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Patterns of lower limb fractures sustained during snowsports in Otago, New Zealand

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Abstract

Aims The aim of this study was to determine the nature and circumstances of lower limb fractures caused by skiing and snowboarding at the Otago skifields that required operative treatment at Dunedin Hospital from 2002 to 2008.

Methods Patients were retrospectively identified from clinical records.

Results 108 cases were included in the study; 28 snowboarders and 80 skiers. Snowboarders had more fractures involving the ankle whereas skiers had more fractures of the proximal third of the tibia and fibula. Snowboarders were more likely to fracture the fibula compared to skiers. Nearly two-thirds of fractures in snowboarders were to the left limb whereas in skiers a laterality was not demonstrated. Most fractures were the result of falls but a greater proportion of snowboarders had jump-related injuries.

Conclusions Snowboarding related lower limb fractures are more likely to involve the ankle and be left sided. Skiing related lower limb fractures are more proximal with no laterality.

Snowsports in New Zealand have increased in popularity since 1979 with 1.4 million visitors to New Zealand skifields in 2006.[1] The most popular sport is still traditional alpine skiing which has been developing for over a century. Over this time alternative downhill sports have been invented, most of which have been short lived. However snowboarding has grown disproportionately and now accounts for a third of snow sport participants in New Zealand.[1] With increasing popularity there is a need to understand the pattern of injuries associated with these sports.

Injury rates in skiers have fallen from 5–8 injuries per 1000 skier days in the 1970s to 2–3 injuries per 1000 skier days currently[2]. This has been attributed to the evolution of equipment design, such as break-away bindings, and improved planning and grooming of slopes. It has been noted that the pattern of injury has also changed with lower leg injuries becoming less common while the incidence of proximal leg and knee injuries are increasing.[3]

Snowboarders experience a higher injury rate of 4–16 injuries per 1000 snowboarder days [4, 5] and this appears to be increasing. The most common injuries in descending order are head and facial, left upper limb, spine, chest and abdomen, left lower extremity, right upper extremity, and right lower extremity.[6] This pattern demonstrates laterality of injury as one-side leads, a technical variance to skiing[7]; it also shows that upper body injuries are more common.[8,9]

Differences in equipment and body position between the two sports may lead to different mechanisms and hence patterns of injury. The injury rate is also influenced

by the demographics of participants. In regard to the lower limb the most obvious difference is the plane of stance to the direction of travel i.e. skiers travel forward, whereas snowboarders go sideways with one side leading.

The boots and bindings are also very different. Snowboarders fix both feet to one board with 'soft' boots and non-releasing bindings. Skiers use 'hard' plastic shelled boots with releasing bindings and a ski on each foot. We aimed to define the differences in the pattern of lower limb fractures requiring operative management in these contrasting sports at the Central Otago skifields.

Methods

All patients who required surgical, orthopaedic treatment for ski or snowboard-related leg injuries treated by the orthopaedic department at Dunedin Hospital during the period 2002 to 2008 were included. An electronic search via the clinical coding of injuries was undertaken to find all cases of leg fractures that had been admitted. This was then focused to those that had occurred whilst skiing or snowboarding.

Patient records were manually reviewed to determine the nature and mechanism of injury. Age, gender and nationality were noted. Circumstance of injury was grouped as occurring during a jump, fall or collision. If the specific skifield that the injury occurred at was available this was also recorded. Laterality of the injury was documented.

Anonymous data retrieval was used to fulfil local ethical requirements.

Results

A total of 108 cases (80 skiers and 28 snowboarders) suffered fractures of the patella and distally, whilst participating in their chosen sport during the seven year study period. A mean of four cases per year occurred due to snowboarding and 11.4 cases per year due to skiing.

The demographic characteristics of the 108 cases are presented in Table 1. The snowboarders had an mean age of 27 years (range 9 to 45 years) and 86% were male. The mean age of the skiers was 32 years (range 4 to 65 years) and 60% were male. In both groups the majority of patients were resident in New Zealand (15 snowboarders and 51 skiers).

Table 1. Patient demographics

Variable	Snowboarders (n=28)	Skiers (n=80)
Age		
Mean	27 years	32 years
Range	9 to 45	4 to 65 years
Gender		
Male %	86%	60%
Female %	14%	40%
Nationality		
New Zealand	15	51
Australian	4	22
Other	9	7

Each group was analysed to establish the fracture pattern and circumstances of the injury, as displayed in Tables 2 and 3.

Table 2. Fracture pattern and circumstance among *snowboarders*

Fracture position	Snowboarders (n=28)		
	Jump	Fall	Collision
Knee		1	
Proximal		3	
Midshaft	3	5	
Distal	1	3	1
Ankle	5	6	
Total	**9**	**18**	**1**

Table 3. Fracture pattern and circumstance among *skiers*

Fracture position	Skiers (n=80)		
	Jump	Fall	Collision
Knee		1	1
Proximal	2	23	1
Midshaft	3	25	8
Distal	1	6	1
Ankle		8	
Total	**6**	**63**	**11**

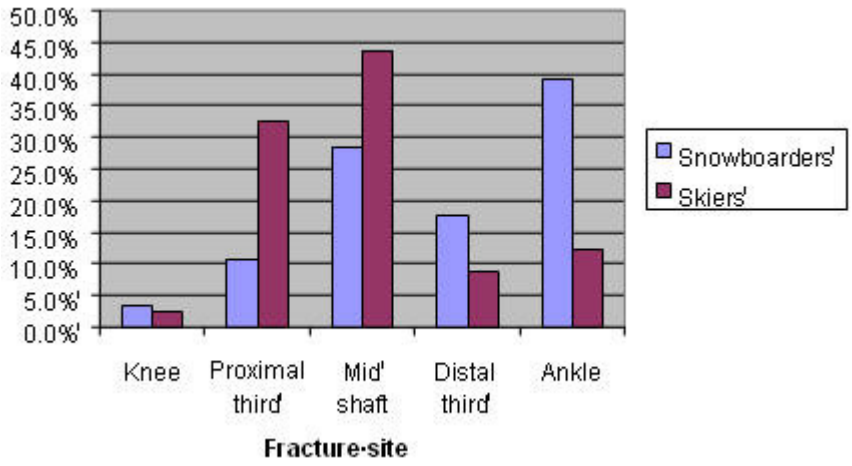
In both sports falls were the most common cause of injury. However the next most common cause for injury in snowboarders was jump related, making up 32% of the group. For skiers this only accounted for 7.5% of injuries. Collision was the cause of injury in 13.8% of cases for skiers but only 3.6% of snowboarder injuries.

Snowboarders were more likely to injure the ankle (39% of cases). The next most common point was mid shaft tibial fractures (28%), followed by distal third (18%), proximal third (11%), and knee (4%). Skiers were most likely to have a midshaft tibial fracture (44%). Followed by proximal third (32.5%), ankle (12.5%), distal third (9%), and knee fractures (2.5%). This is illustrated in Figure 1.

19 of 28 fractures occurred to the left leg in snowboarders and 9 to the right. In skiers the laterality was evenly distributed, 41 right and 39 left.

Of 16 tibia and fibula fractures in snowboarders, 5 involved the tibia alone, and 9 involved both the tibia and fibula, only 2 were isolated fibula fractures. Of the 70 tibia or fibula fractures in skiers, 36 were of the tibia alone and 34 involved both the tibia and fibula with no isolated fibula fractures.

Figure 1. Comparison of fracture site between skiers and snowboarders



Discussion

The demographic data suggests that a male in their late 20's is the most likely snowboarder to sustain a leg fracture. This is consistent with previous studies [8, 10]. Today's Otago skiers have a higher average age and a more even gender split than snowboarders, also consistent with previous studies.[11] The majority of patients in our study were from New Zealand but a higher proportion of non New Zealand residents are snowboarders. This fits with the analysis of the New Zealand ski industry which shows a static domestic market but an overall increase in overseas users, particularly snowboarders, in the last 10 years [1].

A large proportion of the injuries to the proximal tibia are tibial plateau fractures. Of these the higher grade (Schatzker classification 5&6) injuries occur in high speed skiing accidents. Skiers are also more likely to sustain avulsion fractures of the anterior tibial spine or posterior intercondylar area, where the anterior and posterior cruciate ligaments, respectively, insert.[13,14] Our finding of a higher number of proximal third tibia and fibula fractures, including tibial plateau fractures, in skiers corresponds with the published data.

Fractures of the tibial diaphysis are common long bone fractures. Often the consequence of road traffic accidents they are also common in snowsports. Traditionally they have been difficult to manage but advances in intramedullary nails, pre-contoured plates and locking plates has led to a decrease in fracture complications and an improved outcome.[15] Both skiers and snowboarders have a high incidence of these fractures but snowboarders are more likely to fracture more distally than skiers.

Compared to skiers the snowboarder group had a slightly higher proportion of fractures that involved the tibia and fibula, 57% versus 47%, which have been associated with high energy or rotational forces.[15] In the case of skiers these large rotational forces may be due to the ski failing to release from the breakaway binding and thus acting as a long lever arm, in snowboarders these injuries may be caused by a higher initial force transmitted through bindings that are not designed to breakaway.

The higher initial force being related to the preponderance for snowboarders to undertake activities such as jumping.

Isolated fibula fractures were seen exclusively in the snowboarders and we postulate that the hard shell boots worn by skiers protect them from these injuries. A study of novice snowboarders using hard ski boots showed similar findings,[16] and we know that prior to the introduction of modern ski boots and bindings the pattern of injury was similar to that seen in modern snowboarders.[17]

The finding of more left sided injuries in snowboarders (68%) may be explained by the stance. Most snowboarders lead with their left foot and when moving at speed this is at 90 degrees to the direction of travel, with weight distribution biased towards this lead leg. Skiers will transfer their weight from one leg to the other as they turn, and when moving at speed the foot and ankle face in the direction of travel with no laterality of weight distribution. This accounts for the equal distribution of fractures between sides we observed in skiers.

Conclusion—The pattern of injury in these two sports is very different. This study has highlighted how vulnerable the ankle is to injury in snowboarding and we offer reasoning for this based upon an understanding of the differences in equipment used in skiing and snowboarding. The challenge to reducing the incidence of ankle injury in snowboarders is in the balance of allowing movement in order to accomplish the tricks and jumps deemed integral to the sport whilst protecting the ankle, although more rigid boots such as those used in skiing may create more proximal injuries by transmitting force proximally.

We propose a more protective boot for the lead foot of snowboarders that includes a lace up ankle support. In our opinion and with personal experience of both sports, no advances in equipment design can negate the importance of common sense and abiding by local skifield policies when undertaking these sports.

Limitations—Many injuries that do not require orthopaedic operative intervention are seen and treated by skifield doctors and general practitioners within Otago, thus we were unable to obtain details of these injuries within our unit. Injuries sustained in the Queenstown skifields that require operative management are usually treated in Invercargill, and as such the incidence of injuries is higher, but the anatomical distribution or circumstances of injury should not differ. We elected to exclude injuries of the femur and above in order to make data retrieval less complicated. Inaccurate coding may have led to some cases being missed.

Competing interests: None known.

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