Carpal tunnel syndrome: what is attributable to work? The Montreal study

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Abstract

Objective—To estimate the fraction of carpal tunnel syndrome (CTS) that is attributable to work in the total adult population of the island of Montreal.

Methods—The population consisted of 1.1 million people 20 to 64 years of age, with 73.2% of men and 60.6% of women employed. The rates of first surgery for CTS were compared between occupational groups and the total adult population with the standardised incidence ratio (SIR) method. Rates of surgery for the island of Montreal were obtained from the provincial data base of payments. The occupational history was obtained from telephone interviews of a sample of surgical cases. The attributable fractions in exposed people were calculated with odds ratios (ORs) obtained from logistic regressions with non-manual workers as the control group.

Results—The surgical incidence of CTS was 0.9/1000 adults. SIRs for all manual workers were 1.9 (95% confidence interval (95% CI) 1.4–2.5) in men and 1.8 (95% CI 1.4–2.2) in women, and the fractions attributable to work were 76% (95% CI 47–88) and 55% (95% CI 33–69), respectively. Seven occupational groups were identified as having excess risk of surgical CTS, with fractions attributable to occupation ranging from 75% to 99%.

Conclusion—Among manual workers on the island of Montreal, 55% of surgical CTS in women and 76% in men was attributable to work. Increased risk of surgical CTS was found in seven occupational groups.

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In a recent review of the scientific evidence linking carpal tunnel syndrome (CTS) and occupation, a panel of experts characterised the evidence as good.[1] The evaluation of the strength of the causal relation was based on the review of 11 epidemiological studies that consistently showed strong associations between occupational exposure and CTS with evidence of a temporal association. Uncertainty remains however, about the fraction of CTS that is attributable to work. Hagberg *et al* have calculated fractions attributable to exposure ranging from 50% to 90% from data pub-

lished in 13 epidemiological studies that reported an association between CTS and occupation. Those studies, however, were carried out in specific workplaces and were not representative of the total population of workers. We are not aware of any study that estimated the proportion of cases of CTS attributable to work in a general population. The objective of this study was to provide such an estimate for the total population on the island of Montreal, Canada and to identify occupations at risk.

Method

Standardised incidence ratios (SIRs) were computed with incident surgical procedures for CTS. Surgery was used because there is a provincial data base (Med-Echo) that records all surgical procedures that are charged to the Quebec Health Insurance Plan. All CTS surgeries put charges through to the Quebec Health Insurance Plan whether performed in public or private clinics. All Quebec residents are covered by the Quebec Health Insurance Plan independently of their employment. The definition of incidence was a first lifetime surgery for CTS. The Med-Echo data base allows computation of incidences for the total adult population of the island of Montreal by age and sex, but does not provide information on occupation. Therefore, a telephone survey was conducted among a prospective sample of patients operated on for CTS for the first time between June 1994 and July 1995.

Consecutive patients were recruited in Montreal from 20 plastic surgeons who agreed to participate in the study. The sites of their practices allowed for representation of all major geographic and socioeconomic regions on the island of Montreal. Inclusion criteria were: first lifetime surgery for CTS, age between 20 and 64 years and residence on the island of Montreal. Lists of all patients operated on by each surgeon in the 12 months of the study were sent to the researchers. Consent was obtained by telephone and followed by an interview with two trained interviewers, on average 2.7 (SD 1.6) months after surgery. The interview included questions on the medical and occupational histories at the time symptoms first started, the history since the beginning of symptoms, and the pain and functional state in the week before surgery. Our questionnaire was an adaptation of that proposed by Katz *et al*[3] and Levine *et al*.[4]

The SIRs were computed by dividing the number of observed cases in each occupational group in the sample interviewed by the number

of cases expected in that group, with the incidence of surgical CTS in the total population of Montreal island as reference (Med-Echo data base, 1993–4). Denominators by age, sex, and occupation were obtained from the Statistics Canada 1991 Canadian Census for the island of Montreal. The total population was 1.1 million, of which 73.2% of the men and 60.6% of women were employed. The SIRs were standardised for age and sex according to the method described in Fleiss[5] and 95% confidence intervals (95% CIs) were calculated by the square root method.[6] The Canadian standard occupational classification of 1981 was used.[7] A global SIR was computed for all manual workers, from a definition that has been validated in Quebec.[8] In brief, manual workers included blue collar workers and white collar workers who do manual work such as nurses, waitresses and bar staff, hairdressers, etc.

The attributable fraction in exposed people was computed for each occupation where the SIR reached significance.[9] Because SIRs represent risks relative to the entire population, which includes those occupationally exposed, they are inappropriate for the calculation of attributable fractions. For this purpose, and to more conveniently examine statistical interactions, we carried out logistic regression analyses of incident cases of CTS surgery, with non-manual workers as the comparison group. As CTS is rare, the Statistics Canada population figures could be considered equivalent to controls in a case-control study. As for the SIRs, the application of this method to a situation in which we had occupational information on only a sample of cases, relies on the assumption that interviewed cases are representative of all cases of surgical CTS. Age and sex were included in all analyses (see table 3). The attributable fractions represent the fraction of surgical CTS in a given occupation that is in excess (attributable) of that observed among all non-manual workers (the control group). Interactions between occupation and sex were found to be significant, so all results are presented separately for men and women.

Results

For the population as a whole, the annual incidence of surgical CTS was 0.9/1000 adults, which represented 969 cases (table 1). The male:female ratio was 1:3 and the highest rates were found in women over the age of 45. Between June 1994 and July 1995, 400 patients were identified by the 20 plastic surgeons participating in the study, and 355 (89%) could be reached by telephone. One patient refused to participate. Of those contacted, 238 patients met the inclusion criteria and were interviewed. Their distribution by age and sex (table 1) was identical to that of all surgical cases in the Quebec data base. The main reason for non-inclusion was age over 64.

Of the 238 patients interviewed, 224 (94%) reported having had at least one electrodiagnostic test and described a distribution of their symptoms in the first three digits and the palm of the hand. Half of the patients reported a

Table 1   Incidence of surgical carpal tunnel syndrome, island of Montreal adult population 20 to 64 years of age

	Incidence* (/1000)	Number interviewed n (%)
Total	0.9	238 (100)
Men	0.4	63 (27)
Age:		
20-34	0.2	9 (4)
35-44	0.4	19 (8)
45-54	0.7	21 (9)
55-64	0.9	14 (6)
Women	1.2	175 (74)
Age:		
20-34	0.3	14 (7)
35-44	1.2	46 (19)
45-54	2.4	59 (25)
55-64	2.2	53 (22)

* Incidence for island of Montreal from Med-Echo, the Quebec hospital discharge data base, including outpatient surgery, 12 month period 1993-4. Total number of first surgery for CTS = 969. Denominators from Statistics Canada, 1991 census.

duration of symptoms, at the time of surgery, of two years or more. Surgery was performed on the dominant hand in 154 (65%) of the patients. The symptoms in the week preceding the surgery were reported as being present every day in 85% and interfering with sleep for three nights or more in 71%. Functional limitations were reported as being severe for the following tasks: carrying grocery bags (51%); unscrewing the cap of a jar (43%); carrying a full cup (30%); writing (28%); and holding a telephone receiver (27%). Non-surgical treatments were received by 139 patients (58%) before the surgery. There were no differences in the intensity of symptoms or functional limitations reported in the week preceding surgery among age or occupational groups. A greater proportion of women than men reported the presence of very severe symptoms (33% *v* 18%, P=0.04). This is another reason that the results are presented separately for women and men.

Of all patients interviewed, 53% reported that when their symptoms first began, they had a job with physically demanding tasks for the hands and wrists, including use of force, vibrating hand held power tools, or exposure to cold. From the medical history, 40% reported the presence of a medical condition known to be associated with the development of CTS (present when the symptoms first started), the most frequent being diabetes (12%), thyroid disease (9%), a history of wrist fracture (8%), and pregnancy (5%).

Of the 238 patients interviewed, 74% were actively employed at the time symptoms first started (70% of women and 87% of men), and 53% were manual workers.

For all manual workers, the SIR was 1.8 (95% CI 1.4–2.2) in women and 1.9 (95% CI 1.4–2.5) in men, indicating an incidence almost twofold higher than in the total adult population (table 2). In specific occupational groups, housekeeping occupations had the highest risk and included commercial and domestic categories. Work on a data processer had the second highest risk, and was the only job category among all clerical occupations that showed an increased incidence. Workers at risk in the material handling occupations were those in the packaging subcategory. The food

Table 2 Standardised incidence ratios (SIR) * of incident surgical carpal tunnel syndrome by occupation†

	Women		Men	
Occupation	n	Observed SIR (95% CI)	n	Observed SIR (95% CI)
All manual workers‡	79	1.8 (1.4-2.2)	47	1.9 (1.4-2.5)
All non-manual workers	43	0.8 (0.6-1.1)	8	0.5 (0.2-0.9)
Not working	53	0.7 (0.5-0.9)	8	0.4 (0.2-0.8)
Specific manual workers categories:				
Housekeepers or cleaners	7	7.2 (2.8-13.4)	4	67.2 (17.3-148.0)
Data processing operators	5	3.1 (1.0-6.3)	2	11.2 (1.1-31.8)
Material handlers	6	6.0 (2.2-11.8)	4	5.5 (1.4-12.3)
Food and beverage:				
Processing	4	7.0 (1.8-15.3)	2	2.7 (0.3-7.8)
Service	7	3.6 (1.4-6.7)	1	3.0 (0.0-11.9)
Child care	4	3.9 (1.0-8.6)	0	—
Lorry and bus drivers	0	—	6	3.1 (1.1-6.1)
Hairdressers	4	3.0 (0.8-6.7)	1	4.2 (0.0-16.5)
Specialised educators	4	2.2 (0.6-4.8)	0	—
Manufacturing	9	1.2 (0.6-2.1)	6	1.6 (0.6-3.2)
Clerical occupations	30	1.0 (0.7-1.4)	5	1.3 (0.4-2.7)
Health care occupations	12	0.9 (0.4-1.4)	1	0.7 (0.0-2.8)
Construction workers	0	—	3	1.1 (0.1-2.8)

* SIR = standardised incidence ratio = number of observed cases of surgical CTS in interviewed patients divided by number expected from Montreal island adult population incidence. It represents the excess incidence in that occupation, compared with the total population.
† Occupations: categories from the Canadian standard occupational classification, 1980.
‡ Manual workers include blue collar workers and white collar workers with manual work—such as nurses, waitresses and bar staff, hairdressers, etc.[8]

Table 3 Attributable fraction in exposed people (AFE) for incidence of surgical carpal tunnel syndrome by occupation*

	Women		Men	
Occupation	OR† (95% CI)	AFE‡ (%) (95% CI)	OR† (95% CI)	AFE‡ (%) (95% CI)
All manual workers§	2.2 (1.5-3.2)	55 (33-69)	4.1 (1.9-8.6)	76 (47-88)
Housekeeping and cleaners	9.0 (4.0-20.1)	89 (75-95)	143.4 (42.3-485.3)	99 (98-100)
Data processing operators	4.0 (1.6-10.1)	75 (38-90)	29.5 (6.2-140.8)	97 (84-100)
Material handlers	7.5 (3.2-17.8)	87 (69-94)	12.3 (3.7-41.1)	92 (73-98)
Food and beverage:				
Processing	8.5 (3.0-23.9)	88 (67-96)	5.7 (1.2-27.0)	82 (17-96)
Service	4.6 (2.1-10.3)	78 (52-90)	7.9 (1.0-63.9)	87 (0-98)
Child care	5.0 (1.8-14.0)	80 (44-93)	—	—
Lorry and bus drivers	—	—	6.4 (2.2-18.6)	84 (55-95)

* Occupations: 3 and 4 digit categories from the Canadian standard occupational classification, 1980.
† Odds ratios obtained from multiple logistic regressions with surgery for carpal tunnel syndrome as the dependent variable and including age, sex, and occupation. The reference group included non-manual workers.
‡ AFE = attributable fraction in exposed people, represents the fraction of surgical CTS in each occupational group that is attributable to that occupation—that is, in excess compared with non-manual workers.
§ Manual workers include blue collar workers and white collar workers with manual work—such as nurses, waitresses, and bar staff, hairdressers, etc.[8]

and beverage sector was the most highly represented with increased incidence both in the processing and in the service occupations. Child care occupations and transportation operators showed a risk of borderline significance. Child care included home based day care service providers. Transportation operators were restricted almost exclusively to lorry drivers.

Increased but not significant SIRs were found among hair dressers and specialised educators for exceptional or handicapped students (table 2). No excess risk was found among manufacturing occupations which include sewing machine operators (a large sector in Montreal), clerical workers (other than data processing operators), health care occupations, and construction workers. Because this study was done in an urban environment, occupa-

tions in the primary industries (mining, fishing, forestry, and farming) were not represented.

Table 3 shows odds ratios (ORs) and their fractions attributable to occupations for all manual workers and each of the seven occupations with increased SIRs. Odds ratios were consistent with SIRs but slightly more increased because the comparison group consists of non-manual workers (OR) rather than the total population (SIR) which includes manual and non-manual workers as well as people not working. For all manual workers, the attributable fraction was 55% in women and 76% in men. In each specific occupational category, attributable fractions were all above 75% which indicates that 75% or more of surgical CTS in those occupations is attributable to work. The fractions attributable to occupation are slightly higher in men than in women except in the food and beverage processing occupations.

Discussion

Our annual surgical CTS incidence of 0.9/1000 and the sex distribution, were similar to those reported by Liss et al[10] in Ontario, Canada and Vessey et al[11] in the United Kingdom. The distribution of patients interviewed by age, sex, and geographical location where surgery was performed, was identical to that of all surgical cases of CTS on the island of Montreal. Only one patient refused to participate, so we are confident that the sample interviewed is representative of all surgical CTS. To our knowledge, no scientific data currently exist that find the proportion of surgical cases of CTS in the total cases of CTS. We suggest that it might be high because from the patient's point of view, surgery for CTS is an intervention that is readily available in Montreal, does not necessarily require a stay in hospital, and is completely covered by the provincial health insurance plan. From the medical point of view, there seems to be a consensus that CTS associated with severe symptoms and poor functional state is referred to a surgeon. In our population, 42% of the patients report having received no other form of treatment before surgery.

An important concern is potential referral bias. Rates of surgical CTS by occupation would be biased as estimators of underlying risk of CTS if physicians were more likely to refer patients in certain occupations for surgery or to refer them more quickly. We do not think that this played an important part in our study because the severity of symptoms and functional limitations in the week preceding surgery was comparable between workers and non-workers, and between manual and non-manual workers. Also, we found no difference in the delay between the onset of symptoms and surgery between occupations, age, or sex. Thus, the indications for surgery seemed to be comparable. Moreover, as CTS is seldom recognised by the Quebec Workers' Compensation Board, there is little incentive for workers to file a claim. In fact, the total number of claims for CTS for the whole province was only 348 in 1995, for a rate of 0.13 cases/1000

workers, which is one 10th of that found in the province of British Columbia where CTS is recognised as an occupational disease.

Our analyses were controlled for age and sex but not for other potential confounders that are associated with employment and occupational or non-occupational risk factors. Also, absence from the workplace due to CTS, did not play a part in underestimating the number of cases in this study, because subjects were recruited from the surgeons' offices, irrespective of their work status. The available sample size provided a power of 90% to detect SIRs ≥2.0 in occupational groups that constituted at least 5% of the workforce.[12] Large SIRs were found in smaller groups of workers but their 95% CIs were wider.

The food and beverage processing occupations have been found to be at risk of a high incidence of CTS in previous studies with scientific evidence of a strong association between CTS and occupation.[13-16] Other occupations identified at greater risk in our study that have been corroborated with less rigorous evidence include housekeeping,[17-22] data processing,[18] wrapping or packaging,[17] food and beverage service occupations,[23-18] and lorry driving.[24 25] The results obtained for child care occupations are surprising. Perhaps the number of providers of home based day care services may have been underestimated in the denominator (number of people who declared to the Canadian census to be working as providers of child care) and thus, overestimating the SIR.

By estimating denominators we were able to compare rates of occurrence of disease, not just absolute numbers of cases. Studies that reported only numbers of cases by occupation cannot identify workers at greater risk.[24] For example, in our study, clerical workers (except operators of data processing equipment), healthcare workers, and manufacturing occupations represented 32% of all cases of surgical CTS among those who had a job when symptoms first started. However, the incidences of surgical CTS found in those occupations were no greater than those for the total population.

Other studies have described the potential contribution of work related and personal medical factors to the development of CTS. The Centers for Disease Control[26] and Miller *et al*[27] reported respectively that 47% and 43% of workers diagnosed with CTS were exposed to at least one risk factor at work, findings similar to ours (53%). Stevens *et al*[28] reported that 57% of patients with CTS diagnosed at the Mayo Clinic, had one of the medical conditions known to be associated with the development of CTS, which is higher than in our study population (40%), but the patients at the Mayo Clinic were probably a selected group. These proportions, however, are not mutually exclusive.

Hagberg *et al*[29] calculated attributable fractions from relative risks published in 13 epidemiological studies that used a control group. The range of attributable fraction in those studies ranged between 50% and 90% of CTS that could be attributable to work. Those high numbers reflect the selection criteria used in the studies, which attempted to maximise the

contrast between the exposed and non-exposed groups. Our calculation of attributable fraction in the seven occupations that showed an increased SIR, resulted in similarly increased values (75% to 100%). These findings support the idea that occupational risk factors for CTS are concentrated in specific occupations. An important contribution of our study was the estimation of an attributable fraction for all occupations in which manual work is involved, in a population defined by a geographical territory without restriction on work or compensation.

Conclusion

Among manual workers on the island of Montreal, 55% of surgical CTS in women and 76% in men was attributable to work. Increased risk of surgical CTS was found in seven occupational groups.

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