

Overview

This publication represents the peer reviewed articles that were submitted and accepted for publication in the eleventh volume of *Ski Trauma and Skiing Safety*. The International Society for Skiing Safety (ISSS) was founded in 1974 under the leadership of Ejnar Eriksson of Stockholm, Sweden. After the second meeting in 1977, the International Society has met biennially. Since 1983 ASTM has joined the ISSS in sponsoring the symposiums from which these articles were generated. The initial meeting of the combined sponsorship of ISSS and ASTM was held in Keystone, Colorado, in 1983. Special technical publications of the proceedings of that meeting and subsequent meetings have been published by ASTM. The cosponsored meetings of ISSS and ASTM following 1983 included Naiba, Japan in April 1995; Chamonix, France in May 1987; Riksgräsen, Sweden in May 1989; Thredbo, NSW Australia in June 1991; Zell am Zee, Austria in May 1993; and finally, the meeting from which these proceedings were generated occurred in Voss, Norway in April 1995. The earlier volumes from the fifth through the tenth International Symposia are found in ASTM/STP volumes 850, 938, 1022, 1104, 1182, and 1266.

The lecturers and attendees at the international symposiums on ski trauma and ski safety include individuals from many walks of life who have a strong interest in the promotion of skiing safety. Attendees include individuals from the skiing industry, binding and boot manufacturers, engineers from industry, universities, and technical institutes, skiing professionals, physicians, ski patrollers and instructors, and the public. Individuals who present papers at the combined symposium are encouraged to submit their articles for publication. The twelve articles published in this volume were selected from seventy-eight papers that were presented in Voss. This continuing series of ASTM/STP symposiums on skiing safety represents a valuable resource for those interested in skiing safety and advancing this worthy cause. It is hoped that the continuing efforts of ASTM/ISSS will provide this outlet to not only encourage those who are already interested in the advance of skiing safety, but to stimulate others to join the efforts already under way.

At the time of this writing, planning for the development of the twelfth International Symposium to be held in Whistler, Vancouver, Canada from 3–10 May 1997 is underway. All who read this overview are encouraged to participate in this upcoming meeting.

The papers presented in this STP are organized into three categories. The first section entitled *Epidemiology*, includes six papers concerning the epidemiology of skiing and snowboarding injuries and unfortunately, death in skiing activities. The second section, *Skiing Equipment*, provides three papers dealing with ski boots and bindings. The final section, *Knee Injuries*, includes three papers dealing with that portion of the anatomy which is most frequently severely injured in skiing accidents: the knee.

Summary of Sections

Epidemiology

Epidemiologic studies strive to describe the deleterious patterns of injury or disease, relate the patterns of injury occurrence to causative factors, and gain insight into ways of decreasing the risk of injury or disease. The six papers in this section evaluate injuries in Olympic alpine racers, study the effect of alcohol on the production of injuries, evaluate death from

cardiac causes and trauma during skiing activities, observe ongoing trends in skiing injury over a long period of time, and provide insight into the present problem of snowboard injuries.

In the first paper, Ekeland and his co-workers evaluate previous serious skiing injuries recorded amongst participants in the alpine disciplines of the 1994 Olympic games in Lillehammer. They observed that three-fourths of the Olympic racers had suffered one or more significant ski injuries. The knee accounted for 43% of these injuries followed by the lower leg (10%) and the head (8%). Thirty-two percent of the women and ten percent of the men had previously suffered a ruptured anterior cruciate ligament. The most common discipline resulting in serious injury was the downhill event.

Alcohol use and its relationship to downhill ski injuries were evaluated by Meyers and his associates. While the incidence of skiers found in their control population with alcohol in their blood was only 6%, 34% reported alcohol use within the 24 h previous to the interview. Injured skiers generally reported that they do not drink while skiing, but were likely to have used alcohol within 24 h of the interview. The authors concluded that there is a strong relationship between alcohol use and skiing injuries, there is a need for educational countermeasures, and finally, they suggested that more conclusive field studies are needed to fully ascertain the relationship between ski injuries and alcohol use.

In the two articles by Burtscher and his associates, the risk of sudden cardiac death and traumatic death during downhill skiing was evaluated. Six hundred and fifty-six Austrians died during mountain sport activities between 1986 and 1992. Seventy-four percent of the deaths were due to trauma, 24 percent to cardiac disease and 2 percent to other causes. In an attempt to stratify the risk of traumatic death, the authors compared downhill skiers to cross country skiers, hikers, and rock and ice climbers. Traumatic death was lowest amongst the downhill skiers at 0.52 per hundred thousand participants; 1.57 per hundred thousand for ski touring; 2.62 per hundred thousand for hiking; and 6.6 per hundred thousand for rock and ice climbing. The vast majority of cardiac deaths were found to occur in men more than thirty-four years of age. It was felt by the authors that they had evidence that regular physical activity may be considered preventive among the older males.

In an ongoing evaluation of the trends of alpine ski injuries occurring at a Northern Vermont ski area, Johnson and his co-workers presented an update of data which had been monitored continuously from 1972 through the end of the 1994 ski season. During that time, nearly 2½ million skiers' visits occurred. The overall injury rate decreased by 44% during the study, with lower leg injuries improving 87%. The greatest concern is the ongoing observation that anterior cruciate ligament injuries, which have increased 228%, do not show any sign of abating, even with the development of new equipment and safety consciousness.

In the final paper of this section, Shealy based his study on snowboarding injuries on ski patrol reports between 1988 and 1995. This analysis included 3696 snowboarding injuries, while at the same time 15 323 downhill ski injuries were recorded. The rates expressed as mean days between injuries were 227 for downhill skiers and 167 for snowboarding. This indicates a slightly higher injury rate for snowboarders than for alpine skiers. The injury patterns of snowboarding were found to be significantly different from those of alpine skiers. Snowboarders sustained a lower rate of lower leg and knee injuries, and a higher rate of wrist and ankle injuries than alpine skiers. Male snowboarders had a higher percentage of injuries to ankle and lower leg, while females had a higher percentage of wrist and knee injuries.

Skiing Equipment

In the first article of this section, Senner and Schaff evaluated the influence of boot spoiler design on muscle activity and kinematics during a landing from a jump. Their main concern

evolved around the production of ACL injuries resulting from a blow of the upper posterior shell of the boot to the back of the leg as an individual landed. The authors found a great deal of difference in the EMG activity of the leg musculature between their two study conditions. These authors concluded that further investigations are needed to clarify how the changes in the spoiler stiffness may affect the production of knee injuries.

Hull and co-authors provide the reader with further illumination of the possibilities of developing an electromechanical ski binding release system. The authors presented their work to develop a prototype binding which has the capabilities of maintaining consistent release level in twist in the presence of combined loads, to release the heel piece based on the anterior/posterior bending moment transmitted by the leg, and also to modulate the release level in twist depending on the degree of contraction in muscles acting across the knee. Their prototype confirmed the ability of their dynamometers to accurately measure desired loads in the presence of extraneous loads and demonstrated the reliability of the solenoid actuated mechanisms to release appropriately under typical loads of skiing. They strongly believe this work demonstrated the feasibility of a hybrid, electromechanical/mechanical release binding.

In their work in this section, Crawford and Mote provided the readers with information concerning ski binding minimum retention requirements based on analysis of testing done on skiers through several ski seasons. They found that four skier characteristics including weight, weight multiplied by height, weight multiplied by boot top height, and weight multiplied by leg length all predicted the forward bending minimum release requirement much better than varus valgus or internal/external twisting minimal release requirements. They found that the minimum release requirements were essentially independent of skiing ability or the skiing maneuvers employed during the testing. The maximum force and moment components were strongly dependent on ankle flexion angle, weight bearing, and the coupled bending and twisting moment components they evaluated.

Knee Injuries

In the first paper of this section, Greenwald and Toelcke evaluated more than 7300 injuries from 1989 to 1995 in an effort to determine if factors related to skier demographics or conditions surrounding a knee injury might be relevant to attempts to reduce the high incidence of severe knee sprains. They found that there were significant differences in the demographics and injury descriptions between men and women with serious knee injuries. They found that women more frequently sustained severe ACL sprains than men. They noted that isolated ACL injuries occurred more frequently in advanced skiers while multiple ligamentous injuries, including primarily the ACL and MCL, were found more frequently in less experienced skiers. They felt that information concerning circumstances surrounding these injuries could be helpful in determining how to teach people which positions are most dangerous in fall situations.

Maury Hull provided us with information from which he concluded that combined medial collateral ligament and ACL injuries typically occur in forward twisting falls where the primary loads to the knee include external axial rotation and valgus moments. Of these two loads, an external axial moment was more damaging than a valgus moment, both to the MCL when the joint is intact, and to the ACL when the MCL has become damaged. He concluded that heel-toe types of bindings offer release sensitivity to this injury mechanism and thus have a potential to protect against such combined lesions.

In the final article of this section, Gerritsen and colleagues presented a computer simulation to investigate ACL injuries that occur during landing from a jump. They demonstrated how a computer simulation could possibly identify **dangerous** modifications to the equipment that

might result in injury to the ACL. They clearly noted that the computer model is only an approximation of reality. Therefore, existing models must be subjected to rigorous validation before predicted ACL ligament forces can be treated with great reliability.

It is the intention of the International Society of Skiing Safety and ASTM in sponsoring the ongoing series of symposiums on ski trauma and skiing safety, to stimulate the production of valuable scientific discourse on the problems involved in skiing safety. Although we continue to chip away at the underlying problems that unfortunately continue to lead to a significant number of ski injuries in the world's skiing populations each year, it is through the efforts of a large group of individuals bringing knowledge from many different fields that we can hope to eventually eradicate some of the major problems remaining. Clearly, severe knee ligament injuries remain the single greatest threat to the average alpine skier, and for that matter, to the skilled racer. To date there is still controversy over the mechanisms that produce these injuries. With the efforts made by a large number of people evaluating these situations, it is hoped that further understanding of this and other severe skiing injury mechanisms can be better defined and eventually mitigated.

Through the years we have seen dramatic improvement in the risk of lower extremity injuries below the knee. Many of the factors resulting in these improvements were first presented in this STP and those that preceded it. It is hoped that the continued combined efforts of the ISSS and ASTM will act as a catalyst to allow us to redouble efforts to speed the process of reducing the risk of all skiing injuries and thus improve the fantastic recreational and competition sports of alpine skiing and snowboarding even further.

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