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The relation between initial symptoms and signs and the prognosis of whiplash

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Abstract Whiplash, a common injury following motor vehicle crashes, is associated with high costs and a prognosis that is variable and difficult to predict. We studied the profile of recovery from whiplash and assessed whether presenting signs and symptoms directly after the crash were predictive of whiplash prognosis. We formed a population-based incident cohort of all 2627 individuals who sustained a whiplash injury resulting from a motor vehicle crash in the province of Québec, Canada, in 1987, and followed these patients for up to 7 years. The data on signs and symptoms were obtained from the medical charts kept by the universal automobile insurance plan (Société de l'assurance automobile du Québec), which covers all 7 million residents of the province, while data on the outcome – the recovery time from whiplash – was obtained from their databases. The median recovery time was 32 days, and 12% of subjects had still not recovered after 6 months. The signs and symptoms that were found to be independently associated with a slower recovery from whiplash, besides fe-

male gender and older age, are neck pain on palpation, muscle pain, pain or numbness radiating from the neck to arms, hands or shoulders, and headache. Together, these factors in older females (age 60) predicted a median recovery time of 262 days, compared with 17 days for younger males (age 20) who do not have this profile. In contrast, using a classification of injury severity previously proposed by the Québec Whiplash Associated Disorders Task Force, the median recovery time varied from 17 to only 123 days. We conclude that whiplash patients presenting with several specific musculoskeletal and neurological signs and symptoms will have a longer recovery period. These patients can easily be identified and closely monitored and targeted for the evaluation of early intervention programmes aimed at managing whiplash patients with a poor prognosis.

Keywords Cervical spine · Epidemiology · Motor vehicle accident · Prognosis · Soft tissue injury · Trauma

Introduction

The term whiplash, a common injury that occurs among motor vehicle occupants involved in collisions, was originally coined to describe the result of a rapid hyperexten-

sion and flexion of the muscles of the neck [2]. Its incidence varies between 70 per 100,000 yearly in Québec [14,15] and 106 per 100,000 in Australia [11]. Its cost to the health care system is high: estimated in Canada to be around \$2,500 in indirect costs per subject [15]. One of the challenges of managing patients with a whiplash in-

jury is the high variability and low predictability of its prognosis [10]. The studies on the duration of this condition are inconsistent: reported results include 27% still affected at 6 months [13], 26% at 1 year [3], 44% at 2 years, and 7% still unable to return to work at 2 years [7]. Our previous study identified several socio-demographic and crash-related factors associated with a longer recovery from whiplash [5].

With respect to the predictive ability of initial signs and symptoms, studies are highly variable in their results. Patients present with a multitude of signs and symptoms that range from simple neck pain to combinations of several musculoskeletal and neurological manifestations [1, 6, 7, 12, 13]. The profile of presenting symptoms varies widely across studies, with, for example paresthesia present in 62% [12] versus 13% [13] of patients, and auditory symptoms in 18% [12] versus 4% [7]. Their predictive ability is uncertain, as finger paresthesia [13], the presence of neck stiffness and muscle spasm [12], and pain in the upper limbs and back [4] were all found to be associated with a delay in recovery. These studies are limited by the small number of subjects, less than 100, and an unclear time zero for the cohort.

In this article, we investigate the duration of whiplash injury in a population-based cohort of motor vehicle crash subjects in Québec. We assess the predictive ability of the initial signs and symptoms reported after the crash on this length of recovery, and we compare this method of prediction to the classification of signs and symptoms proposed by the Québec Whiplash-Associated Disorders Task Force, as a tool for grading severity [14].

Materials and methods

Study population

The source population for this epidemiologic cohort study has already been described in detail elsewhere [5, 15]. It is made up of all motor vehicle crash subjects who sustained a whiplash injury in 1987 in Québec and who submitted a claim for compensation to the Société de l'assurance automobile du Québec (SAAQ). The SAAQ is a government body that administers the province's sole universal insurance system, for a population of almost 7 million inhabitants, to provide financial compensation to injured motor vehicle accident subjects, whether driver, passenger or bystander, regardless of fault. The study subjects were identified from the SAAQ's computerised information systems by searching for individuals with an ICD-9 diagnostic code of 847.0 (sprains and strains of the neck, including whiplash injury) in 1987. The year 1987 was selected as the basis for this study because, in that year, the SAAQ achieved complete coding of claimant injury data by trained professional medical archivists.

An historical cohort was defined as subjects who received some form of compensation from the SAAQ and who did not have other injuries besides whiplash. The date of entry into the cohort was defined as the date of the crash. The exit date from the cohort was the earliest of either the date on which the whiplash subject's file was closed by the SAAQ or May 1993.

Prognostic factors

To collect information on signs and symptoms, we accessed the medical charts of all 2843 subjects identified in this cohort. Data were extracted by trained medical archivists, who coded all signs and symptoms noted in the charts, corresponding to all visits to a physician, an emergency room or a hospital following the crash, using a standardised abstraction form. These signs and symptoms were all included in the present study. These same signs and symptoms were also then classified from 1 to 3 by one of the authors (M.V.) according to the Québec Task Force classification of any neck complaint of pain, stiffness or tenderness. A classification of 1 is used if there are no physical signs or symptoms; 2 if there are musculoskeletal signs or symptoms; and 3 if neurological signs or symptoms accompanied the complaints [14]. Socio-demographic factors, namely gender, age, area of residence, marital status, employment status and number of dependents, were also available directly from the SAAQ's computerised databases.

Outcome and data analysis

The outcome of interest was the length of time the subject took to recover from the whiplash injury. Although this length of time could not be determined exactly, we used as a proxy the span, in days, between the date of the crash and the last date for which compensation to replace regular income was made by the SAAQ. This outcome corresponded roughly to the amount of time taken off work by the whiplash subject, if the subject was employed, or the length of time during which the whiplash subject could not carry out his or her usual activities, if the subject was a student, homemaker, retired, or unemployed. Since SAAQ policy dictates that motor vehicle crash subjects who are able to return to work or to their usual activities within 7 days of the crash are ineligible to receive compensation to replace regular income, such crash subjects, whose injuries were presumably rather mild, were assigned a median time of recovery of 3.5 days.

Recovery time was analysed using methods for survival data [8]. Cumulative recovery curves were estimated by the Kaplan-Meier method. The Cox proportional hazards model was used to estimate rate ratios of recovery from whiplash simultaneously for several prognostic factors [8].

Results

Of the 4766 people who submitted claims for compensation for a whiplash injury following a motor vehicle crash in 1987 in Québec, 1923 who had multiple injuries besides whiplash were not eligible for the cohort. The remaining 2843, who only had a whiplash injury, formed our study population. Thirty-five with no medical chart and 146 who were found not to have neck pain were excluded from the cohort, leaving 2627 subjects in the cohort for analysis. The extracted data on signs and symptoms came from reports submitted by the subject's physician (83.1%), an emergency room (8.3%), a hospital (0.3%) and the subject (8.3%).

The socio-demographic characteristics of the cohort members are provided in Table 1. These subjects are on average 36 years old, 64% are female, 53% married or living in common-law, 77% have no dependents and, among those with data on employment status, 58% are working full time. The estimated Kaplan-Meier recovery curve for

Table 1 Socio-demographic characteristics of all 2627 whiplash subjects in Québec, 1987

% Female	63.7
Age (mean±SD)	35.5±12.9
% Married or living with common-law spouse	53.1
% With no dependents	76.9
Employment status	
% Employed full time	42.6
% Not employed full time but capable of working ^a	29.0
% Other (Students, disabled, minors)	2.7
% Missing data	25.6

^aIncludes home makers, part-time students, casual and volunteer workers, etc

Table 2 Crude rate ratio (RR) of recovery, with 95% confidence intervals (CI) for each sign and symptom reported at the first physician contact after the accident

Signs or symptoms	N	%	Crude RR	95% CI
Rheumatological symptoms				
Muscle pain	232	8.8	0.80	0.74–0.98
Muscle stiffness	157	6.0	0.89	0.80–1.11
Muscle spasm	200	7.6	0.90	0.80–1.08
Rheumatological signs				
Neck pain on palpation	305	11.6	0.85	0.78–1.00
Tenderness on palpation	247	9.4	0.88	0.82–1.08
Decreased neck mobility	308	11.7	0.89	0.84–1.07
Neck pain on mobilization	272	10.4	0.87	0.82–1.06
Neurological symptoms				
Pain or numbness radiating from neck to:				
Back or chest	348	13.2	0.90	0.82–1.03
Arms or hands	88	6.2	0.64	0.57–0.83
Shoulders	186	7.1	0.79	0.72–0.98
Headache	310	11.8	0.78	0.74–0.95
Non-radiating numbness	120	4.6	0.66	0.43–0.91
Dizziness or vertigo	55	2.1	0.86	0.74–1.28
Loss of consciousness	54	2.1	0.76	0.67–1.15
Visual and ENT problems	20	0.8	0.83	0.61–1.53
Anxiety or insomnia	43	1.6	0.67	0.47–1.10

the entire cohort shows that 26% recovered within 1 week of the crash, that the median recovery time was 32 days and that 6 months after the crash, 12% still had not recovered.

The list of all signs and symptoms reported at the initial visit after the crash is given in Table 2, along with the crude rate ratios of recovery relative to the absence of the sign or symptom. The most frequent rheumatological signs and symptoms are neck pain on palpation (11.6%), decreased neck mobility (11.7%) and neck pain on mobilization (10.4%). Neurological signs and symptoms were relatively infrequent, except for pain or numbness radiating from neck to back or chest (13.2%) and headache (11.8%). Visual or ENT problems, anxiety or insomnia,

Table 3 Crude and adjusted rate ratios of recovery for the significant signs and symptoms reported at the first physician contact after the accident

Signs or symptoms	Crude RR	Adjusted ^a RR	95% CI
Neck pain on palpation	0.85	0.85	0.76–0.96
Muscle pain	0.80	0.85	0.74–0.97
Pain or numbness radiating from neck to:			
Arms or hands	0.64	0.64	0.55–0.76
Shoulders	0.79	0.83	0.71–0.97
Headache	0.78	0.82	0.73–0.92

^aAdjusted for age, gender and one another

dizziness or vertigo, and loss of consciousness were the least frequent symptoms.

The crude rate ratios (RR) of recovery, with a value less than 1 indicating that the likelihood of recovery is reduced, indicate that the neurological signs or symptoms are the most predictive of a lower chance of recovery. Non-radiating paresthesia or numbness (RR=0.66), anxiety or insomnia (RR=0.67) and pain or numbness radiating from neck to arms or hands (RR=0.64) may be the most predictive signs and symptoms, all associated with a slower recovery. Others are pain or numbness radiating from neck to shoulders (RR=0.79) and headache (RR=0.78), while the only rheumatological signs or symptoms are neck pain on palpation (RR=0.85) and muscle pain (RR=0.80).

The multivariate analysis shown in Table 3 determined that, among all signs and symptoms, neck pain on palpation (RR=0.85; 95% CI: 0.76–0.96), muscle pain (RR=0.85; 95% CI: 0.74–0.97), pain or numbness radiating from neck to arms or hands (RR=0.64; 95% CI: 0.55–0.76), or to shoulders (RR=0.83; 95% CI: 0.71–0.97), and headache (RR=0.82; 95% CI: 0.73–0.92) were the only five that, independently and adjusted for age and gender, made a significant contribution toward a slower recovery.

The signs and symptoms of Table 2 were regrouped according to the proposed Québec classification of whiplash-associated disorders (WAD) [14], as shown in Table 4, along with the rate ratios of recovery. The majority of subjects are classified as grade 1 (66.4%), and only 5% are classified as grade 3, that is, neck complaint involving neurological signs. The rate of recovery, adjusted for age and gender, decreases with worsening grade, with rate ratios of 0.82 (95% CI: 0.75–0.89) for grade 2 and 0.61 (95% CI: 0.51–0.73) for grade 3 relative to grade 1.

The Kaplan-Meier recovery curve for each of the three grades of WAD is shown in Fig. 1. The cumulative probability of recovery decreases with the grade. The median recovery time was 25 days for grade 1, 54 days for grade 2 and 76 days for grade 3. One year after their crash, 4.8% of grade 3 subjects still had not recovered, compared with only 1.8% of grade 2 subjects and 1.4% of grade 1 subjects.

Table 4 Crude and adjusted rate ratios of recovery according to the Québec classification of signs and symptoms at the time of the crash

Grade	Definition	<i>N</i>	%	Crude RR	Adjusted ^a	
					RR	95% CI
Neck complaint of pain, stiffness or tenderness with:						
1	No physical signs or symptoms	1743	66.4	1	1	Reference
2	Musculoskeletal signs or symptoms	755	28.7	0.83	0.82	0.75–0.89
3	Neurological signs or symptoms	129	5.0	0.62	0.61	0.51–0.73

^aAdjusted for age and gender

Fig. 1 One-year cumulative recovery curve by the three grades of the Québec classification of whiplash severity

Fig. 2 Predicted cumulative recovery curves according to signs and symptoms for subjects with slowest recovery (female gender, age 60, with neck pain on palpation, headache, paresthesia and pain or numbness radiating from neck to arms or hands) and fastest recovery (male gender, age 20, none of the four signs or symptoms)

Figure 2 displays the predicted recovery curves for two extreme groups defined by the prognostic factors of Table 3. Since age was measured as a continuous factor, we selected two extreme values, namely 20 and 60 years, to describe the limits of the recovery curves. The slowest re-

Fig. 3 Predicted cumulative recovery curves according to the Québec classification of whiplash severity for subjects with slowest recovery (female gender, age 60, grade 3) and fastest recovery (male gender, age 20, grade 1)

covery is for female subjects aged 60 with neck pain on palpation, muscle pain, and pain or numbness radiating from the neck to the arms or hands, or shoulders, as well as headache. The fastest recovery is for male subjects aged 20 with none of these six signs or symptoms. At 60 days, for example, only 19% of the slow recovery group will have recovered, while 77% of the fast recovery group will have recovered by that time. The median (the time at which 50% of subjects recover) is 17 days for the former group and 262 days for the latter.

Figure 3 displays the corresponding curves using the rate ratios of Table 4 for the Québec classification of WAD, contrasting the slow recovery group of 60-year-old women with grade 3 classification with the faster recovery group of 20-year-old men with grade 1. Here, at 60 days, 35% of the first group compared with 76% of the second will have recovered by that time. The median recovery time is 17 days for the first group and 123 days for the second.

Discussion

Using a population-based cohort of 2627 whiplash injury subjects followed for over 5 years, the present study found that, in addition to older age and female gender, six

presenting symptoms lead to a poorer prognosis, namely: neck pain on palpation, pain or numbness radiating from the neck to the arms or hands, or to shoulders, headache, and muscle pain. These prognostic factors are powerful since, when used in combination, they can vary the median recovery time (the time by which 50% of patients recover) from as low as 17 days to as high as 262 days. In contrast, the simple Québec classification of signs and symptoms into three grades of whiplash severity, based primarily on the presence of musculoskeletal or neurological signs, was able to predict moderately well the patients' time to recovery, with the median recovery time varying from 17 days to 123 days.

The few other studies that assessed the prognostic value of presenting signs and symptoms of whiplash have been limited by their small sample size – all less than 100 patients – and other design constraints, and have produced different findings from our study. First, we found that by 6 months into follow-up, only 12% of patients still had not recovered, compared with other studies' findings of 27% to over 44% [3, 7, 13]. This difference is likely due to the fact that our cohort is population based, and we had precise data on time zero for all subjects. Nevertheless, because subjects with very mild injury may not have proceeded with a claim, the 6-month recovery rate may in fact be lower than 13%. Second, paresthesia, the presence of neck stiffness and muscle spasm, pain in the upper limbs and back, and the general presence of musculoskeletal or neurological signs were found to be associated with a delay in recovery [4, 12, 13]. The classifications used in our study made it possible to uncover other symptoms and signs, as well more specific profiles than simply the "musculoskeletal or neurological signs" on which the Québec classification is based, making a more precise prognosis possible.

Several aspects of the study could have affected the validity of the results. First, we relied on claims data to identify the cohort. The data entry and completeness of the SAAQ computerised databases have been shown to be reliable [9], so this is not considered an important source of error or potential bias in this study. Nevertheless, the outcome measure used in this study, namely the time to recovery, was potentially subject to different sources of misclassification, since it was based on administrative compensation data. It is likely that some whiplash patients may have continued to live with pain or discomfort for

some time after resuming their usual activities or, conversely, that some may have continued to be compensated although their pain and discomfort had disappeared. Such measurement error would have to be systematically associated with the signs and symptoms found to be predictive of recovery to affect the results' validity. This is not possible to assess. Second, we only extracted the signs and symptoms that were reported in the medical charts. In view of the legal status of the SAAQ, the physicians who completed the charts were required to note all relevant information for the diagnosis and subsequent compensation. As a result, we feel that the medical charts were quite complete, and missing signs and symptoms would have occurred only from misdiagnosis and not carelessness. Third, despite its large sample size and population-based nature, this study excluded 5% of subjects who did not actually have whiplash but were coded as such. We do not know how many patients of the 25,000 claimants to the SAAQ in 1987 actually had whiplash and should have been part of this cohort, but were not coded as such. We suspect that this number is small, since any tendency is likely to have been to the contrary: physicians may have tended to diagnose any neck pain as whiplash if a more specific diagnosis could not be made.

Finally, the SAAQ's regulation that crash subjects are not eligible for per diem income replacement compensation if they are able to return to work or their usual activities within 7 days of their crash may also have affected the external validity of the study. This regulation may have resulted in the exclusion of a sub-population of individuals with mild whiplash injuries, except those who filed a claim for compensation of one or more types of expenses related to the crash. This should tend to underestimate the rates of recovery over time, but should not affect the rate ratios of recovery unless the risk factor profile of this excluded group is different from that of the cohort.

In conclusion, this study shows that whiplash patients presenting with neck pain on palpation, muscle pain, headache, pain or numbness radiating from neck to arms, hands or shoulders are expected to have a longer course of recovery. They should be monitored closely and targeted when evaluating or implementing early intervention programmes aimed at identifying and managing whiplash patients with a poor prognosis. The other patients with few symptoms can be expected to recover fully within a few weeks.

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