Eur J Trauma Emerg Surg (2015) 41:299–305
DOI 10.1007/s00068-014-0429-0

ORIGINAL ARTICLE

Young adults with mild traumatic brain injury—the influence of alcohol consumption—a retrospective analysis

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Received: 31 March 2014 / Accepted: 20 June 2014 / Published online: 16 July 2014

Abstract

Purpose Alcohol abuse has been associated with aggressive behavior and interpersonal violence. Aim of the study was to investigate the role of alcohol consumption in a population of young adults with mild traumatic brain injuries and the attendant epidemiological circumstances of the trauma.

Subjects and methods All cases of mild traumatic brain injury among young adults under 30 with an injury severity score <16 who were treated as inpatients between 2009 and 2012 at our trauma center were analyzed with regard to the influence of alcohol consumption by multiple regression analysis.

Results 793 patients, 560 men, and 233 women were included. The age median was 23 (range 14–30). Alcohol consumption was present in 302 cases. Most common trauma mechanism was interpersonal violence followed by simple falls on even ground. Alcohol consumption was present more often in men, unemployed men, patients who had interpersonal violence as a trauma mechanism, and in patients who were admitted to the hospital at weekends or during night time. It also increased the odds ratio to suffer concomitant injuries, open wounds, or fractures independently from the trauma mechanism. Length of hospital stay or incapacity to work did not increase with alcohol consumption.

Conclusions Among young adults men and unemployed men have a higher statistical probability to have consumed alcohol prior to suffering mild traumatic brain injury. The most common trauma mechanism in this age group is interpersonal violence and occurs more often in patients who have consumed alcohol. Alcohol consumption and interpersonal violence increase the odds ratio for concomitant injuries, open wounds, and fractures independently from another.

Keywords Alcohol · Traumatic · Brain · Injury · Fracture · Wound

Introduction

Traumatic brain injury (TBI) has an estimated incidence of 91–546 per 100,000 people in Europe [1]. An estimated 70–90 % of all TBIs are mild TBIs (mTBIs) [2]. Among patients with mTBI, a peak in frequency in the second to third decade in life has been reported (i.e., young adults) [3–5].

Alcohol consumption and binge drinking are more frequently seen in adolescents and young adults [6, 7]. Recent studies have suggested neuroprotective effects of alcohol on TBI [8]. Nevertheless, the influence of alcohol consumption on trauma mechanism, concomitant injuries, and epidemiological data has been rarely addressed in patients with mTBI. Because rates of alcohol consumption and the incidence of mTBIs among young adults and adolescents are both higher than in other patient groups, a closer look at this population is of interest.

The aim of the present study is to investigate the role of alcohol consumption in a population of young adults with

Electronic supplementary material The online version of this article (doi:10.1007/s00068-014-0429-0) contains supplementary material, which is available to authorized users.

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mTBIs and the attendant epidemiological circumstances of the trauma. Moreover, we evaluate whether alcohol consumption increases the risk for concomitant injuries such as open wounds or fractures.

Subjects and methods

We retrospectively reviewed all cases of mTBIs that were treated as inpatients in our supraregional trauma center [9] between 2009 and 2012. The data were gathered by a request to our in-hospital medical controlling database, where the diagnosis-related group (DRG) for every inpatient is retained.

All files of patients with a DRG code B80Z ("head trauma", SwissDRG version 1.0) were reviewed between April 2013 and August 2013. mTBI was defined as a head trauma with an initial Glasgow Coma Score (GCS) of 13–15 at the time of admission and/or impaired consciousness, focal neurologic findings, persistent vomiting, or seizures [10, 11].

Levels of blood alcohol were measured at the time of admission to our emergency department; a positive blood alcohol level was defined as being >2.3 mmol/l (>10.6 mg/dl). We also recorded gender, age, social status, trauma mechanism, concomitant injuries (open wounds, fractures, or intracranial bleeding), and findings in the obligatory computer tomography (CT) scan of the head. Furthermore, we registered the length of the hospital stay and the duration over which the patient was unable to work. Only patients with an injury severity score <16 were included in the study.

Statistical analysis

Statistics were calculated using SPSS (IBM SPSS Statistics for Windows, Version 20.0 Armonk, NY, USA) in collaboration with an institutional biostatistician in August 2013.

First, patients under the influence of alcohol were compared with sober patients with regard to differences in social status, admission time to hospital (nighttime (0–6 o'clock) compared with daytime; weekends (Saturdays, Sundays) compared with working days), length of hospital stay, number of sick days, concomitant injuries in general, open wounds, fractures, and the trauma mechanism. Second, patients with interpersonal violence were compared with all other trauma mechanisms with regard to the influence of interpersonal violence on concomitant injuries in general, open wounds, and fractures. Third, we analyzed a specific subgroup of patients who had a simple fall from a standing position as the trauma mechanism. We compared patients under the influence of alcohol with sober patients within this group with regard to concomitant injuries in general, open wounds, and fractures. Crosstabs were computed using Pearson's Chi-squared test or Fisher's exact tests, where appropriate. The level of significance was defined as $p < .05$.

As a fourth step, we performed a multiple logistic regression analysis to calculate the adjusted odds ratio (OR) for positive alcohol consumption and interpersonal violence with regard to their influence on concomitant injuries in general, open wounds, and fractures.

Results

Patient baseline characteristics

The request to our database resulted in 795 patients who were 30 years or younger and were treated as inpatients with the diagnosis B80Z. Two patients did not fulfill the above criteria and were excluded from the analysis; we therefore retained 793 cases in our study. The patients were predominantly male (560/793; 70.6 %) with a male/female ratio of 2.4:1; the median patient age was 23 years (range 14–30 years) (Tables 1, 2).

Imaging of the head was performed in 98.9 % (784/793) of all patients. We used cranial CT for the vast majority of cases (783/784, 99.9 %); magnet resonance imaging was performed in one patient and a pure clinical observation was made in nine cases. Intracranial bleeding was seen in two cases (2/793, 0.3 %) and treated conservatively. Both patients with intracranial bleeding had consumed alcohol.

Alcohol and gender

Alcohol consumption was documented in 38.1 % (302/793) of cases. Of these, data on alcohol blood levels were available for 299 patients with a median of 40.6 mmol/l (187.1 mg/dl) [range 2.7–104.4 mmol/l (12.4–481.1 mg/dl)]. Male patients were more likely to be under the influence of alcohol (257/560, 45.9 %) compared with women (45/233, 19.3 %) ($p < .001$).

Alcohol and social status

Employed or self-employed patients constituted 62.3 % (494/793) of patients; 16.8 % (133/793) were students or pupils, 8.4 % (67/793) were unemployed, 1.8 % (14/793) were asylum-seekers, 1.3 % (10/793) were disabled, and 9.5 % (75/793) had an unknown social status. All unemployed patients were male and significantly more likely to have consumed alcohol than others (52.2 %, 35/67 versus 35.9 % (234/651), $p = .006$).

Table 1 General results

		Patients	Alcohol		p value
			Sober patients	Positive alcohol consumption	
Gender	Men	70.6 % (560/793)	54.1 % (303/560)	45.9 % (257/560)	$p < .001$
	Women	29.4 % (233/793)	80.7 % (188/233)	19.3 % (45/233)	
	Ratio men:women	2.4:1	1.6:1	5.7:1	
Age	Mean	22.9	22.9	22.9	Not applicable
	Median	23	23	23	
	Range	14–30	14–30	15–30	
Diagnosis	Cranial computer tomography	98.7 % (783/793)	Not applicable	Not applicable	Not applicable
	Magnet resonance imaging	0.1 % (1/793)			
	Clinical diagnosis	1.1 % (9/793)			
Blood alcohol levels	Mean	Not applicable	Not applicable	40.7 mmol/l (187.6 mg/dl)	Not applicable
	Median			40.6 mmol/l (187.1 mg/dl)	
	Range			2.7–104.4 mmol/l (12.4–481.1 mg/dl)	
Social status	Unknown	9.5 % (75/793)	56.0 % (42/75)	44.0 % (33/75)	Not applicable
	Unemployed	8.4 % (67/793)	47.8 % (32/67)	52.2 % (35/67)	$p = .006$
	Asylum seekers	1.8 % (14/793)	64.1 % (417/651)	35.9 % (234/651)	
	Disabled	1.3 % (10/793)			
	Employed or self-employed	62.3 % (494/793)			
	Students or pupils	16.8 % (133/793)			
Admission time (o'clock)	0–6	36.8 % (292/793)	30.1 % (88/292)	69.9 % (204/292)	$p < .001$
	6–24	63.2 % (501/793)	80.4 % (403/501)	19.6 % (98/501)	
Admission day (working day or weekend)	Working day	50.9 % (404/793)	79.0 % (319/404)	21.0 % (85/404)	$p < .001$
	Weekend	49.1 % (389/793)	44.2 % (172/389)	55.8 % (217/389)	
Length of hospital stay (days)	Mean	1.2	1.3	1.2	$p = .051$
	Median	1	1	1	
	Range	1–9	1–9	1–5	
Length of work incapacity (days)	Mean	5.5	5.7	5.2	$p = .084$
	Median	5	5	5	
	Range	0–45	0–45	0–32	
Trauma mechanism known in 765 patients	Interpersonal violence	31.1 % (238/765)	34.5 % (82/238)	65.5 % (156/238)	$p < .001$
	All others (confer supplementary material)	68.9 % (527/765)	76.7 % (404/527)	23.3 % (123/527)	

Table 2 Concomitant injuries

		Concomitant injuries in general		Open wounds		Fractures	
Concomitant injuries in all 793 patients	Sober patients	76.2 % (374/491)	$p < .001$	38.7 % (190/491)	$p < .001$	18.1 % (89/491)	$p < .001$
	Positive alcohol consumption	91.1 % (275/302)		63.9 % (193/302)		38.7 % (117/302)	
Trauma mechanism known in 765 patients	Interpersonal violence	91.6 % (218/238)	$p < .001$	58.4 % (139/238)	$p < .001$	39.5 % (94/238)	$p < .001$
	All other trauma mechanisms	77.2 % (407/527)		43.8 % (231/527)		19.5 % (103/527)	
Adjusted odds ratio	Alcohol	2.5 (95 % CI 1.5–4.1)		3.0 (95 % CI 2.1–4.1)		2.2 (95 % CI 1.5–3.1)	
	Interpersonal violence	2.3 (95 % CI 1.3–3.9)		1.2 (95 % CI .8–1.6)		2.0 (95 % CI 1.4–2.8)	
	Both factors	5.7		3.4		4.3	
Concomitant injuries in 153 patients who had fallen on even ground from standing position	Sober patients	71.4 % (75/105)	$p = .039$	41.0 % (43/105)	$p = .005$	12.4 % (13/105)	$p = .036$
	Positive alcohol consumption	87.5 % (42/48)		66.7 % (32/48)		27.1 % (13/48)	

Alcohol and time of admission

There was a characteristic distribution pattern for patients under the influence of alcohol with regard to day of the week and time of admission. The fraction of patients with mTBI under the influence of alcohol was significantly higher between midnight and 6 am (69.9 %, 204/292 versus 19.6 %, 98/501, $p < .001$) and on the weekends (Saturday/Sunday, 55.8 %, 217/389 versus 21.0 %, 85/404, $p < .001$) than during the day and late evening and on workdays.

Alcohol and return to work

The median length of hospital stay was 1 day (range 1–9 days). Patients under the influence of alcohol were hospitalized for a median of 1 day (range 1–5 days) and sober patients were also characterized by a median hospital stay of 1 day (range 1–9 days). There was a tendency toward a shorter length of hospital stay for patients who had consumed alcohol, but this finding was not statistically significant ($p = .051$). Return to work was possible after a median of 5 days (range 0–45 days). Again, the statistical analysis did not reveal any relevant differences between patients who were or were not under the influence of alcohol ($p = .084$).

Alcohol and concomitant injuries

Concomitant injuries were diagnosed in 81.8 % (649/793) of all patients. Patients who had consumed alcohol more frequently showed concomitant injuries (91.1 %, 275/302) than sober patients (76.2 %, 374/491, $p < .001$).

In all patients, open wounds were the leading finding (48.3 %, 383/793), followed by fractures (26.0 %, 206/793). Patients under the influence of alcohol had more open wounds (63.9 %, 193/302 versus 38.7 %, 190/491, $p < .001$) and were more likely to have one or more fractures (38.7 %, 117/302 versus 18.1 %, 89/491, $p < .001$) compared with sober patients.

Alcohol and violence

The trauma mechanism was documented in 765 patients. The most common trauma mechanism was interpersonal violence (31.1 %, 238/765), followed by falls on level ground from a standing position (20.0 %, 153/765). Of the patients with a known trauma mechanism, 36.5 % (279/765) had consumed alcohol. There was a significant association between interpersonal violence as a trauma mechanism and being under the influence of alcohol ($p < .001$); 65.5 % (156/238) of individuals who were involved in interpersonal violence had positive blood alcohol levels.

Patients with mTBI after interpersonal violence were also more likely than patients with all other trauma mechanisms to have concomitant injuries in general (91.6 %, 218/238 versus 77.2 %, 407/527, $p < .001$) and to be diagnosed with open wounds (58.4 %, 139/238 versus 43.8 %, 231/527, $p < .001$) and fractures (39.5 %, 94/238 versus 19.5 %, 103/527, $p < .001$).

Alcohol consumption and interpersonal violence were independent risk factors for the presence of concomitant injuries after mTBI [adjusted OR: 2.5 (95 % confidence interval (CI) 1.5–4.1) and 2.3 (95 % CI 1.3–3.9), 5.7 if both factors were present].

The adjusted OR to have an open wound after mTBI was 3.0 (95 % CI 2.1–4.1) for patients under the influence of alcohol and 1.2 (95 % CI 0.8–1.6) for patients with mTBI after interpersonal violence (if both factors were present, the OR was 3.4).

The adjusted OR to have a fracture was 2.2 (95 % CI 1.5–3.1) for patients who consumed alcohol and 2.0 (95 % CI 1.4–2.8) for patients who were involved in interpersonal violence (if both factors were present, the OR was 4.3).

Alcohol and falls

In 153 patients, a fall on level ground from standing position was the primary cause of mTBI. Also, in this subgroup, patients had a higher probability of concomitant injuries (87.5 %, 42/48 versus 71.4 %, 75/105, $p = .039$), open wounds (66.7 %, 32/48 versus 41.0 %, 43/105, $p = .005$), and fractures (27.1 %, 13/48 versus 12.4 %, 13/105, $p = .036$) if they were under the influence of alcohol.

Discussion

In the present study, we analyzed the role of alcohol consumption in a population of young adults with mTBIs and the attendant epidemiological circumstances of the trauma, as well as the risk for concomitant injuries such as open wounds or fractures.

The current literature has shown that adolescent males and young men have a higher risk for alcohol abuse and binge drinking compared with women [1, 12, 13]. An increased rate of alcohol consumption among unemployed men is common [14–18], which is consistent with our data; a large fraction of our patients who were under the influence of alcohol were either men or unemployed. Alcohol consumption studies from other European countries have shown that patients of all ages with TBI were under the influence of alcohol in 24–51 % of cases [1, 3]. In our population, 38.1 % of all patients had consumed alcohol before suffering trauma, which shows that young adults with mTBI do not have higher rates of alcohol consumption compared with patients of other age groups.

It is known that risk-taking behavior and impulsivity are increased [19, 20] and aggressive behavior and fighting occur more often after alcohol ingestion, especially among young adults [21, 22]. Other TBI studies observed interpersonal violence as the leading trauma mechanism in 1–28 % of their patients [1, 23]. Since 31.1 % of our patients had interpersonal violence as the leading trauma mechanism, our study has a remarkably higher rate of interpersonal violence, which suggests that among young adults interpersonal violence is a much more common mechanism for mTBIs compared with all other age groups and all grades of traumatic head injury. This finding is in line with the fact that alcohol consumption was strongly linked to interpersonal violence as a trauma mechanism in our study. As has been reported in the literature [6], the time and day of the week of admission exhibited a characteristic pattern, with more patients being under the influence alcohol during the night and on weekends. Our data do not conclusively prove, however, that it was the consumption of alcohol itself that modified our patients' behavior toward being more aggressive.

The median length of hospital stay in our study was 1 day (range 1–9 days). This length is shorter than other studies that reported durations of inpatient treatment between 1 and 28 days [24, 25]. Schmal et al. [24] also described a shorter hospital stay for patients under the influence of alcohol with mTBI compared with sober patients. Although our data also showed the same tendency, our results were not significant. Data from the literature with regard to return to work were not available for comparison. The assumption that patients under the influence of alcohol and mTBI had a longer time to return to work could not be confirmed.

Although other studies have revealed that being intoxicated is correlated with a higher chance of suffering a fracture [26, 27] little is known about the influence of alcohol consumption on concomitant injuries among young adults with mTBI. Leong et al. [28] reported concomitant injuries in 78 % of all age groups with TBI but did not include information on the influence of alcohol abuse on those injuries. Our data fill this gap: alcohol consumption and interpersonal violence were both shown to be independent risk factors for the presence of concomitant injuries after mTBI.

Even though our data do not prove a direct causality, we believe that the higher statistical probability of suffering concomitant injuries, open wounds, and fractures is explained by the generally accepted alcohol-related impairment of neurological functioning in the form of reflexes and visual disturbances [29, 30].

In this context, it is important to note that both mTBI and alcohol can lead to neurological impairment. It is crucial, therefore, to differentiate between both causes and not to forget that both can be present—as shown by our data.

Schmal et al. [24] reviewed 1,841 patients with mTBI and reported a deteriorating health status due to undiagnosed intracranial events in three cases. In their study, only 69.5 % of patients had received a cranial CT. Two of our patients were shown to have intracranial bleeding by cranial CT scan and both had ingested alcohol. Even though the treatment was conservative in these two cases, we believe that CT is necessary in patients with trauma of the head who are under the influence of alcohol. The clinical evaluation in these patients can be difficult and may lead to the underestimation of potentially fatal brain injuries.

Although mTBI is a common result of all kinds of trauma mechanisms, the costs and cost effectiveness of this disease have been seldomly addressed in the literature [31]. As our study also did not include any data on the economic impact of this disease, more research is needed to investigate the costs and cost effectiveness of mTBI.

Conclusions

Young adult men and unemployed men had a higher statistical probability of having had consumed alcohol prior to suffering mTBI. The most common trauma mechanism in this age group was interpersonal violence. This trauma mechanism occurred more often in patients who had consumed alcohol. The length of inpatient treatment and the length of work incapacity did not increase with alcohol consumption. Alcohol consumption and interpersonal violence were both shown to be independent risk factors for the presence of concomitant injuries after mTBI. Therefore, doctors must raise their awareness for open wounds and fractures when treating patients with mTBI, particularly if the patient has consumed alcohol and/or has been involved in interpersonal violence.

Conflict of interest Philip Johannes Felix Leute has no conflict of interest. Rudolf Nikolaus Maria Moos has no conflict of interest. Georg Osterhoff has no conflict of interest. Jörk Volbracht has no conflict of interest. Hans-Peter Simmen has no conflict of interest. Bernhard Dimitris Ciritsis has no conflict of interest.

Ethical standard It is a retrospective study which was performed in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

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