BRIEF REPORT

Injury Patterns in Recreational Alpine Skiing and Snowboarding at a Mountainside Clinic

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Objective.—The purpose of this study was to examine the demographic and injury characteristics of skiing and snowboarding at a mountainside clinic.

Methods.—Prospectively collected data of all acutely injured patients at the Big Sky Medical Clinic at the base of Big Sky Ski Area in the Northern Rocky Mountains were reviewed. A total of 1593 patients filled out the study questionnaire during the 1995–2000 and 2009–2010 ski seasons. Injury patterns by sport, demographics, and skill level were analyzed and compared over time.

Results.—The mean overall age was 32.9 ± 14.9 years, 35.4 ± 15.2 for skiers and 23.6 ± 9.5 for snowboarders ($P < .01$). The knee accounted for 43% of all skiing injuries, the shoulder 12%, and the thumb 8%. The wrist accounted for 18% of all snowboarding injuries, the shoulders 14%, and the ankle and knee each 13%. Beginner snowboarders were more likely to present with wrist injuries compared with intermediate ($P = .04$) and advanced snowboarders ($P < .01$). Demographic and injury patterns did not significantly change over time.

Conclusions.—At this mountainside clinic, the most frequent ski injuries are to the knee and shoulder, regardless of skill level. Beginning snowboarders most frequently injure their wrists whereas shoulder injuries remain frequent at all skill levels. Knowledge of these injury patterns may help manage patients who present for medical care in the prehospital setting as well as help in designing targeted educational tools for injury prevention.

Key words: skiing, snowboard, injury

Introduction

Alpine skiing was brought to North America from the Scandinavian countries during the mid-19th century and has grown in popularity to an estimated 11.2 million skiers in the United States as of 2010.¹ Snowboarding is a much newer sport that was invented in the 1970s by surfing and skateboarding enthusiasts. Snowboarding and skiing equipment, as well as style of riding, have tremendous differences. Unlike skiers, who face forward on 2 skis, carry poles, and have hard-shelled boots with releasable bindings, snowboarders are aligned sideways along a

single board, do not carry poles, and typically have soft boots with nonreleasable bindings.² The inherent differences in the riding equipment and style have made for reported differences within the sports medicine literature in the demographics of injuries between skiers and snowboarders that are of significance to the prehospital care providers working at and responding to a ski resort.^{1,2}

We sought to study the injury pattern for skiers and snowboarders at Big Sky ski area's mountainside clinic over several ski seasons and determine if the injury patterns changed 10 years later. Big Sky ski area is a destination ski resort in Montana within the northern Rocky Mountain range. The resort has a wide range of terrain, from beginner slopes to lift-serviced extreme terrain with cliffs, steepes, and tree skiing. Big Sky also offers a variety of terrain parks for all skill levels of snowboarders ranging from beginner to advanced, the latter of which include half-pipes and rails.³

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Methods

This study is an analysis of the patients seen at the Big Sky Medical Clinic, the sole medical clinic at the base of the mountain, during the ski seasons from 1995 to 2000 and a more recent cohort, using the same surveys, during the 2009–2010 season. The clinic sees almost all of the patients brought down by the ski patrol, as well as many walk-in patients. Before evaluations, the patients were asked to complete an injury survey that included but was not limited to information such as age, height, weight, physical condition, type of activity, skill level, equipment, boot type, run difficulty, snow conditions, injury location, time of injury, and method of transport to the clinic. The patients were then evaluated and treated by a physician blinded to the survey. Diagnoses was made by the clinic physician, and consultation requests received follow-up reports to ensure correct diagnoses.

The data for this study were directly based on the patient survey and on the clinical and radiographic evaluation and diagnosis. This information was entered into a computer database and cross-referenced with the official International Classification of Diseases, Ninth Revision (ICD-9), database from the clinic. All patients who answered the survey, provided the documentation was

complete, and for whom an appropriate ICD-9 code was available, were included in the study. Patients who were severely injured and transported directly from the slopes to a higher level of care were excluded. The data were analyzed looking at injury location and prevalence for all patients, in skiers versus snowboarders, those surveyed 1995 to 2000 (“circa 2000”) versus 2010, and for each self-reported skill level. A Student’s *t* test, χ^2 test, and Fisher’s exact test were used with an alpha < .05 for statistical significance. This study was approved by the Georgetown University Institutional Review Board.

Results

DEMOGRAPHICS

A total of 1662 patients filled out the questionnaire during the study period; 69 patients were excluded owing to incomplete diagnostic data, resulting in a total enrollment of 1593. Snowboarders represented 25% of the patient cohort. The total number of patients seen during the study period and the injury breakdown are shown in [Table 1](#). Skiers tended to be older than snowboarders, with mean ages of 35.4 ± 15.2 and

Table 1. Demographics and injury location

<i>Demographics</i>	<i>Skiing</i>	<i>Snowboarding</i>		
Total injuries	1196	397		
Mean age, years	35.4 ± 15.2	23.6 ± 9.5		
Sex				
Male	48%	73%		
Female	52%	27%		
Body mass index	23.6 ± 4.5	22.7 ± 3.5		
<i>Injury location</i>	<i>1995–2000 (n = 1109)</i>	<i>2010 (n = 87)</i>	<i>1995–2000 (n = 332)</i>	<i>2010 (n = 65)</i>
Head	4.9%	4.6%	7.8%	0.0%
Face	2.8	0.0	2.7	1.5
Back	3.1	1.1	7.8	1.5
Shoulder	11.8	13.8	13.9	20.0
Arm	2.1	1.1	6.6	1.5
Wrist	3.3	5.7	18.4	20.0
Hand	1.5	2.3	1.5	9.2
Thumb	8.3	4.6	2.7	3.1
Other fingers	0.5	0.0	0.3	1.5
Clavicle	0.5	3.4	1.2	4.6
Hip	1.0	1.1	1.2	1.5
Elbow	0.4	2.3	2.1	9.2
Ribs	2.7	2.3	3.0	1.5
Leg	14.8	5.7	1.8	1.5
Knee	42.8	43.7	11.7	7.7
Ankle	3.6	8.0	13.3	3.1

23.6 $\pm$ 9.5 years, respectively ($P < .01$). There was no significant change in this age profile when comparing skiers and snowboarders circa 2000 and 2010 ($P = .77$ and $P = .33$, respectively). The profile was roughly equal for skiers of both sexes, at 48% male and 52% female, whereas snowboarders were 73% male and 27% female ($P < .01$).

INJURY LOCATIONS

The anatomic location of injury for all skill levels was evaluated for each activity. [Table 1](#) outlines these data. The most frequent injury locations differ for skiing and snowboarding. From 1995 to 2000, the most commonly injured anatomic site for skiing was the knee, accounting for 43% of all skiing injuries, while the leg accounted for 15% and the shoulder for 12%. Of all skiing injuries, 43% involved the knee, whereas only 13% of all snowboarding injuries involved the knee ($P < .001$). Ankle injuries were found to be much more common in the early cohort among snowboarders, 13%, compared with 3.4% for skiers ($P < .004$), but this relation did not hold true in 2010. An additional datapoint collected of importance for snowboarding ankle injuries is that 24 of 25 snowboarders (96%) with injured ankles wore soft-shelled boots.

The most common snowboarding injury from 1995 to 2000 was the wrist, accounting for 18% of all snowboarding injuries, followed by the shoulder (14%) and knee (13%). The wrist was the most injured anatomical site for all snowboarders, making up 18% of all injuries compared with 3.2% ($P < .001$) for skiers in the early cohort. Shoulder injuries, however, occurred in a roughly equal percentage among skiers (12%) and snowboarders (14%) in the early cohort.

The 6 most common injuries by general ICD-9 coding are listed in [Table 2](#). For skiers, the most common specific ICD-9 diagnosis was a torn cruciate ligament of the knee, representing 10.6% of all diagnoses. Overall,

knee injuries represented about a third of all injuries by ICD-9 coding. The most common snowboarding injury was a radius or ulnar fracture, with distal radius fractures comprising almost half (48%) of all snowboarding wrist injuries and 8% of total snowboarding injuries. Shoulder dislocations made up 3% of all injuries and were 1 of the top 5 ICD-9 diagnoses for both skiers and snowboarders.

INJURY LOCATION BY SKILL LEVELS

The patients were asked to rate their skill level in the activity in which they were injured. The patients chose from a scale that included first day, first week, beginner, early intermediate, advanced intermediate, expert, and extreme. The data for first day, first week, and beginner were combined into the beginner category for injury analysis. The self-reported skill levels for ski and snowboarders at the time of presentation are presented in [Table 3](#), along with the P value reflecting the significance of the variation in skill level between groups.

The data indicate that the injury rates for skiing and snowboarding differ according to skill level. In general, skiing injuries were more common among those with intermediate or advanced level experience whereas snowboarding injuries were more common among beginners. The greatest number of skiing injuries was seen in the advanced intermediate group, with 37%. The beginner snowboarders had the highest percentage of injuries, 31%. Injuries in the first week accounted for 66% of the injuries to beginner snowboarders. Injury percentages in both sports declined as the skill levels rose above the advanced intermediate level ($P < .05$).

We combined the skill levels into beginner, intermediate, and advanced to analyze the most common skiing and snowboarding injuries at each anatomic site. The data for skiers are shown in [Table 4](#) and data for snowboarders in [Table 5](#). It is apparent that beginner skiers are more likely to injure their knees compared with their intermediate and advanced level counterparts

Table 2. Top six injuries for skiers and snowboarders by ICD-9 coding, 1995–2000 and 2010 combined

Skiing			Snowboarding		
ICD-9	Frequency	Injury description ^a	ICD-9	Frequency	Injury description ^a
844	362 (25%)	Knee ligament sprain/strain	813	40 (10.1%)	Fracture of radius/ulna
717	88 (6%)	Internal derangement of knee	844	28 (7%)	Knee ligament sprain/strain
842	65 (4.5%)	Wrist and hand sprains/strains	845	25 (6.3%)	Sprains/strains of ankle/foot
873	52 (3.6%)	Open wound of scalp/face	831	16 (4%)	Shoulder dislocation
831	46 (3.2%)	Shoulder dislocation	850	13 (3%)	Concussion
823	46 (3.2%)	Tibia/fibula fracture	923	12 (3%)	Upper limb contusion

^a Injuries partially grouped according to International Classification of Diseases, Ninth Revision (ICD-9), for example, 844.1 and 844.2 were grouped into 844.

Table 3. Skill levels of injured skiers and snowboarders, 1995–2000 and 2010 combined

<i>Skill level</i>	<i>Skiing</i>	<i>Snowboarding</i>	<i>P values</i>
Beginner, total	16%	31%	<.01
First day ^a	3%	11%	<.01
First week ^a	4%	10%	<.01
Early intermediate	24%	20%	.06
Advanced intermediate	37%	27%	<.01
Expert	19%	16%	.19
Extreme	4%	6%	.07

^a Combined with total beginner group.

($P < .001$). However, the knee is the most common site injured at all 3 skill levels for skiers. Shoulder and thumb injuries represented the second and third most common injuries, respectively, for all 3 experience levels. For snowboarders, beginners sustained significantly more wrist injuries compared with their intermediate ($P = .04$) and advanced ($P < .01$) skill level counterparts, for whom shoulder injuries become the more frequent injury.

Discussion

This study contributes to the literature showing that recreational skiing and snowboarding have unique injury patterns. Skiers have an increased occurrence of lower extremity injuries in every category except for ankle injuries. Given the different mechanics involved in dual-surface movement such as skiing as opposed to snowboarding, a typical skiing injury involves the skier catching an edge and torquing the body with relation to a knee joint.¹ A previous study of lower extremity injuries in snowboarding postulates that increased ankle injuries may be related to the soft-shell boot design used by snowboarders, which was worn with almost all of the ankle injuries seen in our study.⁴

Upper extremity injuries were found to be more common among snowboarders in our study. This finding

Table 4. Most common skiing injuries by skill level, 1995–2000 and 2010 combined

<i>Injury site</i>	<i>Beginner^a</i> (<i>n</i> = 172)	<i>Intermediate^b</i> (<i>n</i> = 692)	<i>Advanced^c</i> (<i>n</i> = 257)
Knee	56% (97)	30% (205)	35% (89)
Shoulder	10% (18)	12% (84)	12% (32)
Thumb	7% (12)	8% (58)	7% (17)

^a Includes skiers who report their injury occurring on their first day or first week.

^b Includes self-reported early intermediate or advanced intermediate.

^c Includes self-reported expert or extreme.

Table 5. Most common snowboarding injuries by skill level, 1995–2000 and 2010 combined

<i>Injury site</i>	<i>Beginner</i> (<i>n</i> = 116)	<i>Intermediate</i> (<i>n</i> = 174)	<i>Advanced</i> (<i>n</i> = 84)
Wrist	32%	21%	7%
Shoulder	11%	15%	15%
Knee	10%	12%	13%
Ankle	11%	10%	15%

Values are percent of total injuries for each skill level.

is consistent with those of previous studies that suggest that the snowboarder's upper extremities absorb most of the impact of a fall because the snowboarder's legs are attached to the board with nonreleasable bindings.¹ Previous studies have noted the shoulder injury rate in skiers to be 4% to 11% of all injuries and ranging from 8% to 16% of all injuries among snowboarders.⁵ One of the more common skiing injuries is a sprain/strain or tear of the ulnar collateral ligament, commonly referred to as "skier's thumb." Previous studies have reported thumb injuries making up 7% to 10% of all skiing injuries, whereas snowboarders injured their thumbs only 1% to 2% of the time.⁶ The results of our study are consistent with this, as reflected in Table 1.

There are distinct differences when comparing skiing and snowboarding injuries according to skill level. Among snowboarders, the beginners in our study had the highest rate of injury, which could reflect a steeper initial learning curve for snowboarders to learn to control their speed and to stop than for alpine skiers. The most common skill level for skiing injuries and second highest for snowboarders is the advanced intermediate level. This finding is similar to what has been found by others at a major California ski resort.⁷ It may be that at this level riders begin to explore more difficult terrain and steeper slopes. The most common injury site for each skill level among skiers was the knee, accounting for more than half of the injuries to beginner skiers (Table 4). Less experienced skiers have a large percentage of knee injuries owing to a higher frequency of torque injuries during falls.⁷ In contrast, snowboarders have a different injury pattern based on skill level compared with their skiing counterparts. Beginners and intermediates primarily injured their wrists more frequently than advanced level snowboarders did, similar to data seen in a previous study.⁸

The primary limitation to this study is that it looked at injuries at only a single resort in the Rocky Mountains; however, it provides a unique perspective on slope-side injuries as opposed to hospital-based reports. Similarly, some injuries are likely underrecorded in our study

because critically ill or seriously injured patients did not present to the clinic but were immediately transferred to a hospital-based system by an emergency medical service. An additional limitation is that we were not able to calculate the injuries per skier per snowboarder days to evaluate the actual injury incidence.

Conclusions

At one mountainside clinic, the most frequent ski injuries are to the knee and shoulder, regardless of skill level. Beginning snowboarders most frequently injure their wrists whereas shoulder injuries remain frequent at all skill levels. Knowledge of these injury patterns may help manage patients who present for medical care in the prehospital setting as well as aid in designing targeted educational tools for injury prevention.

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