

SKIING TRAUMA and Twelfth Volume SAFETY

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editor



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Skiing Trauma and Safety: Twelfth Volume

Robert J. Johnson, editor

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Peer Review Policy

Each paper published in this volume was evaluated by two peer reviewers and the editor. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM Committee on Publications.

The quality of the papers in this publication reflects not only the obvious efforts of the authors and the technical editor(s), but also the work of the peer reviewers. In keeping with long standing publication practice, ASTM maintains the anonymity of the peer reviewers. The ASTM Committee on Publications acknowledges with appreciation their dedication and their contribution of time and effort on behalf of ASTM.

Foreword

This publication, *Skiing Trauma and Safety: Twelfth Volume*, contains papers presented at The Twelfth International Symposium on Skiing Trauma and Safety held in Whistler Blackcomb, British Columbia, Canada, on 4–10 May 1997. The symposium was sponsored by ASTM committee F27 on Snow Skiing and the International Society of Skiing Safety (ISSS). Robert J. Johnson, University of Vermont, was editor of this publication.

Overview

This publication contains 16 papers that were presented at the 12th International Symposium on Ski Trauma and Skiing Safety jointly sponsored by the International Society of Skiing Safety and the American Society of Testing and Materials at Chateau Whistler Resort, Whistler, British Columbia, Canada between May 4–10, 1997. At that meeting 81 papers were presented and the 16 represented here are those that were accepted for publication following a peer review process.

The cooperation between American Society of Testing and Materials (ASTM) and the International Society of Skiing Safety (ISSS) began with the 5th International Symposium on Ski Trauma and Ski Safety that was held in Keystone, Colorado in May of 1983. All meetings since that time have resulted in a bound proceedings of many of the outstanding articles that were presented at the symposiums. The ISSS was founded as a result of a meeting on ski trauma and skiing safety that was organized in 1974 by Ejnar Eriksson of Stockholm, Sweden. This meeting was held in Riksgräsen, Sweden. As a direct result of that congress the organization of the International Society of Skiing Safety was formalized and, starting in 1977, meetings have been held every other year. The second meeting was held in Sierra Nevada of Spain in 1977 and those that followed included meetings in Queens-town, New Zealand in 1979, Bormio, Italy in 1981, Keystone, Colorado, USA in 1983, Naiba, Japan in 1985, Chamonix, France in 1987, Riksgräsen, Sweden again in 1989, Thredbo, Australia in 1981, Zell am Zee, Austria in 1993, Voss, Norway in 1995, and the most recent meeting in Whistler/Blackcomb, British Columbia, Canada in 1997. The 13th International Symposium on Ski Trauma and Skiing Safety will be held in Cervino, Italy May 2–8, 1999. The next meeting to be held in 2001 is tentatively scheduled for a ski field in New Zealand.

The published proceedings of these meetings from the beginning have provided the single most important format for the dissemination of literature on ski trauma and skiing safety in the world. This special technical publication continues the tradition of providing information concerning winter sports trauma and the means of its prevention. While alpine skiing has been the main concern of the ISSS and ASTM, other activities including cross country skiing, back country skiing, snowboarding and its variants are also included.

As in the past the individuals participating in the International Symposiums on Ski Trauma and Skiing Safety represent a wide cross section of society. Attendees include representatives of the skiing industry such as binding, boot and ski manufacturers, engineers from industry, universities and technical institutions, skiing professionals, physicians, lawyers, ski patrollers and instructors, ski area managers, and the public. All individuals who present papers to the International Symposiums are encouraged to submit articles that undergo the standard ASTM peer review process and those articles deemed acceptable are published in special technical publications such as this one. As in the past it is hoped that this publication not only brings a wide variety of subjects concerning skiing safety to the general public and those specifically interested in the problems of skiing safety but also stimulates others to join the process of scientifically studying these problems.

The fundamental goal of the ISSS and ASTM is to improve the sport of skiing by reducing the risk of injury and producing a better and more enjoyable means of participating in winter sports activities.

Summary of Sections

This STP has been organized into four sections. The first deals with several topics concerning skiing safety and the behavior of skiers and snowboarders. The second section deals with the biomechanical aspects of knee and ankle injuries. Three articles investigating binding function are presented in the third section, and the final portion of the book deals with epidemiologic studies.

Safety and Behavior

In a study of young skiers and snowboarders comparing groups of injured and uninjured participants Macnab and coworkers found that an injured cohort of winter sports athletes had less knowledge of the skiers responsibility code than an uninjured control group. They concluded that the lack of knowledge of safety rules and skiing or riding without due care by young participants indicates that major ski and snowboard injuries are often preventable.

In a series of two articles Senner and Jendrusch and their colleagues present observations concerning vision which they point out is an essential factor for skiing safety. In their first article they feel that observation and perception errors in combination with the lack of attention lead to the majority of skiing falls. They observed changes in the ability of individuals to respond to obstacles met unexpectedly while skiing in conditions of normal visual acuity and those of reduced acuity. They noted that the reaction time was similar between the reduced visual acuity and that of normal acuity for larger objects such as skiers in their path. However, the reduced vision group reacted less quickly to a more subtle obstruction to their progress in the form of a simulated ice patch. In the second study they found that 43% of skiers requiring corrected vision in fact did not ski with appropriate glasses or contact lenses. They did find that the use of yellow goggles were helpful in identifying dangerous spots in poor lighting conditions.

In his article Penniman provides his insight into the present customs and practices used by U.S. ski areas in developing and maintaining ski trails. Insight is also given to the means used to reduce the risk of skier injuries. He points out that not all hazards can be removed from ski trails and that it is still the skiers responsibility to act responsibly and to ski appropriately in situations where unavoidable environmental factors may produce potential for injury.

The hazard of fatal avalanches between 1986 and 1995 in Austria was evaluated by Burtcher and Nachbauer. They found that the overall risk of fatality to back country skiers due to avalanche was one death in 333 350 back country skiing days. They found to their disappointment that current training programs and information were inadequate to reduce the risk of death in avalanches. It seemed that those that had the most training were at the greatest risk of being involved in fatal avalanches.

In the final paper in this section Whelan and her associates provide insights into the effect of a warm-up program designed to reduce the risk of alpine skiing injuries. They found that their program did result in significant increases in body temperature, heart rate, and flexibility when compared to a controlled condition. These findings demonstrated that they could effectively warm up the body and provide us all with a challenge to determine whether these

types of activities can in fact help reduce the risk of injury in skiers by further epidemiologic studies.

Biomechanics

Barone and his colleagues had the unfortunate circumstance of observing an ACL injury that accidentally occurred during the study of boot induced anterior drawer ACL injuries. The event was recorded on video tape and EMG activity was recorded. They felt that the injury resulted from kinematics different from those described in boot induced anterior drawer mechanism and that muscle activity observed may have contributed to the production of this injury.

Hull, Estes and Wang devised a dynamic system model of a snowboarder to determine which model parameters most strongly influenced ankle deflections during a forward fall. They found that boot stiffness was the most important variable and noted that the potential exists for reducing the risk of ankle injuries through judicious boot design.

In their efforts to more fully understand injury mechanisms of the anterior cruciate ligament, Bach and Hull evaluated unenbalmed cadaver specimens and found there was no significant difference in the strain produced in the anteromedial and posterolateral bundles of the ACL during loading. They also observed that the relationships between quadriceps load and strain were highly linear for flexion angles of 60° and less.

Bindings

In their study Scher and Mote determined forces and moments measured at the toe and heel of bindings during skiing activities for twelve subjects. They found that in many instances both the vertical force at the heel and the lateral force at the toe actually occurring during skiing would have allowed binding settings suggested by ASTM standards to be reduced without increasing the risk of inadvertent release. They found that the minimum retentions did not correlate well to the subjects age, height, and weight. They concluded that binding settings that relied primarily on those variables for prediction of minimum retention cannot be expected to be reliable.

Shealy and his coworkers used signal detection theory to evaluate binding function. Using this unique system of analysis the authors have demonstrated that there has been an 85% decline in mid-shaft tibia fractures due to failures of the binding to release appropriately and also a 75% reduction of inadvertent releases leading to injury during the last 25 years.

Bally, in his observations concerning the feasibility of releasable bindings for snowboards, determined that at least in theory such bindings could reduce the risk of lower extremity injuries. It was the author's opinion that the addition of release bindings would not necessarily be accompanied by an increased rate of inadvertent binding release.

Epidemiology

Janes and Abbott present a study of snowboarding injuries that occurred between 1988 and 1996 in Colorado. Forty-seven medical facilities identified 4390 physician-diagnosed snowboard injuries. Forty-four percent of the injuries involved the upper extremity, 38% the lower extremity, and 18% other areas of the body. The most common injury involved the wrist (20%) and knee trauma represented 15% of all injuries, an amount that was noted to be less than half that of alpine skiers. A fracture of the lateral process of the talus was found in 110 cases and appears to be an injury relatively unique to the sport of snowboarding.

The article by Meyers and Misra presents their findings concerning the grim subject of spinal cord injuries involving skiers and compares these in an epidemiologic fashion with individuals who sustain similar injuries in other activities. They found that in general those who sustained these severe injuries as a result of skiing fare somewhat better than those who sustain such injuries in other sports. They found that skiers have fewer acute hospital days and lower acute rehabilitation care costs. Individuals who sustain spinal cord injury in skiing are more likely to be white, somewhat better educated, but younger than their counterparts who sustain these injuries in other sports.

In a study involving femur fractures, Laporte and colleagues found that the incidence of femur fracture was 1.5 per 100 000 skier days compared to 2.5 per 1000 skier days for all downhill skiing injuries. They have found that there is apparently an increased risk of femoral neck fractures among women skiers over 55 but noted a lesser risk of femoral fractures among females less than 55 years of age compared to males. Although these injuries account for only 0.62% of all winter sports accidents, their severity and high social and economic impact makes mitigation of these injuries one of high priority.

In their paper, Boldrino and Furian evaluate the epidemiology of 70 000 injured skiers and 8000 snowboarders. They highlighted the variation in gender and skill level and found that snowboarders were more predominately male and less skilled. They provided information concerning such factors as motivation, sport related motor skills characteristics, attitude toward risk, and understanding of the accident situation. They found that female snowboarders have a higher risk of injury than their male counterparts and that those who ski aggressively have a higher risk of injury, while those who snowboard carefully have a higher risk of injury. They give thoughtful suggestions for further investigations based on the information that they gleaned from their study.

Concluding Statements

It is without question that the activities of the International Society of Skiing Safety and the American Society for Testing and Materials have been instrumental in leading to the reduced risk of ski injuries that we have observed in the past 25 years. In the early 1970s the injury rate per 1000 skier days was five or above in most studies, and this has been reduced to 2.5 or less per 1000 skier days at the present time. Although this marked improvement is to be applauded, we have seen that serious problems still exist. Among these are the fact that no apparent reduction in injury risk has occurred during the last several years, serious knee sprains are occurring at epidemic rates, and there is continued occurrence of catastrophic injuries to the head, neck, and thorax, some of which result in death. It should be the goal of all those interested in skiing safety to continue to focus on such problems as these. Although there has been no convincing evidence that changes in equipment can reduce the risk of serious knee injuries, work should still continue to identify possible means of reduction of injuries not only by changes in equipment but also by educating skiers to avoid behavior that can lead to situations known to produce knee injuries. Although there has not been an increase in the incidence of catastrophic injuries such as paralysis and death noted through the years, this continues to be a major concern. Interesting discussions began at the last symposium on Ski Trauma and Skiing Safety concerning the use of helmets. This is another area that warrants our attention in the future.

It is also the goal of the ISSS and ASTM to bring to the attention of all those interested in skiing safety that specific research methods must be applied to epidemiologic studies of skiing safety to be certain that new data generated is of value in our efforts to reduce the risk of injury. It is hoped that the efforts of the ISSS and ASTM continue to bring excellent

research to the public's attention, stimulate young investigators, and encourage experienced researchers to redouble their efforts to find meaningful and effective ways to reduce the risk of injury and thus improve the enjoyment of alpine and nordic skiing, snowboarding, and their many derivations.

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