

Chronic neck pain and whiplash: A case-control study of the relationship between acute whiplash injuries and chronic neck pain

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The authors undertook a case-control study of chronic neck pain and whiplash injuries in nine states in the United States to determine whether whiplash injuries contributed significantly to the population of individuals with chronic neck and other spine pain.

Four hundred nineteen patients and 246 controls were randomly enrolled. Patients were defined as individuals with chronic neck pain, and controls as those with chronic back pain. The two groups were surveyed for cause of chronic pain as well as demographic information. The two groups were compared using an exposure-odds ratio.

Forty-five per cent of the patients attributed their pain to a motor vehicle accident. An OR of 4.0 and 2.1 was calculated for men and women, respectively.

Based on the results of the present study, it reasonable to infer that a significant proportion of individuals with chronic neck pain in the general population were originally injured in a motor vehicle accident.

Key Words: Case-control study; Chronic neck pain; Motor vehicle crash; Whiplash

The rate of recovery following acute whiplash injuries has been the subject of multiple studies. The majority of these studies have been designed as either prospective or retrospective case series, in which there was no control group. Generally, the prospective studies are of higher quality because they use an inception cohort, and are more likely to include consecutive patients presenting to a hospital emergency room (1-9). In comparison, the retrospective studies are more likely to describe cohorts that have been assembled from a specialist's practice. These studies are more susceptible to bias in the patients' recall of the etiological event initiating their symptoms, because the patients are enrolled months, and sometimes years, after the original injury (10-18).

Notwithstanding the efforts of prior researchers, there are many unanswered questions regarding the nature of late whiplash, for example:

Douleur cervicale chronique et coup de fouet cervical : Étude cas-témoins du rapport entre coup de fouet cervical aigu et douleur cervicale chronique

Les auteurs ont entrepris une étude cas-témoins sur la douleur cervicale chronique et le coup de fouet cervical dans neuf états des États-Unis afin de déterminer si le coup de fouet cervical contribuait de façon significative au problème de douleur cervicale ou d'autres dorsalgies chroniques chez une population de patients ainsi affligés.

Quatre cent dix-neuf patients et deux cent quarante-six témoins ont été randomisés dans le cadre de l'étude. Les patients étaient des personnes souffrant de douleur cervicale chronique et les témoins, des personnes souffrant de dorsalgie chronique. Les deux groupes ont été interrogés sur la cause de leurs douleurs chroniques et sur leurs caractéristiques démographiques. Les deux groupes ont été comparés quant à leur risque relatif approché d'exposition. Quarante-cinq pour cent des patients ont relié leur douleur à un accident de la route. Des RR de 4,0 et de 2,1 ont été calculés pour les hommes et les femmes, respectivement.

Sur la base des résultats de la présente étude, il serait raisonnable de supposer qu'un accident de la route soit à l'origine de la douleur cervicale chronique chez une proportion importante de patients atteints dans la population générale.

- how do individuals with chronic neck pain compare with individuals with other chronic spinal pain with regard to a history of a motor vehicle accident (MVA) as the origin of their pain; and
- what is the contribution of late whiplash to the total pool of individuals with chronic neck pain in the general population.

The objective of the present study was to compare exposure histories of consecutive patients with chronic neck pain presenting to a random sample of chiropractors' offices with the exposure histories of consecutive patients with chronic back pain presenting to the same office. The primary exposure history of interest was prior involvement in an MVA. As a matter of practicality, attribution of cause of pain was used as a surrogate for cause of pain in the present

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study. We chose to study patients in chiropractic practices because:

- most chiropractic patients present with complaints of spine pain (19);
- typically, a substantial proportion of a chiropractor's practice consists of patients with chronic neck and back pain (20); and
- in the United States, chiropractors are the initial treating physician for one of three individuals who seek treatment for spine pain (21), and provide 40% of all treatment for low back pain (22); thus, chiropractors treat a broad cross-section of the population with spinal pain.

METHODS

One hundred chiropractic physicians were randomly selected from a list of 8000 practitioners who had written or telephoned an interest in attending an annual whiplash injury conference presented by the Spine Research Institute of San Diego (California, USA). The study participants were recruited from nine states in the United States: California, Louisiana, New York, Oklahoma, Oregon, Texas, Washington, Wisconsin and Utah (the states with the largest proportion of practitioners on the list). The chiropractors were contacted initially by telephone and then by letter, and asked to participate in a general study of patients with chronic spine pain. The chiropractors were not told the specific study hypothesis under investigation. The participating chiropractors were sent a packet of instructions on survey administration protocol, 50 presurveys (described below), 10 study questionnaires, a copy of a statement of informed consent and a tally sheet. The study questionnaire was pilot tested on 30 people with chronic spine pain.

The instruction packet directed each chiropractor to administer a brief presurvey to each patient coming to his or her office to determine if the patient met the eligibility criteria of the study. These criteria were:

- older than 18 years; and
- experience with at least one intrusive episode of back or neck pain per week, for the preceding consecutive 26 weeks (six months) or longer.

When a patient was determined to be eligible for the study, he or she was given a questionnaire to complete, along with an informed consent document. Along with demographic information, the questionnaire examined the region of the spine affected, the duration of chronic pain and the attributed origin of the pain. Additionally, if the pain originated with a MVA details of the crash were sought.

The chiropractor was given a tally sheet to record the number of surveys completed for chronic neck pain patients (cases), and chronic back pain patients (controls). The questionnaires were colour coded for the two groups. When five surveys were completed for each category, the completed surveys along with the tally sheets were to be returned to the investigators. The chiropractors were asked to record the number of patients, if any, who refused to complete the questionnaire.

Initially, 163 chiropractors were contacted by phone and asked if they would participate in the study. Of the 100 who agreed, six returned the information packet and survey forms, stating that they would not have time to administer the questionnaires. Of the remaining 94 chiropractors, 33 returned 10 completed surveys,

five cases and five controls. Thirty-four chiropractors returned 10 surveys that were collected from consecutive patients, without regard to case or control status. Fifteen returned surveys were unusable because they were incomplete. Sixty-seven chiropractors participated in the study, for a response rate of 41% (67 of original 163 contacted). There were a total of 665 completed surveys returned: 419 cases and 246 controls. Every eligible patient in the participating offices agreed to fill out the questionnaire.

The data from the questionnaires were tabulated and stratified by age and sex. An exposure-odds ratio (EOR) was calculated for the different strata with regard to a history of MVA-induced chronic pain. The χ^2 heterogeneity test was used to test for effect modification between age groups and sex, and the Mantel-Haenszel pooled estimator was used to calculate a point estimate and 95% CI for those strata that were found to have homogenous effects. Epi Info 6 (Centers for Disease Control and Prevention, USA) was the statistical program used for these calculations.

RESULTS

Of 665 respondents, 419 (63%) had chronic neck, or chronic neck and back pain (cases), and 246 (37%) had chronic low back pain (controls). The cases consisted of 120 (40%) men and 299 (60%) women; the controls comprised 117 (48%) men and 129 (52%) women. The median age of the male and female cases was 44 and 43 years, respectively. The mean age of the male and female controls was 40 and 44 years, respectively.

Cause of pain

Among all patients, 37% attributed their chronic pain to a MVA, more than any other single cause. The second most common origin of chronic pain (27%) was insidious onset. Lifting, sports injuries and falls each caused less than 10% of chronic pain (7%, 7% and 5%, respectively). Other unspecified causes were named by 17% of the study population as the cause of their chronic pain.

The most frequently named cause of chronic pain among the cases was an acute MVA injury, reported by 44% of all male cases and 45% of all female cases. The highest proportion of MVA-caused chronic pain (67%) was observed in male cases, 21 to 30 years of age. Among the controls, the most frequently reported cause of chronic pain for the men was a work injury (27%), and for the women was insidious or unknown onset (38%). The next most prevalent cause of chronic pain in the female-control group was MVA injuries (29%), whereas for the male controls, insidious onset (22%), lifting (21%) and other causes (21%) all ranked ahead of MVA injuries (17%). The group with the highest proportion of work-related chronic pain was female cases, with 38% of respondents attributing their neck or neck and back pain to an on-the-job injury (Tables 1 to 4). In the data analysis, work-related injuries were treated as a separate category from the other causes, and were not exclusive of other types of injuries (eg, a work-related injury could also be a lifting injury or a MVA injury). For this reason, work-related injuries are presented in a table separate from the other causes of chronic spine pain (Table 5).

Comparison of cases with controls

A χ^2 for heterogeneity was calculated for all of the age strata for men and women to determine whether age modified the effect of a MVA. The χ^2 calculation showed that there was no statistically significant difference among the EORs of the different age strata ($P=0.80$ for men, $P=0.43$ for women).

TABLE 1
Attribution of cause of pain for male respondents with chronic neck, or chronic neck and back pain (cases), stratified by age

Age (years)	Cause of pain, n (%)						Total for each age
	Motor vehicle accident	Insidious onset	Lifting	Fall	Sports	Other	
21 to 30	12 (67)	2 (11)	1 (5)	0 (0)	2 (11)	1 (5)	18 (100)
31 to 40	18 (58)	6 (19)	0 (0)	1 (3)	1 (3)	5 (17)	31 (100)
41 to 50	11 (34)	7 (22)	3 (10)	2 (6)	2 (6)	7 (22)	32 (100)
51 to 60	4 (20)	7 (35)	1 (5)	2 (10)	1 (5)	5 (25)	20 (100)
61 to 79	8 (42)	7 (37)	2 (11)	1 (5)	0 (0)	1 (5)	19 (100)
Total male cases	53 (44)	29 (24)	7 (6)	6 (5)	6 (5)	19 (16)	120 (100)

TABLE 2
Attribution of cause of pain for female respondents with chronic neck, or chronic neck and back pain (cases), stratified by age

Age (years)	Cause of pain, n (%)						Total for each age
	Motor vehicle accident	Insidious onset	Lifting	Fall	Sports	Other	
18 to 30	37 (56)	14 (21)	0 (0)	2 (3)	3 (5)	10 (15)	66 (100)
31 to 40	29 (51)	13 (22)	2 (4)	2 (4)	1 (2)	10 (17)	57 (100)
41 to 50	39 (45)	23 (26)	0 (0)	6 (7)	5 (6)	14 (16)	87 (100)
51 to 60	17 (35)	16 (33)	1 (2)	2 (4)	4 (8)	9 (18)	49 (100)
61 to 83	12 (30)	16 (40)	2 (5)	5 (13)	2 (5)	3 (7)	40 (100)
Total female cases	134 (45)	82 (27)	5 (2)	17 (6)	15 (5)	46 (15)	299 (100)

TABLE 3
Attribution of cause of pain for male respondents with chronic back pain (controls), stratified by age

Age (years)	Cause of pain, n (%)						Total for each age
	Motor vehicle accident	Insidious onset	Lifting	Fall	Sports	Other	
19 to 30	6 (37)	3 (19)	4 (25)	0 (0)	2 (13)	1 (6)	16 (100)
31 to 40	6 (19)	4 (12)	6 (18)	2 (6)	5 (15)	10 (30)	33 (100)
41 to 50	3 (10)	9 (28)	6 (19)	4 (12)	4 (12)	6 (19)	32 (100)
51 to 60	3 (11)	6 (24)	5 (19)	2 (8)	3 (11)	7 (27)	26 (100)
61 to 83	2 (20)	3 (30)	3 (30)	0 (0)	1 (10)	1 (10)	10 (100)
Total male controls	20 (17)	25 (21)	24 (21)	8 (7)	15 (13)	25 (21)	117 (100)

TABLE 4
Attribution of cause of pain for female respondents with chronic back pain (controls), stratified by age

Age (years)	Cause of pain, n (%)						Total for each age
	Motor vehicle accident	Insidious onset	Lifting	Fall	Sports	Other	
18 to 30	15 (44)	8 (23)	1 (3)	3 (9)	2 (6)	5 (15)	34 (100)
31 to 40	8 (23)	16 (47)	2 (6)	2 (6)	1 (3)	5 (15)	34 (100)
41 to 50	8 (28)	9 (31)	1 (3)	0 (0)	3 (10)	8 (28)	29 (100)
51 to 60	2 (12)	8 (47)	3 (17)	0 (0)	2 (12)	2 (12)	17 (100)
61 to 79	5 (33)	8 (53)	1 (7)	0 (0)	0 (0)	1 (7)	15 (100)
Total female controls	38 (29)	49 (38)	8 (6)	5 (3)	8 (6)	21 (18)	129 (100)

The overall Mantel-Haenszel (pooled) OR comparing cases with controls controlling for age was 4.0 (95% CI 2.1 to 7.5) for men and 2.1 (95% CI 1.3 to 3.3) for women. These findings indicate that respondents with chronic neck, or neck and back pain, were significantly more likely to report a history of a MVA as the cause of their pain than were the respondents with chronic back pain (Tables 6 and 7).

DISCUSSION

Potential sources of error

The disparity between the number of cases and controls in the study was a result of the enrollment techniques employed by the chiropractors who participated in the study. While precautions were taken to prevent misinterpretation of the instructions, approximately one-half of the chiropractors collected

TABLE 5
Number of respondents with chronic neck, or chronic neck and back pain (cases), and chronic back pain (controls), who attributed their pain to an on-the-job injury, stratified by age and sex

Age (years)	Work-related injuries, n (%)					
	Cases			Controls		
	Men	Women	Total	Men	Women	Total
18 to 30	2 (20)	8 (80)	10 (100)	6 (60)	4 (40)	10 (100)
31 to 40	8 (40)	12 (60)	20 (100)	15 (71)	6 (29)	21 (100)
41 to 50	12 (34)	23 (66)	35 (100)	13 (72)	5 (28)	18 (100)
51 to 60	10 (48)	11 (52)	21 (100)	9 (69)	4 (31)	13 (100)
61 to 83	3 (30)	7 (70)	10 (100)	1 (25)	3 (75)	4 (100)
Total	35 (36)	61 (64)	96 (100)	44 (67)	22 (33)	66 (100)

TABLE 6
Age-specific and pooled exposure-odds ratios (EORs) for men

Age (years)	EOR	95% CI
19 to 30	3.3	0.6 to 17.8
31 to 40	6.2	1.8 to 23.0
41 to 50	5.1	1.1 to 26.4
51 to 60	1.9	0.30 to 12.9
61 to 83	2.9	0.4 to 26.7
Mantel-Haenszel pooled estimate	4.0	2.1 to 7.5

the surveys from the first 10 consecutive patients with chronic spinal pain, rather than five chronic neck, or neck and back pain patients, and five chronic back pain patients. Because the definition of a case was less restrictive than that of a control (ie, neck pain, or neck and back pain, as opposed to back pain alone), the prevalence of cases in the general population, and in this study, was higher than the prevalence of controls. Thus, 63% of the respondents had neck, or neck and back pain, and 37% had back pain only. It is unlikely that this difference biased the results of the study because it was due to external factors (ie, the prevalence of the injury) rather than internal factors, such as a systematic error in the way the patients were enrolled in the study, because the patients were selected consecutively.

The other disparity observed among the patients was in the distribution of sex. Sixty per cent of the cases were women and 40% were men. This difference is accounted for by the fact that more women have chronic neck pain than men (23). Any potential bias resulting from the disparity was controlled for by stratifying by sex in the data analysis.

Although the 41% response rate (67 of 163) among the chiropractors was lower than anticipated, it was not considered to be a substantial source of bias, because both the cases and the controls were recruited from the same clinicians' offices and because the chiropractors were unaware of the hypothesis under investigation.

Recall bias was prevented by the design of the survey, particularly with regard to questions about chronic pain causation, and the use of chronic pain as a criteria for inclusion in the study. That is, because chronic pain can act as a psychological confounder and, thus, affect recall (24), both the cases and the controls were matched for the presence of chronic pain.

TABLE 7
Age-specific and pooled exposure-odds ratios (EORs) for women

Age (years)	EOR	95% CI
18 to 30	1.6	0.7 to 4.1
31 to 40	3.4	1.2 to 9.7
41 to 50	2.1	0.8 to 5.9
51 to 60	4.0	0.7 to 28.6
61 to 83	0.9	0.2 to 3.7
Mantel-Haenszel pooled estimate	2.1	1.3 to 3.3

Cause of pain

MVAs caused more chronic neck, and chronic neck and back pain (chronic pain among the cases), than any other etiological agent. While men and women are acutely injured at different rates in MVAs (16), the etiological fraction of MVA injuries of chronic neck, and neck and back pain in this study was similar for each sex (44% for men and 45% for women). For both sexes, younger age was generally associated with a higher etiological fraction of MVA injuries for neck pain in comparison with older age. This increase probably was due to a lack of competition from other causes of pain, particularly insidious onset of pain, which was observed to be directly related to age. The observed increase in insidious onset of pain with age most probably is due to the effect of degenerative disc and joint disease, which typically begins at 40 years of age and progresses thereafter, and can cause or contribute to chronic spine pain (25).

MVAs were the second most frequently reported cause of chronic low back pain among women (29%) after insidious onset (38%). This finding was in marked contrast to the most frequently named causes of chronic low back pain among men, for whom lifting, insidious onset and other causes each accounted for 21% of responses (MVAs caused only 17% of chronic pain among male controls).

Among men, it was not surprising to observe that lifting and insidious onset were the leading causes of chronic low back pain, because men, more often than women, work in occupations in which lifting is involved. In addition, degenerative changes in the low back are more prevalent among men than women (26).

Among men and women combined, MVA injuries accounted for 45% of all neck and neck and back pain, and 24% of all low back pain. MVA injuries were the cause of 37% of all chronic spine pain, 9% more than the next largest cause, insidious onset (28%), and more than all of the remaining causes combined.

Comparison between cases and controls

The study results indicate that men with chronic neck, or chronic neck and back pain, are four times more likely to attribute that pain to an MVA than men with chronic back pain. Women with chronic neck, or neck and back pain, are twice as likely to attribute their injury to an MVA vehicle crash compared with their counterparts with chronic low back pain.

These findings are unusual in the medical literature in that, to our knowledge, no other authors have studied the contribution of MVA injuries to the prevalence of chronic spine pain, and no studies have examined the difference of that contribution

between neck and back pain. The findings of the current study also differ from conclusions reached in previous studies; these studies found that acute MVA injuries are unlikely to or do not progress to chronic pain (16,27).

CONCLUSION

The study findings suggest that injuries resulting from MVAs contribute significantly to the population of individuals with chronic spine pain in the United States. In addition, individuals with chronic pain in the neck, and neck and back, are more likely to have acquired their pain as a result of an MVA, in comparison with individuals with chronic back pain alone. The present study suggests that chronic symptoms following whiplash, or 'late whiplash', is considerably more prevalent than previously reported (19,28).

The prevalence of chronic neck pain in the general population has been estimated by various authors to range from 13.8% for both sexes, to 32.9% for women and 27.5% for men (28). Extrapolating the 45% etiological fraction of MVA injuries found in the present study to the most conservative estimate of chronic neck pain prevalence (13.8%) yields 6.2%

prevalence of late whiplash, or 15.5 million Americans alone, with this chronic pain disorder. This figure is close to an estimate published earlier by Croft (29).

Whiplash injuries are common in industrialized countries. For many years, the whiplash-injured individual with persistent symptoms has been viewed by some as an opportunist, a malingerer, or both. Even the originator of the term 'whiplash' later joked that a whiplash injury was "any strain of the cervical spine that doesn't resolve until all litigation is concluded" (30). Although the connection between whiplash injuries and litigation has been investigated and refuted in several studies (8,9,13-15), the motives of individuals seeking compensation for chronic pain resulting from an MVA injury continue to be questioned (16). Thus, further well-controlled studies of the chronic effects of whiplash might serve to resolve this misperception.

While further study of late whiplash is needed, the present study helps to clarify several of the ambiguities regarding the disorder, leading to better understanding of the epidemiology of the condition, and eventually, the mitigation or prevention of late whiplash.

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