.8	82	6.2	137	6.4
All fingers in both hands	25	3.1	67	5.0	92	4.3
All fingers in one hand and no numbness or tingling in the other	18	2.1	41	3.1	59	2.8
Other patterns of numbness or tingling	93	11.4	198	14.9	291	13.6
No numbness or tingling in either hand	608	74.8	884	66.5	1,492	69.7
Total	813	100.0	1,329	100.0	2,142	100.0

TABLE 3. Prevalence of neck pain and of neck pain with restricted neck movement according to the anatomic distribution of numbness and tingling in the hands, Southampton, England, 1998–2000*

Distribution of numbness and/or tingling	Neck pain† (*n* = 580; 27%)			Neck pain with restricted neck movement‡ (*n* = 108; 5%)		
	Prevalence (%)	PR§	95% CI§	Prevalence (%)	PR	95% CI
Extensive median in one or both hands (*n* = 25)	24.0	1.1	0.5, 2.1	4.0	1.4	0.2, 9.5
Limited median in one or both hands but no extensive median (*n* = 46)	28.3	1.2	0.8, 1.9	10.9	3.7	1.5, 8.9
Nonmedian in both hands or nonmedian in one hand and no numbness or tingling in the other (*n* = 137)	33.6	1.4	1.1, 1.8	9.5	3.2	1.8, 5.7
All fingers in both hands (*n* = 92)	34.8	1.4	1.0, 1.9	15.2	4.9	2.8, 8.6
All fingers in one hand and no numbness or tingling in the other (*n* = 59)	40.7	1.7	1.2, 2.9	8.5	2.8	1.2, 6.8
Other patterns of numbness or tingling (*n* = 291)	36.1	1.5	1.3, 1.8	8.6	2.8	1.7, 4.6
No numbness or tingling in either hand (*n* = 1,492)	23.7	1		3.0	1	

* The prevalence ratios are derived from two separate log-logistic regression models, one with neck pain as the dependent variable and one based on neck pain with restricted neck movement. In each model, the distribution of numbness/tingling was included as a categorical variable taking seven distinct values. "No numbness or tingling in either hand" was used as the reference category.

† Neck pain in the past 7 days.

‡ Neck pain in the past 7 days and an age- and sex-adjusted *z* score of <2 for any of right rotation, left rotation, flexion, extension, right lateral flexion, or left lateral flexion.

§ PR, prevalence ratio adjusted for age (in 10-year strata) and sex; CI, confidence interval.

the pattern of sensory symptoms in the hands. Neck pain was reported most frequently by subjects with involvement of all the fingers of one hand and was generally more common in those with hand symptoms. However, the 25 men and women with extensive median symptoms in one or both hands, among whom the prevalence of neck pain was similar to that in subjects with no numbness or tingling in either hand, were an exception to this. For neck pain with restriction of neck movement, the contrast between extensive median symptoms and other patterns of numbness or tingling was even more striking. The association with extensive median symptoms was weak (prevalence ratio = 1.4, 95 percent confidence interval: 0.2, 9.5), whereas the prevalence ratios for the other anatomic distributions ranged from 2.8 to 4.9, and all but one had a lower 95 percent confidence limit of at least 1.5.

Table 4 summarizes the association of different patterns of hand symptoms with measures of vitality and mental health from the SF-36 questionnaire. For this analysis, each measure was classified to three levels, with approximately equal numbers of subjects in each level. Among subjects with extensive median symptoms in one or both hands, scores on both measures were similar to those in asymptomatic subjects, whereas those with other patterns of numbness and tingling tended to be classified as having lower vitality and poorer mental health.

Table 5 shows the relation of symptoms in the hand to occupational physical activities. This analysis was restricted to the 1,589 subjects who were in paid work at the time of the survey. None of the symptom patterns was associated with prolonged use of keyboards, but the prevalence of extensive median symptoms was significantly elevated in subjects who reported repeated finger or wrist movements, bending and straightening of the elbow, and carrying weights of at least 5 kg in one hand. No comparable associations were found for other anatomic distributions of numbness and tingling. When risk estimates for the four activities in table 5 were mutually adjusted in a single regression model, they all moved toward unity, and none was statistically significant (prevalence ratios of 0.9 for the use of keyboards, 1.4 for repeated finger or wrist movements, 2.1 for bending and straightening the elbow, and 2.2 for carrying weights in one hand).

DISCUSSION

Our findings suggest that, in classifying numbness and tingling in the hand, it is helpful to distinguish symptoms that involve most of the sensory distribution of the median nerve but not other parts of the hand. Unlike other anatomic distributions of sensory disturbance, extensive median symptoms of this sort were not related to neck pain or restriction of neck movement, as would be expected if they commonly arose from cervical spondylosis or other pathology in the neck. In addition, in contrast to other patterns of sensory symptoms, they were not associated with lower vitality and poorer mental health, although they were more common among subjects who carried out repeated movements of their wrists or fingers for a substantial part of their working day.

The phased approach that we adopted to data collection meant that subjects could be lost from the investigation at two stages. However, we think that the incomplete response is unlikely to have been a major source of bias in relation to the associations that we examined. For example, even if symptomatic subjects responded more readily than those without symptoms, as is plausible, this would not bias comparisons between different patterns of numbness and

TABLE 4. Association of numbness and tingling in the hands with measures of vitality and mental health, Southampton, England, 1998–2000*

Distribution of numbness and/or tingling	Vitality				Mental health			
	Medium (n = 700)		Low (n = 576)		Medium (n = 685)		Poor (n = 653)	
	PR†,‡	95% CI†	PR‡	95% CI	PR§	95% CI	PR§	95% CI
Extensive median in one or both hands (n = 25)	0.5	0.2, 1.4	0.8	0.3, 2.1	1.1	0.4, 2.9	1.1	0.4, 3.0
Limited median in one or both hands but no extensive median (n = 46)	1.7	0.8, 3.2	1.2	0.6, 2.7	1.2	0.5, 2.7	2.2	1.1, 4.6
Nonmedian in both hands or nonmedian in one hand and no numbness or tingling in the other (n = 137)	1.3	0.8, 1.9	1.9	1.3, 2.8	1.1	0.7, 1.7	1.3	0.9, 2.0
All fingers in both hands (n = 92)	2.3	1.3, 3.9	2.5	1.4, 4.3	1.6	0.9, 2.8	2.2	1.3, 3.7
All fingers in one hand and no numbness or tingling in the other (n = 59)	1.1	0.6, 2.1	1.6	0.8, 2.9	2.0	1.0, 4.0	2.1	1.1, 4.3
Other patterns of numbness or tingling (n = 291)	1.1	0.8, 1.4	1.3	1.0, 1.7	1.1	0.9, 1.5	1.1	0.8, 1.4
No numbness or tingling in either hand (n = 1,492)	1		1		1		1	

* The prevalence ratios are derived from 12 separate log-logistic models, two for each distribution of numbness/tingling. The distribution of numbness/tingling was treated as the dependent variable, and vitality and mental health were examined separately, each being treated as a categorical variable with three levels.

† PR, prevalence ratio; CI, confidence interval.

‡ Prevalence ratio in comparison with high vitality, adjusted for age (in 10-year strata) and sex.

§ Prevalence ratio in comparison with good mental health, adjusted for age (in 10-year strata) and sex.

tingling in the hand unless there was differential overrepresentation of people with a specific distribution of sensory disturbance in combination with an associated symptom, physical sign, or risk factor.

A more likely source of error was inaccuracy in the reporting of symptoms. Even when recall is only over a maximum of 7 days, it may be difficult to remember exactly which parts of the hands have been affected by numbness and tingling. In general, any resulting misclassification of symptoms would be expected to blur distinctions between different patterns of anatomic involvement.

Perhaps the most common cause of persistent numbness and tingling of the hand in the general population is compression of cervical nerve roots as a consequence of cervical spondylosis. In support of this, we found that sensory disturbance in the hand was associated with neck pain, particularly if there was also restriction of neck movements (table 3). It is notable, however, that these associations

TABLE 5. Association of numbness and tingling in the hands with occupational activities, Southampton, England, 1998–2000*

Distribution of numbness and/or tingling	Activities performed in an average workday							
	Use of a keyboard for >4 hours (n = 360)		Repeated finger or wrist movements for >4 hours (n = 556)		Bending and straightening the elbow for >1 hour (n = 823)		Carrying weights of ≥5 kg in one hand (n = 569)	
	PR†	95% CI†	PR	95% CI	PR	95% CI	PR	95% CI
Extensive median in one or both hands (n = 18)	0.6	0.1, 2.5	2.6	1.0, 6.8	3.1	1.0, 9.5	2.8	1.0, 8.1
Limited median in one or both hands but no extensive median (n = 32)	1.1	0.5, 2.6	1.2	0.6, 2.4	1.1	0.6, 2.3	1.0	0.5, 2.3
Nonmedian in both hands or nonmedian in one hand and no numbness or tingling in the other (n = 87)	0.8	0.4, 1.3	1.4	0.9, 2.1	1.3	0.9, 2.0	1.4	0.9, 2.1
All fingers in both hands (n = 63)	1.2	0.7, 2.1	1.4	0.8, 2.2	1.3	0.8, 2.1	1.3	0.7, 2.2
All fingers in one hand and no numbness or tingling in the other (n = 43)	0.6	0.2, 1.4	1.1	0.6, 2.0	1.4	0.8, 2.5	1.2	0.6, 2.2
Other patterns of numbness or tingling (n = 214)	0.9	0.6, 1.2	1.3	1.0, 1.6	1.2	1.0, 1.6	1.3	1.0, 1.7
No numbness or tingling in either hand (n = 1,132)	1		1		1		1	

* Analysis was restricted to the 1,589 subjects who were in paid work at the time of the survey. The prevalence ratios are derived from 24 separate log-logistic regression models, four for each distribution of numbness/tingling. The distribution of numbness/tingling was treated as the dependent variable.

† PR, prevalence ratio in comparison with those not performing the activity, adjusted for age (in 10-year strata) and sex; CI, confidence interval.

did not extend to numbness and tingling with an extensive median distribution, which suggests that this specific pattern of sensory symptoms does not commonly arise from pathology in the neck.

Also in contrast to other patterns of numbness and tingling, extensive median symptoms were not associated with low vitality or poorer mental health. That we found a relation of this sort with most categories of sensory disturbance is consistent with the findings of other investigations (2, 3). The association could have arisen, at least in part, because sensory symptoms cause psychologic distress. If this were the case, however, a stronger relation would have been expected for extensive than for limited median symptoms. Another possibility is that psychosocial influences predispose to the development, persistence, or awareness of some hand symptoms, as was indicated by a longitudinal study in which depression predicted the later occurrence of pain in the forearm (4). If so, the lack of association with extensive median symptoms would be consistent with their resulting from a distinct underlying pathology, median nerve compression at the wrist being the obvious candidate. We have previously observed that patients with hip osteoarthritis (which like carpal tunnel syndrome has a well-defined underlying pathology), although physically disabled, did not suffer from poorer mental health than did controls (5).

Different patterns of sensory symptoms in the hand also exhibited differential associations with physical activities (table 5). This analysis was based on a smaller sample size, being restricted to subjects who worked, and if some participants had left employment because of neck or upper limb disorders, then risks may have been underestimated. Furthermore, the assessment of exposure to activities was somewhat crude, and therefore the findings should not be taken to imply, for example, that prolonged use of a computer never causes upper limb disorders. Nevertheless, the distinctive associations with extensive median symptoms again point to a different disease process and, for the most part, would be compatible with underlying median nerve compression.

A causal role of physical activities in carpal tunnel syndrome, particularly forceful and repetitive movements of the wrist and hand, is widely accepted. For example, from a review of 15 cross-sectional studies and six case-control studies, Hagberg and Wegman (6) concluded that repetitive and forceful gripping was a major risk factor for occurrence of the syndrome, and when Silverstein et al. (7) classified the occupations of workers from seven different industries according to the degree of force and repetition required, they found that a combination of high force and high frequency carried an odds ratio of more than 15 for carpal tunnel syndrome in comparison with low force-low repetition jobs. Repeated movements of the elbow would not be expected to cause carpal tunnel syndrome, and the association that we found with extensive median symptoms may have resulted from confounding by other occupational activities.

Symptoms of numbness and tingling in the hands occur frequently in the general population (a point prevalence of 33 percent has been estimated in one British survey (8)), and several different symptom-based case definitions have been proposed previously to distinguish carpal tunnel syndrome from other patterns of complaint. Katz and Stirrat (9) defined symptoms as "classical" of carpal tunnel syndrome if they affected at least two of digits 1–3 but not the palm or dorsum of the hand, as "probable" if the palm was also involved, and as "possible" if symptoms were reported in only one of digits 1–3. Minor modifications to these criteria of Katz and Stirrat were later suggested by Franzblau et al. (10) and by Rempel et al. (11).

These proposals were framed on the basis of clinical consensus, rather than empirically by testing their association with expected clinical accompaniments of carpal tunnel syndrome. Subsequently, a classical distribution of symptoms as defined by Katz and Stirrat (9) was found to be sensitive and specific for delayed median nerve conduction in subjects with suspected carpal tunnel syndrome who had been referred for investigation in the hospital. However, the criteria did not predict delayed nerve conduction in community (8) or occupational (12) samples. A community survey by Ferry et al. (8) also explored the relation of delayed nerve conduction to various other symptom patterns, including hand symptoms that excluded the fifth digit, the dorsum, or both of these sites, but found the correlation to be similarly poor.

One possible explanation for these findings is that the criteria proposed were insufficiently specific in settings where the prevalence of median nerve compression was relatively low. Thus, in the definitions of "classical" and "probable" carpal tunnel syndrome according to the criteria of Katz and Stirrat (9), Franzblau et al. (10), and Rempel et al. (11), no attempt was made to exclude subjects who indicated symptoms in all of their digits; the criteria of Rempel et al. (11) do not seem to differentiate between palmar and dorsal involvement of digits 1–3; and in the survey by Ferry et al. (8), none among the several diagnostic categories defined required symptoms to be present in the palmar aspects of digits 1–3.

Our findings suggest that a further important determinant of specificity is the extent to which the palmar aspect of digits 1–3 is affected. Although Phalen's and Tinel's tests can by no means be regarded as accurate diagnostic markers for carpal tunnel syndrome, they do have limited diagnostic value, and it is notable that in hands with limited median symptoms these tests were positive less often than in those where numbness and tingling occurred in other anatomic distributions. Furthermore, the associations of limited median symptoms with psychosocial and physical risk factors did not resemble those for extensive median symptoms.

Our results suggest that, in classifying numbness and tingling in the hand, it may be useful to distinguish symptoms with an extensive median distribution from those with other anatomic patterns. A further test of this hypothesis would be to compare their correlations with nerve conduction measurements in a community setting.

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