0363-5465/101/2929-0581$02.00/0
THE AMERICAN JOURNAL OF SPORTS MEDICINE, Vol. 29, No. 5
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The Efficacy of Wrist Protectors in Preventing Snowboarding Injuries

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ABSTRACT

Injuries of the wrist are common among snowboarders and in-line skaters. Wrist protectors have been developed to protect against injury. Some studies support the use of such wrist protection, but others emphasize the fact that wrist protectors may transfer the injury to other locations in the forearm. We conducted a prospective, randomized, clinical study of 5029 snowboarders, 2515 in a braced group and 2514 in a control group. The primary endpoint was fracture or sprain of the wrist with loss of range of motion and pain of at least a 3-day duration. Concomitant injuries were also recorded. Eight wrist injuries occurred in the braced group and 29 occurred in the control group. This was a significant difference. Beginners (first 5 days on a snowboard) and snowboarders with rented equipment were more prone to injury than others. No injuries could be related to the use of the wrist brace. We conclude that wrist braces are effective in protecting snowboarders against wrist injury. Beginners are a high-risk group.

Wrist injuries are common among snowboarders[1,6,9,14,17] and in-line skaters.[7,8,11,12,16] Wrist braces in a variety of designs are sold worldwide to customers who hope they will be able to avoid wrist injury through use of the device. In an earlier study from the Hafjell Alpine Center in Norway, we found that snowboarders were injured three to four times more often than alpine skiers.[15] The same study revealed that over a 4-year period, 32% of the total 431 snowboard injuries treated at a hospital were wrist fractures. The number of snowboard injuries is thought to be increasing mainly because of the increasing number of participants.[18] Injury-preventive devices might play an important role in the avoidance of new injuries.

Cadaveric studies have shown that when wrist injury occurs, the injury pattern is different when a wrist protector is used than when it is not used.[10,13] Other studies, including a large multicenter case-control study from the United States, have shown a significant benefit for in-line skaters using wrist protectors.[5,16] However, fractures in the forearm—"splint-top" fractures—have been reported with the use of a wrist brace, suggesting that there may be some unwanted side effects with this type of equipment.[4] So far, no randomized prospective study has been reported on the potential of wrist protectors as an injury-preventive device.

The objective of our study was to evaluate the effect of a wrist brace on injuries to the wrist and on other concomitant injuries in a prospective, randomized trial.

MATERIALS AND METHODS

A prospective, randomized, clinical trial was designed to test the benefit of a wrist protector in snowboarders. The null hypothesis to be tested was as follows: There is no difference in wrist injuries (fracture or sprain) between a group of snowboarders using a wrist brace and a group of snowboarders not using a wrist brace. The study was done at the Hafjell Alpine Center from February to April 1998. Hafjell was the Olympic ski venue during the 1994 Lillehammer Olympic winter games and, as such, is a modern ski resort.

Snowboarders who were over 9 years of age and without any wrist injury within the last 2 months were, on arrival at the arena, demonstrated use of the brace and asked to provide written informed consent for participation in the study. Those who agreed to participate were then randomized to either the use (braced) or no use (control) group. The wrist brace used was a D-ring wrist brace (Smith & Nephew, Nesbru, Norway) (Fig. 1). Block randomizing with variable size blocks (two to six) was used, ensuring the same number of snowboarders in each group present

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No author or related institution has received any financial benefit from research in this study. See "Acknowledgments" for funding information.

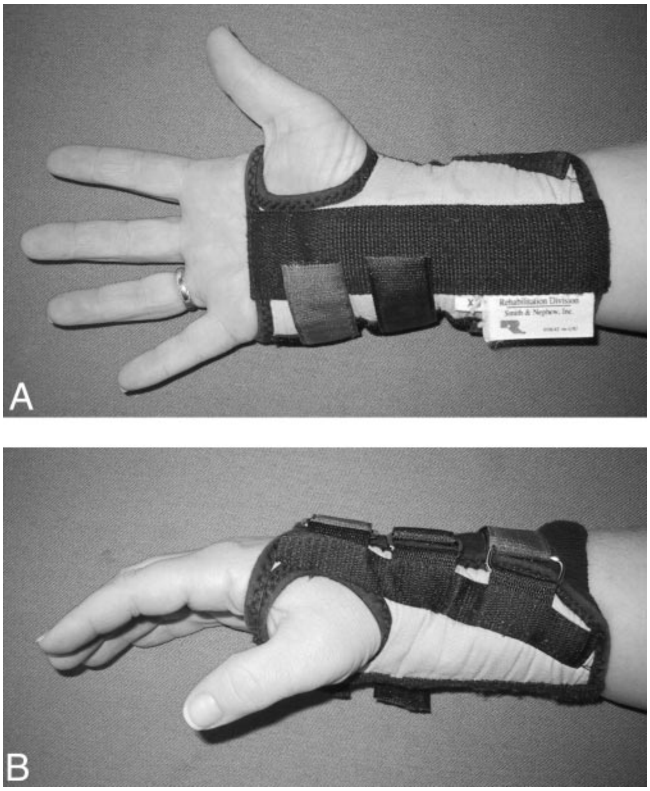

Figure 1. Front (A) and side (B) views of the D-ring wrist brace used in the study. An aluminum splint is inserted in the pouch on the volar side for support of the wrist.

in the pistes at all times. The same snowboarder was allowed to be included in the study more than once, but was randomized each day to either the braced group or the control group. Because of the great number of participants, each observation was considered as an independent observation. One observation was defined as one snowboarder participating for 1 day.

Data collected at inclusion included name, address, date of birth, sex, nationality, prior snowboard experience (three groups: 0 to 5 days, 6 to 10 days, or more than 10 days of snowboarding experience) and type of equipment (two groups: snowboarder's own equipment or rented equipment). In addition, in cases of injury, we recorded the injury mechanism, type of boot used, binding system, and type of snowboard.

The snowboarders were examined for wrist injuries at the end of each day. A physician then examined all the injured snowboarders. The physician was blinded as to the group in which the snowboarders were randomized. The primary endpoint was fracture or sprain of the wrist. Fracture was defined as a radiologically evident fracture, and sprain as pain in the wrist together with decreased range of motion for a duration of at least 3 days. Radiographs were taken of all subjects where the physician suspected a fracture. After the initial examination by the physician, all injured snowboarders were followed up with telephone interviews.

Based on previously observed injury incidences at the resort,[15] we estimated the sample size needed to be 5000 observations to detect a 50% reduction in wrist injuries in the braced group versus the control group, with a power of 0.80 and alpha level of 0.05. Statistical analysis of categorical data was done with the chi-square test, using SPSS (SPSS, Inc., Chicago, Illinois) statistical software on a personal computer. Risk rates (number of injuries/number of participants $\times$ 1000), with 95% confidential intervals, were calculated regarding experience and type of equipment.

RESULTS

A total of 5029 snowboarders was included in the study, 2515 in the braced group and 2514 in the control group. Of these, 64.2% (3229) were male snowboarders and 35.8% (1800) were female snowboarders. The mean age for male snowboarders was 19.1 years (median, 17; range, 10 to 68) and for female snowboarders, 17.4 years (median, 16; range, 10 to 67). Concerning prior snowboard experience, 1713 (34.1%) had 0 to 5 days, 648 (12.9%) had 6 to 10 days, and 2612 (51.9%) had more than 10 days of prior snowboard experience. Fifty-six snowboarders (1.1%) did not answer this question. Concerning equipment, 3651 (72.6%) used their own equipment and 1346 (26.8%) rented their snowboard equipment; 32 snowboarders (0.6%) did not answer this question. Analysis revealed that there was no difference regarding age, sex, nationality, prior snowboard experience, and type of equipment between the two groups.

After 1 day of snowboarding, 99.3% (2497 of 2515) of the subjects in the braced group and 86.9% (2185 of 2514) in the control group were evaluated. Eighteen snowboarders did not return the brace after snowboarding, were impossible to locate afterward, and were thus lost to follow-up. Fifteen subjects did not tolerate the brace and removed it and snowboarded without any support for the rest of the day. We had decided in advance to handle this type of incident as if the snowboarder had used the brace, and therefore these subjects were counted in the braced group.

In the braced group, 8 wrist injuries (3 fractures and 5 sprains) were recorded, compared with 29 wrist injuries (2 fractures and 27 sprains) recorded in the control group (Table 1). Based on these data we were able to reject our null hypothesis (chi-square test: $\chi^2 = 12.0$, $df = 1$, $P = 0.001$). Considering not only the wrist injuries but all types of injuries, a total of 33 injuries occurred in the braced group and 51 in the control group.§ This is a significant difference in favor of the braced group (chi-square test: $\chi^2 = 3.9$, $df = 1$, $P = 0.05$).

Injuries were seen in all three experience groups. Forty-seven injuries occurred in the 1713 snowboarders in the 0-to-5 days experience group, for a risk rate of 27.4 (95% confidence interval, 20.6 to 36.5). Seven injuries occurred in the 648 snowboarders in the 6-to-10 days experience

§ For detailed information on injuries recorded other than wrist injuries, please contact the corresponding author.

TABLE 1
Wrist Injuries Among the 5029 Snowboarders

Sex	Age	Brace	Experience (days)	Equipment	Diagnosis
Female	12	No	0–5	Own	Fracture
Male	16	No	0–5	Rented	Fracture
Male	15	No	>10	Own	Sprain
Male	16	No	>10	Own	Sprain
Male	14	No	>10	Own	Sprain
Male	12	No	>10	Own	Sprain
Male	17	No	>10	Own	Sprain
Male	17	No	>10	Own	Sprain
Male	11	No	>10	Own	Sprain
Female	15	No	>10	Own	Sprain
Male	22	No	>10	Own	Sprain
Male	21	No	>10	Own	Sprain
Male	15	No	0–5	Own	Sprain
Male	27	No	0–5	Own	Sprain
Female	27	No	0–5	Own	Sprain
Female	17	No	0–5	Own	Sprain
Female	17	No	0–5	Own	Sprain
Male	17	No	0–5	Rented	Sprain
Female	15	No	0–5	Rented	Sprain
Female	17	No	0–5	Rented	Sprain
Female	17	No	0–5	Rented	Sprain
Female	17	No	0–5	Rented	Sprain
Female	17	No	0–5	Rented	Sprain
Male	16	No	0–5	Rented	Sprain
Male	17	No	0–5	Rented	Sprain
Female	21	No	0–5	Rented	Sprain
Female	23	No	0–5	Rented	Sprain
Female	18	No	0–5	Rented	Sprain
Male	13	No	6–10	Own	Sprain
Female	21	Yes	>10	Own	Fracture
Male	15	Yes	0–5	Rented	Fracture
Male	15	Yes	6–10	Rented	Fracture
Male	35	Yes	0–5	Rented	Sprain
Female	14	Yes	0–5	Own	Sprain
Female	17	Yes	0–5	Own	Sprain
Male	13	Yes	0–5	Rented	Sprain
Female	17	Yes	0–5	Rented	Sprain

group, for a risk rate of 10.8 (95% confidence interval, 5.1 to 22.7). There were 30 injuries in the 2614 snowboarders with more than 10 days' experience, for a risk rate of 11.5 (95% confidence interval, 8.0 to 16.4). If we test the group of beginners against all others with more than 5 days of prior snowboard experience, we find significantly more injuries in the beginner group (chi-square test: $\chi^2 = 17.5$, $df = 1$, $P < 0.001$).

More injuries were seen in the group that rented snowboards than in the group that used their own equipment. Forty-six of the 3651 snowboarders who used their own equipment were injured while using it, for a risk rate of 12.6 (95% confidence interval, 9.4 to 16.8). Thirty-eight of the 1346 snowboarders who rented equipment were injured while using it, for a risk rate of 28.2 (95% confidence interval, 20.5 to 38.8; chi-square test: $\chi^2 = 14.5$, $df = 1$, $P < 0.001$).

There was no difference regarding age between the injured and noninjured groups. All of the injured snowboarders used soft boots with a strap-on binding system and a freestyle board. This is the most common type of snowboard equipment used in Norway. Of the 37 snowboarders who injured their wrist, 23 were injured because of a backward fall, 9 because of a forward fall, 1 after a high jump, and 4 were not able to tell exactly how they fell. No injuries could be related to the use of the wrist brace.

DISCUSSION

The main problem in a study like ours is to find a solid parameter as an endpoint. We used both fractures and sprains in the wrist as a primary endpoint. We required that the definition of sprain include not only pain, but also decreased range of motion and duration of the symptoms for at least 3 days, thus ensuring that insignificant trauma was not reported as a sprain. Magnetic resonance imaging might have provided interesting additional information about the sprains, but the imaging method was not available. It would have been interesting to use fracture as the sole endpoint, but our prior calculations of study population showed that this would have been practically impossible. More than 15,000 observations would have been needed to predict a 50% reduction in fractures, with a power of 80% and an alpha level of 0.05.

As is the case for all injury types, the severity of wrist injuries during snowboarding is closely related to the amount of energy absorbed by the body during trauma. A wrist brace can absorb a certain amount of energy, but if the energy increases above a given level, soft tissue damage or fracture will occur. Cadaveric studies indicate that wrist guards may have a prophylactic effect during low-energy dynamic impact situations.[10] The design and material properties in the brace are important factors for how much energy the brace can absorb. A brace system that is too rigid will generate high-stress forces at the proximal and distal ends of the brace and in this way may produce a fracture below or above the brace.[4] From a biomechanical point of view, the ideal brace should absorb as much energy as possible without creating any stress points. The ideal stiffness of the brace is difficult to determine in advance because of individual differences in muscle support of the wrist. Because of this difficulty we chose a brace with a deformable aluminum support, located only on the volar side of the wrist, with the support located from the palm and up one-third of the forearm. We found three fractures in the braced group and two fractures in the control group. All fractures in the braced group were nondislocated fractures. In the control group, one fracture was dislocated and one was nondislocated. This might indicate that the brace used was too soft to absorb the necessary amount of energy to reduce the number of fractures in the wrist. A more rigid brace system, on the other hand, might have caused other kinds of injuries, as discussed.

The significant difference between the two groups is because of the large number of sprains in the unprotected group. We think this finding is important, and therefore recommend the use of wrist braces to all snowboarders, even though the beginners will be the group who benefit the most from it.

Another essential point in our study is the follow-up of the two groups studied. Eighteen snowboarders in the braced group were impossible to follow up. To change the main conclusion of the study, eight or more of these snowboarders would have to have been injured. However, none of these 18 snowboarders received assistance from the ski patrol or registered at Lillehammer Central Hospital, the natural referring hospital close to Hafjell. None of the 18 snowboarders were to be found in the personal registers in Norway, or in the registers of the country they told us they came from. We have no reason to believe that these snowboarders have been injured, and they are considered not injured in the statistical analysis of the material.

There were 329 snowboarders in the control group who were not examined after snowboarding. For purposes of the study, these subjects were placed in the "worst-case scenario" category and assigned as not injured.

Fifteen snowboarders did not tolerate the brace, turned it in, and kept on snowboarding afterward. We had determined in advance of the study that subjects in this type of scenario would be counted in the braced group. None of these snowboarders sustained injury.

Variable block randomizing was used to ensure the same number of participants in each group on the slopes at all times. In this way the observations were independent of weather, snow and slope conditions, and distance and terrain, all of which are known to be important factors in injury occurrence.

Other authors have noticed an increased injury incidence in inexperienced snowboarders,[1–3] and our study confirms this. Beginners should be aware of the increased risk of injury. We also found an increased injury rate in snowboarders who used rented equipment. This increase is most probably caused by the fact that beginners often rent their equipment. It is possible, however, to look at the problem the other way around, blaming the increased injury rate among beginners on the higher levels of rented equipment in this group.

We know that inadequately adjusted equipment is an important factor to consider in alpine skiing injuries. Proper adjustment of the binding systems is crucial for the prevention of lower leg and ankle injuries in downhill skiers. It is difficult to use the same argument in the evaluation of snowboard injuries. The technology in snowboard design and binding systems is quite unsophisticated. All of the injured snowboarders in our study used soft boots with a strap-on binding system and a freestyle board, which is the usual equipment for the recreational snowboarder. Hard-shell boots with "click-on" binding systems are mostly used by competitive slalom snowboarders and are seldom used by novices. The strap-on binding system gives a semirigid fixation to the board and is fairly similar whether the board is rented or not. The development of new binding systems for snowboarders may potentially reduce the problem snowboarders have when they fall and are not able to release their feet.

The injury mechanism when sustaining a wrist injury is commonly a backward fall. The snowboarder's fixed stance on the board is due to a nonreleasing, semirigid, strap-on binding system that causes the feet to be attached to the board during a fall. The snowboarder then reaches out with his or her arms to reduce the impact when hitting the ground. During a backward fall the wrist hyperdorsiflexes, often producing a sprain or even a fracture. The fixation of the feet to the board, which provides a double support, is thought to reduce the risk of knee and other lower extremity injuries and probably explains the low frequency of injuries in the lower extremities in snowboarders.[2,3,15]

We used an isolated, nonglove-fixed brace in our study. Most snowboarders use gloves, and it is difficult to get the brace inside some types of gloves. We suggest that snowboarding gloves be designed with wrist support included in the glove itself. This would make the use of the brace easier and compliance might increase.

Our study confirms the benefit of using a protective wrist brace during snowboarding. The difference between the braced group and the control group was due to the different incidences of wrist sprain in these groups. No difference according to fracture incidence was seen. No injuries related to the use of the brace were seen. Beginners are a high-risk group.

ACKNOWLEDGMENTS

The authors acknowledge the assistance of Smith & Nephew, Nesbru, Norway; the Gjensidige Insurance Company, Lillehammer; the Norwegian Society for Ski Injury Research, Oslo; and the Hafjell Alpine Center, Øyer, Norway.

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