Duration of cognitive dysfunction after concussion, and cognitive dysfunction as a risk factor: a population study of young men

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Abstract

Objectives: To establish how long cognitive dysfunction lasts after concussion, and the extent to which it may be a predisposing risk factor for concussion, by examining the prevalence of cognitive dysfunction among young men who have sustained concussion.

Design: Observational study.

Setting: Denmark.

Subjects: 1220 young men who had been admitted to hospital for concussion between the ages of 16 and 24 (identified in a national register of admissions) and who had also been cognitively tested by the Danish conscription draft board.

Main outcome measure: Score on the draft board's cognitive screening test, dichotomised as dysfunctional or non-dysfunctional (20.4% of the general population of Danish men appearing before the draft board had a dysfunctional score).

Results: 700 of the 1220 men had been tested after sustaining concussion; 520 had been tested before concussion. Four (50%) of the eight men who were tested less than seven days after the injury had a dysfunctional score. Among groups of the remaining 692 men who were tested at later time points after injury, the rates were only marginally raised (range 21.4% to 26.5%) above the population level. Among men tested before injury, the rate of dysfunctional scores was higher (30.4% (158/520)). Apart from suggesting cognitive dysfunction as a risk factor for concussion, this higher proportion seems to relate to the fact that they were typically injured as young adults, whereas those men who were tested after concussion had more often been injured as adolescents. The relative risk for concussion in the presence of cognitive dysfunction is estimated to be 1.57 (95% confidence interval 1.32 to 1.86).

Conclusions: Cognitive dysfunction is not only a short term consequence of concussion but also a predisposing risk factor for concussion, more so for young adults than for adolescents.

Introduction

Concussion is by far the most common form of traumatic brain injury and is particularly prevalent

among children and young adults, especially males.¹⁻³ The neuropsychological evidence on the duration of cognitive dysfunction after concussion, however, is conflicting. Although Bohnen and Jolles reported that "cognitive deficits are maximal in the first week after injury and tend to resolve spontaneously within three to four weeks in the majority of [mild head injury] cases,"⁴ some studies have reported no deficits within a few days of injury,⁵⁻⁶ and others have reported deficits months after injury.⁷⁻⁸ These contradictions are difficult to assess, because well established norms for the neuropsychological tests used are often lacking and because, despite an increasing recognition of the importance of factors before concussion occurs,⁹⁻¹⁰ information on the cognitive function of patients with concussion before they sustain the concussion is typically limited and indirect.

We studied two groups of young men who sustained concussion and in whom a cognitive test had been administered independently for which complete national norms are available. One group comprised men who were tested at varying times after the injury and for whom the relation between time since injury and test performance may therefore be examined. The second group comprised men who had been tested before the injury, permitting an assessment of the role of cognitive function before injury.

Subjects and methods

Subjects were initially located in a computerised Danish national register of hospital admissions. This register was created in 1979 and, up to 1993, used the diagnosis codes from ICD 8 (the international classification of diseases, eighth edition). We identified all men who were born between 1970 and 1974 and who had a single admission with a diagnosis at discharge of concussion (850.0) between the ages of 16 and, at most, 24—that is, not later than 1993. The date of admission was also noted. The sample was restricted to patients in whom concussion was the sole diagnosis and who were discharged not later than the second day after admission. This search located 1405 patients, most of whom had been admitted either to a department of orthopaedic surgery (808) or to general surgery departments in smaller, provincial hospitals (436). The injuries resulted mainly from accidents (966

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cases) and violence (165); four other minor categories (including self inflicted injury) accounted for 20 cases, and in 254 cases the cause of injury was not recorded on the discharge form.

We then traced these patients in the archival records of the Danish draft board—there is conscription in Denmark, and all men have to be evaluated by the draft board with a view to suitability for military service. A minority of men are evaluated at age 17, and most are evaluated before 20 years of age; postponements are sometimes permitted, though rarely after age 24. The evaluation procedure includes a test of cognitive ability, the Børge Prien Prøve.¹¹ This test measures mental speed and problem-solving ability and correlates highly ($r=0.82$) with the widely used Wechsler adult intelligence scale.¹² The test comprises four subtests (78 items in all) and takes 45 minutes to complete.

For archival purposes the full test score is condensed to a five point scale, the lowest four points of which are all considered as dysfunctional and can lead to the individual being evaluated as “of limited suitability” or as “unsuitable” for military service; the highest score on the archive scale indicates a performance that is at least adequate—that is, within or above the normal range. We dichotomised the scores as being dysfunctional or non-dysfunctional. About 12-13% of men are judged unsuitable for military service without having to appear before the draft board and therefore do not take the test. These men are predominantly those who have a chronic disqualifying illness—for example, asthma and Scheuermann’s disease.

Population baseline for comparison

We derived a population baseline to compare rates of dysfunctional scores using annual tables published by the draft board. All the injured men for whom we obtained test scores and date of testing appeared before the board between the years 1988 and 1996 (mode 1990, median 1991). The annual tables show that during these years the proportion of men with a dysfunctional score among all Danish men appearing before the board (30 000-35 000 annually, about 300 000 between 1988 and 1996) declined from 22.4% to 18.1%. The improvement in the population rate is a continuation of a secular trend reported elsewhere.¹³ To adjust for this trend we averaged the annual

reported percentages of men with a dysfunctional score for 1988-96, weighted in proportion to the numbers of injured men appearing before the board in each of those years. This calculation yielded a weighted average baseline rate of 20.4%.

Results

We obtained test scores and date of testing for 1220 of the 1405 men in our sample; 143 of the rest had been evaluated without appearing before the board. (The date recorded in the archive reflected the date that the test results were processed. As this date was the same as the date of testing in 95% of the cases, we ignored this potential small source of error.) Of the 1220 men, 700 had been tested after their injury and the remaining 520 before their injury. Table 1 shows the ages of the two groups of men at injury and at testing. Those who were injured before testing were injured at an earlier age and tested at a later age than those who were injured after testing. The difference between the two groups was more marked for age at injury than for age at testing. For the 1220 men taken together, there was no correlation between age at injury and age at testing ($r=0.04$).

Table 2 shows the proportion of men with a dysfunctional score among the 700 men tested after injury as a function of the time period between injury and testing. This period was divided into five intervals—namely, 3-6 days after injury (no one was tested less than 3 days after injury), 7-30 days, 31-100 days, 101-200 days, and more than 200 days. We chose these intervals in accordance with several major studies that have used follow ups within 1 week, at 1 month, and at 3 months.¹⁴ Only when the testing occurred at less than 7 days after injury did the proportion of men with a dysfunctional score increase markedly compared with the population rate of 20.4%. Despite the small numbers, this discrepancy approaches significance ($P=0.06$, binomial test). When the time between injury and testing was 7 days or more there were only small and mainly non-significant increases in dysfunctional rates (relative risks ranging 1.05 to 1.30). Cognitive deficit after concussion of a severity that leads to admission therefore seems to be limited to 1 week.

Of the 520 men who were injured after testing, 158 (30.4%) had a dysfunctional score—significantly above the population rate of 20.4% (binomial test $P<0.001$; relative risk 1.49 (95% confidence interval 1.31 to 1.70)). As these subjects had not yet been injured at the time of testing, the raised rate of men with a dysfunctional score must indicate some risk factor for sustaining concussion. There is, however, an apparent paradox in this finding, as such a risk factor might have been expected to manifest itself in men tested after injury, irrespective of the time since that injury. In all, 167/692 (24.1%) men who were tested 1 week or more after injury had a dysfunctional score—a significantly smaller proportion than among those injured after testing (Fisher’s exact test $P=0.02$; 0.79 (0.66 to 0.96)).

That dysfunctional scores should be more common among the men not yet injured may be explained by the fact that they sustained concussion on average later than those who were injured before being tested. Of the 647 men who were injured at age 18 or less, 154 (23.8%) had a dysfunctional score, compared with

Table 1 Mean (SD; SEM) age of men at injury and at testing

Age (years)	Injured before testing (n=700)	Injured after testing (n=520)	P value*
At injury	18.0 (0.97; 0.037)	20.6 (1.27; 0.056)	<0.001
At testing	19.4 (0.93; 0.035)	19.0 (0.61; 0.027)	<0.001

*Derived from *t* test (df=1218).

Table 2 Number (percentage) of men with dysfunctional score in relation to time between injury and testing

Injury time to testing (days)	Men with dysfunctional score	P value (binomial test)*	Relative risk† (95% CI)
3-6* (n=8)	4 (50)	0.06	2.45 (1.23 to 4.90)
7-30 (n=14)	3 (21)	>0.1	1.05 (0.39 to 2.86)
31-100 (n=60)	13 (22)	>0.1	1.06 (0.66 to 1.72)
101-200 (n=68)	18 (26)	>0.1	1.30 (0.87 to 1.93)
>200 (n=550)	133 (24)	0.017	1.19 (1.02 to 1.38)

*None of the men was tested less than 3 days after injury.

†Relative to the rate in the general population of young men with a dysfunctional score (20.4%).

175/573 (30.5%) of those injured at age 19 or more (Fisher's exact test $P = 0.01$, relative risk 0.78 (0.65 to 0.94)). Both rates were significantly raised above the population rate of 20.4% (binomial probabilities 0.019 and < 0.001 respectively), but the latter clearly more so than the former.

To estimate the magnitude of the higher risk for concussion given a dysfunctional cognitive level, we restricted the sample to a group with a constant exposure time—that is, men who had all sustained concussion between the same ages. We selected those born in the years 1970 and 1971 who were injured between their 16th and 22nd birthdays ($n = 574$). All such men had attained the age of 22 before the end of 1993, the final date for our registration of concussion from the national register of admissions, and they had all been injured during a 6 year exposure time.

Of these 574 subjects, 165 (28.7%) had a dysfunctional score. Assuming that this proportion would also have applied to the 85 corresponding men who did not appear before the draft board yielded an estimate of 189 subjects with a dysfunctional score and 470 with a non-dysfunctional score. In the years 1970 and 1971 there were 75 337 live male births in Denmark. Ignoring the probably small loss from death or emigration before age 18 and taking the proportion of men with a dysfunctional score among all of these individuals to be 20.4% yields estimates of 15 369 men with a dysfunctional score and 59 968 men with a normal score. On this basis the prevalence of concussion from age 16 to 22 is 1.23% (189/15 369) among men with a dysfunctional score and 0.78% (470/59 968) among men with a non-dysfunctional score. The relative risk for concussion among men with a dysfunctional score compared with the rest of the population is 1.57 (1.33 to 1.86).

Discussion

This study is based on limited medical and neuropsychological data derived from a national register and concerns only one sex and a restricted age range. Within these constraints, however, our study has some advantageous methodological features. The fact that different men were tested at different times relative to injury means that our finding of an apparently short recovery time after injury (within 1 week) is not attributable to practice effects—that is, a subject with concussion appearing to improve quickly with time simply because of repeated experience with a test and test situation. Practice effects on retesting are a potential artefact to which Binder drew attention in a review of the early literature.¹⁵ The testing used here was completely removed from the medical environment and was not prompted by the injury. The potential complicating factor of malingering with a view to litigation and other financial incentives, which may influence test performance,¹⁶ does not arise.

That we found an increase in cognitive dysfunction within the first week after injury is in agreement with most other studies of concussed patients examined within the same short time.⁴ In contrast with some other studies, however, our data showed no evidence of effects lasting longer than 1 week. Two elements may be involved. The test used by the draft board, on which our study is based, may be less sensitive to subtly

Key messages

- This study supports earlier evidence of a direct influence of concussion on cognitive function of comparatively short duration (up to 1 week)
- Cognitive dysfunction is also a risk factor for sustaining concussion
- The risk factor is greater among young adults than among adolescents

reduced cognitive capacity than the measures used in the other studies. Thus Gronwall and Wrightson found deficits after concussion at intervals over 35 days using a demanding information processing task specifically designed to monitor recovery after traumatic brain injury.¹⁷ A recent study using the same test reported deficits persisting at 3 months after concussion.⁸ Similarly Hugenholtz et al reported deficits at 30 days after injury and (non-significantly) at 3 months after injury, using a complex and lengthy procedure to test their subjects' reaction time.⁷ The cognitive test in our study, however, imposes heavy demands on mental speed and complex problem solving and, lasting 45 minutes, is probably also sensitive to fatigue effects. The apparent short duration of effect in our study may also result in part from our subjects being younger than those in most comparable studies. Recovery from concussion has repeatedly been shown to be quicker for younger than for older patients.^{10 15}

We are unaware of any other population study that has reported cognitive test data for individuals who subsequently sustain concussion. Our results, however, suggest strongly that cognitive dysfunction, as defined by a deficient performance on the draft board test, constitutes a predisposing risk for concussion, increasing the risk by a factor of about 1.6. We also found that the risk is greater among those injured at age 19–24 than among those injured at age 16–18. This suggests that cognitive dysfunction plays a smaller role in the aetiology of concussion among the latter age group, possibly because the injuries often result from play and sports activities and are more a function of non-cognitive factors such as deficient motor coordination, impulsiveness, and sheer ill luck. In contrast, among young adults the injuries may be related more often to alcohol or violence or other factors associated with reduced cognitive abilities. This interpretation is broadly consistent with reports of other social dispositions—for example, higher rates of head injury among alcoholics¹⁸ and among individuals who have experienced adverse life events.⁹ Our finding is perhaps particularly consistent with the observation that concussion occurs more commonly among individuals of lower socioeconomic status.¹⁹

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Responses of consecutive patients to reassurance after gastroscopy: results of self administered questionnaire survey

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Abstract

Objective: To study the time course and prediction of responses to reassurance after gastroscopy showing no serious illness.

Design: Selection of consecutive patients were assessed before gastroscopy, immediately after reassurance, and at follow up at 24 hours, 1 week, 1 month, and 1 year. Responses of subgroups of patients identified as high, medium, and low health anxiety by the health anxiety questionnaire were analysed.

Setting: Endoscopy clinic in a general hospital.

Intervention: Oral reassurance that there was "nothing seriously wrong."

Subjects: One consultant physician and 60 patients aged 18-74 referred for gastroscopy.

Main outcome measures: Physician's and patients' ratings of the extent of the reassurance and patients' ratings of their anxiety about their health and of their illness belief.

Results: There was good agreement between the patients and the physician about whether reassurance had been given. Health anxiety and illness belief decreased markedly after reassurance. Patients with high health anxiety showed a significant resurgence in their worry and illness belief at 24 hours and 1 week, and these levels were maintained at 1 month and 1 year later. Patients with medium levels of health anxiety showed a reduction in worry and illness belief after reassurance, and this was generally maintained during follow up. Patients with low health anxiety maintained low levels of health worry and illness belief throughout the study. Partial correlation analyses showed that the levels of worry and illness belief after reassurance were predicted by the health anxiety questionnaire. This measure also had

predictive value beyond that of a measure of general anxiety.

Conclusions: Medical reassurance results in a reduction of worry about health and of illness belief, but this may be very short term. Measurable individual differences in health anxiety can be used to predict the response to reassurance.

Introduction

Given the high incidence of patients presenting to medical services without serious illness, medical reassurance is very common.^{1 2} Indeed, Bass said that reassurance is probably the most widely used but poorly understood psychotherapeutic intervention in medicine.³ However, some patients who have received reassurance remain concerned^{4 6} and repeatedly attend for further consultations. Patients who remain anxious about their health experience distress and are a considerable drain on healthcare resources. The appropriateness of giving reassurance in all cases and the most effective ways of reassuring patients are therefore debatable. Some clinicians advocate reassurance^{7 8} while others cite problems associated with repeated reassurance.⁹

Individual differences in response to reassurance are predicted by the cognitive model of health anxiety. This model hypothesises that anxiety about health arises from a combination of dysfunctional beliefs about illnesses and their consequences in general and the presence of critical incidents such as the experience of symptoms. The beliefs lead to an interpretation of symptoms as indicating a serious illness. Several factors are proposed to maintain persistent health anxiety despite reassurance. Individuals anxious about their health are excessively preoccupied with their internal bodily state. A perceptual bias results in the selective interpretation of and attention