

Snowboard Head Injury: Prospective Study in Chino, Nagano, for Two Seasons from 1995 to 1997

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Background: The popularity of snowboarding has been growing rapidly throughout the world. To date, however, the risk of head injury associated with this relatively new winter sport, especially in comparison with alpine skiing, has not been well analyzed. This study was conducted to assess the risk of head injury in snowboarding and to elucidate its features in comparison with skiing head injury.

Methods: We prospectively analyzed 301 cases of head injuries related to snowboarding or skiing experienced from December of 1995 to May of 1997 at our institution, which is located close to the most popular skiing areas in Japan. Of those injuries, 143 cases were snowboard related and 158 cases were ski related. In addition to appropriate medical evaluation and medical care, detailed examination was performed on every patient to determine various factors, including sex, age, skill level, cause and mechanism of the accident, and the side of impact to the head. The data are statistically analyzed to elucidate unique features of snowboard head injury.

Results: During the study period, 2.2 million snowboarders

and 4.2 million skiers visited the five skiing facilities that are covered by our hospital. Thus, the incidence of head injury was 6.5 per 100,000 visits for snowboarders and 3.8 per 100,000 visits for skiers. Beginning snowboarders more frequently sustained head injuries compared with beginning skiers (60 of 142 vs. 48 of 154, $p = 0.022$). Likewise, frequent causes of snowboarding head injuries were fall during jumping (43 of 139 vs. 2 of 147, $p < 0.0001$), falling backward (67 of 127 vs. 49 of 144, $p = 0.001$), and occipital impact (67 of 126 vs. 49 of 147). More importantly, there were nine major head injury cases (6.3%) in snowboard head injuries in contrast to only two such cases found in skiing head injuries (1.3%). Of 11 major head injury cases, 10 were caused by occipital impact.

Conclusion: These results indicate that snowboarders, particularly beginners, are at higher risk for head injury, frequently involving occipital impact, and could lead to more major head injuries. We propose that measures should be taken to protect the head, especially the occiput, in snowboarding.

Key Words: Head injury, Snowboard, Ski, Occipital impact.

Snowboarding is a relatively new winter sport whose history only dates back to the 1920s, and the current style of snowboarding device was first introduced in the late 1970s.¹ Over the past decade, the popularity of snowboarding has exploded throughout the world, especially attracting the younger generation. In Japan, the snowboarding population by the end of 1997 is estimated to have reached well over half a million, jumping up from 70,000 in 1989. Reflecting this public enthusiasm, snowboarding was adopted as an official game in the 1998 Winter Olympic Games in Nagano, Japan. On the other hand, this rapid growth of snowboarding population has been accompanied by increasing reports of snowboard-related injuries. Several studies have shown that snowboarding injuries have unique features when compared with injuries caused by alpine skiing such as more fractures especially in upper limbs, more foot or ankle injuries, fewer knee injuries, and more severe injuries caused by impacts rather than by torsion.²⁻¹⁰ To date, however, there has been no published study focusing on head injuries caused by snowboarding. Through several years of practice at an emergency hospital located close to skiing areas in Nagano Prefecture in Japan, we have noticed unique aspects of head

injuries caused by snowboarding compared with those caused by skiing and conducted a prospective study to investigate characteristic features of snowboard head injuries and, if possible, to seek measures to prevent potentially disabling injuries, mostly of the younger population.

MATERIAL AND METHODS

All patients with ski- or snowboard-related head injury treated at the Suwa Central Hospital from December 1, 1995, to May 31, 1997, were subjected to the study. This institution serves as a primary emergency center for the five skiing facilities located in this area and receives almost all trauma cases from those skiing facilities when care beyond first aide is needed. The numbers of snowboarders and skiers who visited the five skiing facilities in the area during the study period was estimated based on admission registration, namely by counting the number of individually issued day passes, at those facilities. The patients who had impact to the head and had related symptoms such as concussion, transient amnesia, headache, nausea, or open wound were treated as cases of head injury. In addition to appropriate medical treatment, a detailed examination was performed on every patient with head injury to determine factors that could potentially be associated with the risk and outcome of head injuries. Those factors included skill levels, cause of the accident, direction of fall, the side of impact to the head, and whether a helmet or other head-protecting device was worn. Skill levels were assigned by self-declaration into one of three levels: begin-

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TABLE 1. Characteristics of snowboarding head injuries and skiing head injuries

Parameter	Snowboarders (n = 143) (%)	Skiers (n = 158) (%)	p Value	OR ^a (95% CI)
Male/female	103/40	94/64		
Age (median, range)	23 (7–51)yr	23 (4–66)yr		
Skill level			=0.022	
Beginner	60 (42)	48 (31)		1.38 (0.86–2.22)
Intermediate	53 (37)	76 (49)		
Expert	29 (20)	30 (20)		
Undetermined	1	4		
Cause of accident			<0.0001	
Self-fall	68 (48)	89 (57)		
Fall during jumping	43 (30)	2 (1)		23.7 (5.63–100.3)
Collision	28 (20)	56 (36)		
Unknown	4	11		
Direction of falling			=0.001	
Backward	73 (58)	51 (35)		1.58 (0.99–2.52)
Foreward	46 (36)	78 (54)		
Sideway	8 (6)	15 (10)		
Unknown	16	14		
Side of Impact			=0.025	
Occipital	67 (53)	49 (34)		1.51 (0.94–2.42)
Frontal	47 (37)	82 (57)		
Parietal	6 (5)	11 (8)		
Temporal	6 (5)	5 (3)		
Undetermined	17	11		
Major head injury	9 (6.3)	2 (1.3)	=0.029	4.97 (1.06–23.4)

^a OR, odds ratio; 95% CI, 95% confidence interval.

ner, intermediate, or expert. The cause of the accident was categorized into either simple fall, collision, or fall during jumping. When the patient was not able to respond, friends, relatives, or other people at the scene were interviewed to obtain necessary information. Computed tomography was performed when a patient presented with any neurologic deficit, persistent headache, or obvious injury suggestive of a strong impact to the head. Major head injury was designated when the computed tomographic scan revealed positive findings such as intracranial bleeding or brain edema. For statistical analysis, χ^2 test or Fisher's exact test was used.

RESULTS

During this period, there were 2.2 million visits by snowboarders and 4.2 million visits by skiers, and we received 559 snowboard-related injury patients of which 143 cases (26%) sustained head injury, and 749 patients with ski-related injury of which 158 cases (21%) sustained head injury. None of these patients wore a helmet or other head-protecting device when injured. Therefore, the overall incidence of head injury was 6.5 per 100,000 visits for snowboarders and 3.8 per 100,000 visits for skiers.

The characteristics of patients with snowboard head injury (SBHI) and patients with ski head injury (SKHI) are shown in Table 1. The most remarkable feature of SBHI which made contrast to SKHI was a strikingly high incidence of fall during jumping ($p < 0.0001$), followed by more backward falling ($p = 0.001$), and the involvement of beginners ($p = 0.022$).

There were 11 major head injury cases that presented with positive computed tomographic findings, including 5 contu-

sion hematomas, 2 acute subdural hematomas, 2 subarachnoid hemorrhages, 1 putaminal hemorrhage, and 1 acute epidural hematomas (Table 2). Of those, nine cases were by SBHI and two were by SKHI. Three cases underwent emergent surgery, but all were left with moderate neurologic sequelae. Another eight cases showed excellent recovery without deficit. Major head injury, thus, accounted for 6.3% of SBHI, and 1.3% of SKHI, suggesting the tendency of SBHI to suffer more serious impact to the head ($p = 0.029$). Remarkably, none of the cases were results of collision. Simple fall or fall during jumping and subsequent hit of the head to the ground was the exclusive accident that led to major head injuries. In all cases, the surface of the ground was covered with icy, packed snow, and 91% (10 of 11) were from occipital impact. Also noted was that eight of nine patients with major head injuries in snowboarding belonged to the beginner level, whereas two major head injury cases caused by skiing belonged to intermediate level skiers, and that five of six cases caused by simple fall occurred at a mild slope designated for beginners (data not shown).

DISCUSSION

Our data presented here revealed unique aspects of snowboard head injury compared with ski head injury. First, the risk of head injury seems to be higher in snowboarding. Proportion of head injuries among all trauma cases was also slightly higher in snowboarding injuries. Second, the cause and the mechanism of the snowboard head injury showed sharp contrast to ski head injury. There was a striking prevalence of fall during jumping as a direct cause of the accident, and patients tend to fall backward much more frequently in

TABLE 2. Cases of major head injury^a

Case	Sport	Age, Sex	Skill Level	Cause	Impact	CT Findings	Surgery	Neurologic sequelae
1	SB	18 M	Beg	Jump	Occ	Left frontal contusion	No	None
2	SB	20 M	Beg	Jump	Temp	Right putaminal hemorrhage	Yes	Left hemiparesis
3	SB	20 M	Beg	Jump	Occ	Subarachnoid hemorrhage	No	None
4	SB	21 M	Beg	Fall	Occ	Right frontal contusion	No	None
5	SB	21 M	Beg	Fall	Occ	Left acute subdural hemorrhage	Yes	Severe ataxia, right hemiparesis
6	SB	21 M	Beg	Fall	Occ	Subarachnoid hemorrhage	No	None
7	SB	22 M	Int	Fall	Occ	Left frontal contusion	No	None
8	SB	24 M	Beg	Fall	Occ	Right acute epidural hematoma	No	None
9	SB	28 F	Beg	Fall	Occ	Right acute subdural hematoma	Yes	Disorientation, gait disturbance
10	SK	18 M	Int	Jump	Par	Frontal contusion	No	None
11	SK	22 M	Int	Fall	Occ	Frontal contusion	No	None

^a SB, snowboard; SK, ski; Beg, beginner; Int, intermediate; jump, fall during jumping; Fall, self-fall; occ, occipital; Temp, temporal; Par, parietal.

snowboarding. Subsequently, occipital impact was more common. Third, although relatively rare, the incidence of major head injury was significantly higher in snowboarding. Lastly, snowboard head injury had a tendency to involve beginners preferentially.

The characteristics of head injury in our study has to be interpreted with caution, because we unfortunately do not have complete demographic data on age and sex of the snowboarders and skiers. Recent studies showed that snowboarders are younger and are predominately male compared with skiers, which is likely to be true in our study.^{2,3} Nonetheless, the higher incidences of occipital impact and major head injuries are obvious, and likely to be inherent to this sport. In snowboarding, a snowboarder always faces sideways with both feet fixed along the board by non-self-releasing bindings. Such a setting causes much more instability in the ventrodorsal direction compared with skiing. Furthermore, it is well known among snowboarders that catching snow by the valley-side edge causes strong rotational acceleration in snowboarding (so called "opposite edge phenomenon"⁹), which leads to falling forward or backward. Many snowboarders report that such a phenomenon occurs more frequently at a mild slope, which could be one explanation to our somewhat counterintuitive observation that most of the major head injury caused by a simple fall in snowboarding occurred not at a steep, difficult slope, but at a mild slope. Falling forward would be less prone to head injury because it is easier to protect the head by sticking out the upper limbs. Interestingly, several studies reported a higher incidence of upper limb fracture by falling forward in snowboarding.^{2,3,7,8,11-13} In contrast, falling backward is more likely to cause a direct occipital impact because the protection by upper limbs are apparently more difficult. A five times higher incidence of major head injury among snowboarding head injuries compared with skiing head injuries, thus, is likely to be a consequence of more backward falling with less protection. Indeed, eight of nine cases of major head injury in snowboarding in our series were from falling backward and subsequent occipital impact.

Incidence of fall during jump as the cause of accident in snowboard head injury was strikingly high. Because jumping

is a very popular practice in snowboarding, the risk of injury associated with jumping is significant.

The prevalence of beginners and males in snowboard head injury cases may not necessarily indicate that beginners and males are more prone to head injury, as it could be a simple representation of the demography of snowboarding population. Nevertheless, that eight of nine patients with major head injury from snowboarding were beginners at least indicates that beginners should be the focus of attention when any preventive measures are to be taken in the future.

The proportion of head injury among all injuries in our study was significantly higher than previous reports, which posted 2 to 11%.^{4,5,8,14,15} It is possible that potential differences in the criteria for head injury may have existed and accounted for the higher incidence in our study. Alternatively, the generally poorer conditions of the skiing slopes in Japan, which are mostly overcrowded and consist of icy, hard-packed snow, may have contributed to the results. In line with this notion, all of the major head injury cases were from falling to the ground of icy, hard-packed snow.

The unique features elucidated by our data will allow a focused approach in preventing snowboard head injury. The most direct and potentially most effective measures to reduce snowboarding head injuries, especially severe closed head injuries, would be to advocate the use of some device to protect the occiput, because falling backward and subsequent occipital blow is the far more common mechanism of head injury in snowboarding. In addition, the higher risk for head injuries, including potentially disabling ones, in snowboarding should be well publicized. Especially, the increased risk of injury by jumping should be stressed, and beginners should be discouraged from trying jumping maneuvers. Lastly, establishing proper training programs to instruct safer technique and improvement of general condition of skiing field would certainly be beneficial not only to snowboarders but also to the other winter sport population.

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