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ORIGINAL ARTICLE

Population-Based, Inception Cohort Study of the Incidence, Course, and Prognosis of Mild Traumatic Brain Injury After Motor Vehicle Collisions

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Abstract

Objective: To determine the incidence, course, and prognosis of adult mild traumatic brain injury (MTBI) caused by motor vehicle collisions.

Design: Prospective, population-based, inception cohort study.

Setting: The province of Saskatchewan, Canada, with a population of about 1,000,000 inhabitants.

Participants: All adults (N=1716) incurring an MTBI in a motor vehicle collision between November 1997 and December 1999 in Saskatchewan.

Interventions: Not applicable.

Main Outcome Measures: Age- and sex-stratified incidence rates, time to self-reported recovery, and prognostic factors over a 1-year follow-up.

Results: Of 7170 adults injured in a motor vehicle collision over the 2-year inception period, 1716 (24%) met our cohort definition of MTBI. There were more women affected (53%), and MTBI was most common in the 18- to 23-year-old group. Most were not hospitalized (73%), but 28% reported loss of consciousness and 23% reported posttraumatic amnesia. The annual incidence of MTBI per 100,000 adults was 106.1 (95% confidence interval [CI], 98.9−113.6) in the first year and 118.3 (95% CI, 110.8−126.3) in the second year of the study. The 1-year follow-up rate was 84%. The median time to recovery was 100 days (95% CI, 97−103), and about 23% reported not having recovered by 1 year. Factors associated with delayed recovery included being older than 50 years, having less than a high school education, having poor expectations for recovery, having depressive symptoms, having arm numbness, having hearing problems, having headaches, having low back pain, and having thoracic back pain. Loss of consciousness and posttraumatic amnesia were not associated with recovery.

Conclusions: MTBI affects almost a quarter of persons reporting an injury after a traffic collision. The median time to recovery is 100 days, but 23% have still not recovered by 1 year. A mix of biopsychosocial factors is associated with recovery, including a strong effect of poor expectations for recovery.

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After falls, traffic collisions are the most common cause of mild traumatic brain injury (MTBI).[1] It is estimated that 70% to 90% of all treated brain injuries are mild, and the incidence of hospital-treated MTBI is between 100 and 400 per 100,000 population in developed nations.[2] However, many persons with MTBI are not treated at hospitals, and therefore, its true incidence is likely above 600 per 100,000 population.[1] Variability in case definition and diagnosis likely accounts for much of the variation across studies, but cultural factors might also be at play.[3,4] Most studies capture cases presenting to hospitals, and there are very few population-based estimates of the problem, and even fewer focused on traffic-related MTBI.[1]

The situation is similar with respect to prognosis because there are few studies on prognostic factors for MTBI after traffic collisions. The World Health Organization Collaborating Centre Task Force on Mild Traumatic Brain Injury systematically reviewed

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this literature and found only 2 scientifically acceptable studies of traffic-related MTBI.[5] Friedland and Dawson[6] compared 64 persons with MTBI admitted to a tertiary care center to 64 persons admitted with other injuries and found that functional recovery and return to work were similar between the groups. Overall, posttraumatic stress was associated with slower recovery in both groups. Cassidy et al[7] reported 657 persons with MTBI with some loss of consciousness (LOC) who made an insurance claim or were treated by a health professional after a traffic collision in Saskatchewan, Canada, in the period 1994 to 1995. During this study, the insurance system changed from "tort" to "no-fault," thereby increasing medical benefits, but discontinuing payments for pain and suffering, and therefore, limiting court actions. Their results showed a decrease in the 6-month incidence of MTBI claims from 36 to 27 per 100,000 adults and an improvement in the median time to claim closure from 408 to 233 days. They also showed that claim closure occurred faster when the claimants' health improved. Prognostic factors associated with slower claim closure included being off work because of the collision, being not at fault for the collision, reporting nausea after the collision, reporting memory problems after the collision, and a greater percent of bodily pain.

Given the lack of good-quality published studies on MTBI after traffic collisions, there is an obvious gap in knowledge in this respect. Unlike most falls, traffic injuries are complicated by insurance issues as noted above, and the World Health Organization Collaborating Centre Task Force on Mild Traumatic Brain Injury called for more studies in this setting. The purpose of this study was to document the incidence and course of MTBI after traffic collisions in the adult population. We also explore potential prognostic factors that have an impact on recovery.

Methods

Participants and setting

A population-based inception cohort was formed of all traffic injuries that occurred between December 1, 1997, and November 30, 1999, in the province of Saskatchewan in Canada. Entry into the cohort occurred if the person was treated by a registered health professional for a traffic injury or if the person made a bodily injury claim to Saskatchewan Government Insurance (SGI), the only insurer for traffic injuries in Saskatchewan. We included participants 18 years and older who were involved in a motor vehicle collision and who made a claim or were treated for injuries within 42 days of their collision. We excluded individuals who died as a result of their injuries or could not answer the baseline questionnaire because of a language barrier or because of serious unrelated illness. We also excluded those injured at work and covered by Workers' Compensation.

We identified the participants with probable MTBI through a 3-step process based on the self-report baseline questionnaire administered by the SGI (fig 1). We first identified participants who answered "yes" to the question, "Did you hit your head in the collision?" Second, we identified participants who had answered "yes" or "don't know" to one of these symptom-based questions: "Did you lose consciousness immediately after the accident?" or "Immediately after the accident, did you experience amnesia or loss of memory?" or "Immediately after the accident, did you experience disorientation or confusion?" In addition, the study participants had to have answered "yes" to at least 1 of the following questions for inclusion in the cohort: "Did the accident cause dizziness or unsteadiness?" or "Did the accident cause memory problems or forgetfulness?" or "Did the accident cause concentration or attention problems?" Finally, we excluded study participants who reported more than 30 minutes of LOC after the collision.

List of abbreviations:

LOC	**loss of consciousness**
MTBI	**mild traumatic brain injury**
PTA	**posttraumatic amnesia**
SGI	**Saskatchewan Government Insurance**

Data collection

The baseline research questionnaire was collected by SGI and was available on all injured persons. It contained questions about demographic characteristics (ie, age, sex, height, weight, marital status, highest education level achieved, household income, number of dependents), number of different preexisting comorbid conditions, collision characteristics (ie, position in the car, direction of impact, seatbelt use, headrests), hospitalization, past head injuries, collision-related symptoms (ie, numbness, dizziness or unsteadiness, memory problems or forgetfulness, concentration or attention problems, irritability, vision problems, hearing problems, sleep problems, unusual fatigue or tiredness, anxiety or worry, painful neck movement, painful jaw, LOC, posttraumatic amnesia [PTA], disorientation or confusion), fractures, depressive symptoms, early treating practitioner type, quality of health before and after the injury, pain location and intensity, expectations for recovery, work status, job satisfaction, and activities of daily living. Pain intensity was measured using the 11-point numerical rating scale, where a score of "0" meant they had no pain at all and a score of "10" meant pain as bad as could be. The numerical rating scale has excellent psychometric properties.[8] The health transition question and the overall general health question of the 36-item short-form health survey were included in the baseline questionnaire along with a question about their general health before the collision.[9] The Centre for Epidemiological Studies–Depression Scale was included at baseline. It was designed to measure current levels of depressive symptoms with a score range of 0 to 60, where a higher score indicates greater depressive symptoms. The Centre for Epidemiological Studies–Depression Scale has been found to have good test-retest reliability and validity.[10] Participants were also asked whether they thought their injury would "get better soon," "get better slowly," "never get better," or "don't know." The presence of comorbid conditions was measured using an inventory that was previously validated.[11,12]

At 6 weeks and 3, 6, 9, and 12 months postinjury, the study participants were followed by computer-aided telephone interviews conducted at our research center. The interviewers were blinded to the participants' previous responses. The participants were asked about how well they thought they were recovering from their injuries, with the response categories of "all better or cured," "feeling quite a bit of improvement," "feeling some improvement," "feeling no improvement," "getting a little worse," or "getting much worse." Using this question, self-reported recovery was defined by grouping the responses of "all better (cured)" and "feeling quite a bit of improvement" together and