A Rare Case of Drunk Driving in Japan: Alcohol-related Sleepwalking

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Abstract

Alcohol has been identified as a potential precipitating factor for parasomnia, particularly sleepwalking (SW), which categorized in a classic form of non-rapid eye movement sleep arousal disorder. The police consulted us regarding the association between alcohol consumed, blood alcohol concentration, and the behavior of a drunken driving suspect with complete memory loss. We report a rare case of a Japanese drunk driver who possibly experienced alcohol-related SW, based on the statements of the suspect, pharmacokinetic analyses of breath alcohol concentration, testimonies of the witnesses, driving recorder data, and medical records. We concluded that the suspect should be considered non-compos mentis when the drunken driving offense was committed because he might not have been able to control his behavior while in a SW state. However, if he again commits crimes during SW under the influence of alcohol, the crimes should not be excusable because he is now aware of his alcohol-related complicated characteristics.

Keywords: Drunk driving; Sleepwalking; Parasomnia; Amnesia; Blood alcohol concentration

Introduction

Alcohol is the most commonly used drug in the world, and its abuse is a primary factor in several transport, domestic, and industrial accidents [1]. Driving a car under the influence of alcohol has been a major social problem in Japan. A new, stricter road traffic law was enacted against alcohol-related traffic accidents, injuries, and fatalities in 2002, which has resulted in a decrease in alcohol-related traffic fatalities; however, drunk driving is still being reported [2,3]. The police or the public prosecutor often consult us for pharmacokinetic analyses of blood alcohol concentration (BAC) and interpretation of the effects of consumed alcohol on driving ability and/or occurrence of road traffic accidents [4].

Alcohol has been identified as a potential precipitating factor for parasomnia, particularly sleepwalking (SW). SW, categorized in classic form of a non-rapid eye movement (NREM) sleep arousal disorder, is a condition wherein an individual arises and ambulates without fully awakening. Although it is very common in children, it is rare in adults, but it can also be triggered by many drugs and stimulants, including alcohol. In the SW state, an individual lacks conscious awareness and suffers from severe impairment of cognitive functions, such as attention, memory, social interaction, and planning. Nevertheless, the individual is capable of complex motor behavior, which means that SW could have devastating outcomes because of the risk associated with the behavior of going outside [5-7]. Previous case studies in Western countries have reported defendants who have alleged to have been in a SW state during criminal acts, such as murders, attempted murders, assaults, and rapes, and who have claimed that alcohol intoxication was responsible for the occurrence of such criminal acts with SW [8,9]; however, criminal cases of alcohol-related SW have rarely been reported in Japan. In this report, we present a rare case of a Japanese drunk driver with complete memory loss, whose behavior was likely to have resulted from alcohol-related SW.

Case Report

Case history

A male suspect in his fifties (body weight, 71 kg) followed his usual routine; he took his mobile recharger, went to work by car, and then changed into his work clothes and shaved his face in the dressing room after arriving at his office.

The suspect entered the workroom at 5:00 p.m., although it was his holiday and his usual work shift was daytime. He collided with a door when entering the workroom and staggered in. The first thing he said was "Good morning," somewhat inarticulately, but he did not react to the responses from his colleagues. After that, looking down, he sat in his seat and absentmindedly said to a colleague who tried to explain to him that it was not his work day. He did not appear to have any symptoms such as paralysis, seizure, vomiting, or injury, and his heart rate was 91 beats per min and blood pressure was 134/87 (Some paramedics were working because his office was a fire station). However, his face was flushed and his breath smelled of alcohol. His colleagues felt that he looked different than usual and were puzzled by his appearance. The superiors came to the scene about 45 min later and tried to conduct an interview with him; they ultimately called the police after surmising from the smell of alcohol that he had driven to the office while under the influence of alcohol. After the police investigation, the man was found to have a breath alcohol concentration (BrAC) of 0.55 mg/l at 7:07 p.m., which exceeded the legal limit in Japan.

The suspect confessed that he had woken up at around 4:00 a.m. and visited a hot spring, which he enjoyed until around 6:30 a.m., because it was a holiday for him. He had played a Japanese pinball game at a pinball saloon for about 30 min from around 9:00 a.m. and then bought some food at a supermarket. Finally, he had reached home at around 12:00 p.m., drunk two glasses of an alcoholic beverage with 25% ethanol content (the police determined this amount to be 338 ml by reproducing the alcohol consumed by the suspect) with lunch until
around 12:30 p.m., fallen asleep watching TV in his living room, and next remembered being interviewed by his superiors. It was the first time he had experienced complete memory loss after consuming alcohol. He was perplexed and could not understand his behavior.

Data from the driving recorder on his car showed dangerous driving for around 25 km from 3:38 p.m. to 4:12 p.m. on that day. The center line and the roadside line were each crossed three times, a red light was gone through, contact with a pole occurred while making a left turn, the car was run in the reverse direction once in the opposite lane, and finally, it took around 10 min to put the car into his office parking lot.

Two days later, the suspect had a medical examination and was diagnosed with transient global amnesia (TGA) because the episode suddenly occurred with memory loss within 24 h accompanied by no symptoms before and after the period, and it could not be attributed to other neurological conditions, such as epilepsy or stroke, based on electroencephalography, magnetic resonance imaging, and magnetic resonance angiography. Neither arrhythmia nor cardiac abnormality was seen in the electrocardiogram or echocardiogram. The blood tests showed diabetes mellitus, hyperlipidemia, and hyperuricemia, but each condition was mild or moderate. The suspect did not take medications or supplements and had no history of head trauma.

The police consulted us regarding the association between alcohol consumed, BAC, and the behavior of the drunk driving suspect with complete memory loss.

**Pharmacokinetic analyses of BAC**

Widmark's formula was used to estimate BAC; this formula relates to the one-compartment model with zero-order elimination kinetics [10]. The BACs were estimated from noninvasive BrAC measurement. A plasma/breath ratio of 2000:1 is typically used in Japan [3]. The $\beta$ value, the zero-order elimination rate constant, used was 0.16 or 0.20 [4].

Our simulation presumed that the suspect had drunk the alcoholic beverage at 12:15 p.m., which is the intermediate time between 12:00 p.m. and 12:30 p.m., because the precise start time of drinking was unknown. First, we estimated the forward time-course of BAC based on the amount of alcohol consumed because the theoretical initial BAC (C₀) was 1.35 mg/ml, which is sufficiently high not to be considered the influence of the absorption phase or first pass effect. Consequently, when $\beta_{00}$ values were 0.16 or 0.20, the calculated BAC at 7:07 p.m. was 0.25 or 0 mg/ml, respectively, which are markedly lower values than the BAC of 1.1 mg/ml converted from the actual measured BrAC of 0.55 mg/ml (Figure 1). The $\beta_{00}$ value calculated based on this forward time-course of BAC was 0.04 mg/ml/h, which is too low to be realistic for a living human without serious illness. These results suggested that the suspect misunderstood the amount of alcohol consumed.

Then, we estimated the backward time-course of BAC from the actual measured BrAC. When $\beta_{00}$ values were 0.16 or 0.20, the calculated BAC values during the time the suspect was driving (3:38 p.m. to 4:12 p.m.) were 1.66-1.57 or 1.80-1.68 mg/ml, respectively, which suggested that he committed a drunk driving offense. When $\beta_{00}$ values were 0.16 or 0.20, the calculated BACs at 12:15 p.m. were 2.20 or 2.47 mg/ml, respectively, which are markedly higher than the C₀ value of 1.35 mg/ml calculated based on the amount of alcohol consumed (Figure 1). These results again indicated that the suspect misunderstood the amount of alcohol consumed. The estimated amount of alcohol consumed was 546 or 615 ml of an alcoholic beverage with 25% ethanol content when $\beta_{00}$ values were 0.16 or 0.20, respectively.

**Figure 1:** Estimation of the time-course of BAC when the $\beta_{00}$ value was 0.16 ($\sim\sim$) and 0.20 (· ·) using Widmark’s formula. The upper two lines show the time-course calculated backward from the BAC based on the actual measured BrAC; the white circle (○) shows 1.1 mg/ml at 7:07 p.m. The lower two lines show the time-course calculated from the amount of drinking; the black circle (●) shows the C₀ value of 1.35 mg/ml at 12:15 p.m. The asterisk (*) shows the suspect's driving period.

**Discussion**

In the present case, we describe a rare case of a Japanese drunk driver with complete memory loss. We evaluated the case based on the pharmacokinetic analyses of BrAC, testimonies of the witnesses, driving recorder data, medical records, and statements of the suspect. The suspect actually had consumed approximately 1.6 to 1.8 times the amount of alcohol mentioned in his statement because the peak value of BAC was calculated to be >2 mg/ml; then, he fell asleep due to the alcohol-induced decreased sleep latency. Finally, he drove his car to work "as usual". There is no consensus among sleep experts regarding the association between alcohol and SW. Some authors have argued that there is no direct experimental evidence that alcohol predisposes or triggers SW due to increases in slow-wave sleep, from which SW results from incomplete arousal; hence, SW should not be diagnosed in the presence of severe alcohol intoxication [8,11], whereas other authors have declared that precluding the relationship based on lack of evidence is inappropriate and may have unwarranted medico-legal implications for defendants [12-15]. In the present case, no evidence based on a sleep-expert clinical interview, polysomnographic sleep study with video monitoring, or the same study with alcohol ingestion to elucidate the cause of his behavior; however other evidences were suggestive of alcohol-related SW.

According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, the diagnostic criteria for SW in NREM sleep arousal disorders are the following: (1) experiencing recurrent episodes of incomplete awakening from sleep, usually occurring during the first third of the major sleep episode, accompanied by SW; (2) recalling little or no dream imagery; (3) showing amnesia regarding the episodes, (4) experiencing clinically significant distress and impairment in social, occupational, or other important areas of functioning owing to the episodes, (5) experiencing disturbance not attributable to the physiological effects of a substance, and (6) showing coexisting mental
and medical disorders that do not justify the episodes of SW. The definitions of SW within the criteria are as follows: repeated episodes of rising from bed during sleep and walking about; the individual has a blank, staring face while SW; the individual is relatively unresponsive to the efforts of others to communicate with him or her; and the individual can be awakened only with great difficulty [5]. In the present case, the suspect's episode at least partially met all the criteria except the fifth one. The onset seemed to occur approximately 2 hours after falling asleep; it was around the first third of his usual major sleep episode. It is unknown whether the onset was recurrent or not, but the suspect was not aware of a similar previous experience. His appearance and condition at his office were consistent with the definitions of SW, and amnesia about driving to work was present. He had not used other substances and had neither coexisting mental nor medical disorders. His episode differs from the immediate biochemical effects of alcohol, such as alcoholic blackout [16] or pathological intoxication [17].

In Japan, the maximum alcohol concentration permitted by the Road Traffic Act is 0.15 mg/l when measured by breath, so a BAC of 0.3 mg/ml is considered the legal limit [3]. In the present case, the pharmacokinetic analyses of BAC based on the actual measured BrAC when β60 values were 0.16-0.20 showed 1.66-1.80 mg/ml during driving. The immediate biochemical effects of alcohol on the brain are either depressing or stimulating in nature, depending on the BAC resulting from the amount of alcohol consumed. Voluntary motor actions usually become perceptibly clumsy at 1.0 mg/ml; at 2.0 mg/ml, clear sensory and cognitive impairment limited to amnesia. TGA is also characterized by the absence of influence of alcohol has not been yet recognized enough, so it should be extended among the police, the public prosecutor and the public in Japan. It is desirable that the interpretation of a sleep and alcohol related criminal act should be carefully constructed by experts of both alcohol-related medicine and sleep medicine.

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