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Shoulder Injuries During Alpine Skiing

Mininder S. Kocher,† MD, and John A. Feagin, Jr.,‡ MD

From the *Department of Orthopaedic Surgery, Harvard Medical School, Boston, Massachusetts, and ‡Division of Orthopaedic Surgery, Duke University Medical Center, Durham, North Carolina

ABSTRACT

We retrospectively reviewed alpine skiing injuries at a destination ski resort during three seasons to characterize the incidence and types of shoulder injuries. A total of 3451 injuries in 3247 patients were reviewed. The overall injury rate was 4.44 injuries per 1000 skier-days. Injuries to the upper extremity represented 29.1% (N = 1004) of all alpine ski injuries. Injuries involving the shoulder complex (393 injuries in 350 patients) accounted for 39.1% of upper extremity injuries and 11.4% of all alpine skiing injuries. The rate of shoulder injury was 0.51 injuries per 1000 skier-days. Patients with shoulder injuries had a mean age of 35.4 years, and the male-to-female ratio of these patients was 3:1. Falls represented the most common mechanism of shoulder injury (93.9%) in addition to collisions with skiers (2.8%), pole planting (2.3%), and collisions with trees (1%). The most common shoulder injuries were rotator cuff strains (24.2%), anterior glenohumeral dislocations or subluxations (21.6%), acromioclavicular separations (19.6%), and clavicle fractures (10.9%). Less common shoulder injuries included greater tuberosity fractures (6.9%), trapezius muscle strains (6.4%), proximal humeral fractures (3.3%), biceps tendon strains (2.3%), glenoid fractures (1.5%), scapular fractures (1%), humeral head fractures (1%), sternoclavicular separations (0.5%), an acromial fracture (0.3%), a posterior glenohumeral dislocation (0.3%), and a biceps tendon dislocation (0.3%).

Injuries are relatively common during alpine skiing, with estimated injury rates from 3 to 10 injuries per 1000 skier-days.3,4,7-11,19-22,24 There have been decreases in the overall injury rate and the lower extremity injury rate, with a resultant increase in the ratio of upper extremity to lower extremity injuries.2,3,9-11,21,24 A recent review of 9749 skiing injuries over 11 seasons, from 1982 to 1993, at the Jackson Hole Ski Resort found that the ratio of upper extremity to lower extremity injuries increased from 1:4 to 1:2 over the study period.24 Suggested explanations for these trends include equipment-related changes, environment-related changes, and behavioral changes.

Epidemiologic data have estimated upper body injuries to account for 42% to 48% of all skiing injuries10,11 and upper extremity injuries to account for 30% to 42% of all ski injuries.4,11,19,21 The most common upper extremity injury is a sprain of the thumb's ulnar collateral ligament, known as gamekeeper's thumb or skier's thumb.2,4,16,22-25

Injuries to the shoulder during alpine skiing have been less well studied. Shoulder injuries are estimated to account for 4.5% to 10% of all alpine skiing injuries.2-13,20,25 The shoulder is the most commonly dislocated joint in skiing, and fractures about the shoulder complex represented 131 of 871 (15%) skiing fractures in one study.11 The purpose of this investigation was to further characterize the incidence and types of shoulder injuries during alpine skiing.

MATERIALS AND METHODS

The Jackson Hole Ski Resort is a large ski area in northwest Wyoming that offers more than 5 square miles of skiable terrain at elevations ranging from 1311 to 10,450 feet above sea level. The area attracts all levels of skiers and presents a full spectrum of skiing injuries. The Jackson Hole Ski Resort is primarily a destination ski resort because of its location. The resort has a single ski clinic at its base and, therefore, most of the injuries that occur on the slopes are seen at the Teton Village Clinic. The medical staff at the clinic consists of orthopaedic surgeons, family practitioners, and physician assistants.

We retrospectively reviewed records of all alpine ski injuries attended to at the Teton Village Clinic during three ski seasons (1990 to 1993). An injury was defined as any accident incurred during alpine skiing that required medical attention at the Teton Village Clinic. Injuries to the shoulder complex were reviewed in detail. Data obtained included injury type, injury date, age, sex, hand

† Address correspondence and reprint requests to Mininder S. Kocher, MD, Department of Orthopaedic Surgery, Massachusetts General Hospital, Fruit Street, Boston, MA 02135.

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dominance, and injury mechanism. The population at risk was determined by annual ticket sales and, thus, the true population at risk was underestimated because professional skiers and pass holders were excluded. The incidence rate of shoulder injuries was determined by calculating the number of injuries per 1000 skier-days.

RESULTS

A total of 3451 injuries in 3247 patients were reviewed. The incidence of all skiing injuries was 4.44 injuries per 1000 skier-days. A summary of injuries by anatomic location is shown in Figure 1. Injuries to the lower extremities accounted for the majority of injuries, with knee ligament sprain the most common injury.

Upper extremity injuries accounted for 29.1% (N = 1004) of all skiing injuries. The most common upper extremity injury was sprain of the ulnar collateral ligament of all the thumb’s metacarpophalangeal joint, also known as gamekeeper’s thumb, which represented 24.2% (N = 243) of all upper extremity injuries and 7% of all injuries. Seventy-three percent of gamekeeper’s thumb injuries were either grade I or II sprains.

Injuries to the shoulder complex (N = 393) accounted for 11.4% of all ski injuries and 39.1% of upper extremity injuries. The incidence of shoulder injuries was 0.51 injuries per 1000 skier-days. A total of 200 (51%) injuries involved the right shoulder and 193 (49%) involved the left shoulder. The types and frequencies of shoulder injuries are shown in Table 1. The most common injuries were rotator cuff strains, anterior glenohumeral dislocations or subluxations (Fig. 2), acromioclavicular separations, and clavicle fractures. Less common shoulder injuries included greater tuberosity fractures (Fig. 3) trapezius muscle strains, proximal humeral fractures, biceps tendon strains, glenoid fractures (Fig. 4), scapular fractures (Fig. 5), humeral head fractures, sternoclavicular separations, and biceps tendon dislocations. Falls represented the most common mechanism of shoulder injury (93.9%) in addition to collisions with skiers (2.8%), pole planting (2.3%), and collisions with trees (1%). The mean age of patients with shoulder injuries was 35.4 years and the male-to-female ratio was 3:1.

The majority of patients with anterior glenohumeral dislocations (61 of 85, 71.8%) had primary dislocations, as opposed to recurrent dislocations (24 of 85, 28.6%). Sixty-seven of 84 (79.8%) dislocations were reduced in the ski clinic without intravenous sedation, and only 3 of the patients (3.6%) needed to be transported to the local hospital for reductions. Fourteen shoulder dislocations (16.7%) reduced spontaneously on the mountain. Because these patients had nondislocated shoulders when seen at the Teton Village Clinic, we cannot be certain whether their injuries represented episodes of subluxation or dislocation. Eleven of 14 patients (78.6%) whose shoulders reduced spontaneously had a history of recurrent instability. One patient sustained a posterior glenohumeral dislocation; however, this injury was associated with a contralateral anterior glenohumeral dislocation and a proximal humeral fracture. Grade I acromioclavicular separation (53.2%) was seen more commonly than grade II (24.7%) or grade III (22.1%) injuries. The most common fracture was a fracture of the clavicle. The majority of clavicle fractures were either lateral (42.1%) or midthird (47.4%). The two patients who sustained medial clavicle fractures included a 30-year-old man, who hit a tree, and a 64-year-old woman, who was osteopenic. Fractures of the greater tuberosity of the humerus were the second most common fracture. These occurred in older patients and 5 of 27 (18.5%) of these fractures were associated with anterior glenohumeral dislocation.

DISCUSSION

The incidence and relative percentage of shoulder injuries in our study are slightly higher than those in previous
studies. Kuriyama and associates reviewed 14,952 injuries during 10 seasons in Japan and found that 4.5% of all injuries involved the shoulder. Carr and co-workers studied 1711 injuries during one season at a Vermont ski area and found that 6.9% of all injuries involved the shoulder and 32.4% of all upper extremity injuries involved the shoulder. Of the 1870 injuries studied during one season in Aspen, Colorado, by Weaver, 135 (7.2%) involved the shoulder, and the incidence of these injuries was 0.2 injuries per 1000 skier-days. Finally, Sherry studied 1850 skiing injuries during one season in Australia and found shoulder injuries to account for 10% of all injuries and 27.7% of upper extremity inju-

Figure 2. The AP (A) and scapular Y (B) views of an anterior glenohumeral dislocation in a 56-year-old man who injured his shoulder during a fall.

Figure 3. Anteroposterior views of the shoulder. A, a non-displaced greater tuberosity fracture in a 22-year-old man who fell on his shoulder. B, a displaced greater tuberosity fracture in a 36-year-old man who fell on his shoulder.
Differences that could account for the slightly higher percentage and incidence of shoulder injuries in our study include differences in injury definition, study design, environmental conditions, and skier attributes. In addition, several studies have noted an increase in the relative percentage of upper extremity injuries over time.2,9,11,14,21,24 Our data may represent a continuation of this trend.

Strain of the rotator cuff musculature was the most common shoulder injury in this study. Carr et al.2 and Sherry and Fenelon21 also found soft tissue strain to be the most common shoulder skiing injury, whereas Kuriyama et al.13 and Weaver25 found anterior glenohumeral dislocation to be more common among skiers. Unlike patients with dislocations or fractures of the shoulder complex, patients with soft tissue strains typically showed vague symptoms, subtle physical findings, and variable disability. In fact, rotator cuff strains were probably underreported because some patients may not have sought immediate medical attention. This variability in reporting may account for the different incidences of rotator cuff strain reported in the literature. The majority of rotator cuff injuries were associated with falls. Many patients reported the mechanism of injury to be resistance of active abduction by the slope during the fall, suggesting a muscle strain injury. Some patients reported a mechanism of direct loading on the shoulder during the fall, suggesting a muscle contusion injury. The consistent findings on physical examination were pain and weakness with active abduction in the scapular plane. The glenohumeral joint was the most commonly dislocated joint during skiing, and glenohumeral dislocation ranked second among the type of shoulder injuries in our series. Similar to other reviews, the vast majority of glenohumeral dislocations were directed anteriorly.13,18,25 All patients in our study had anterior dislocations except for one patient who sustained a high-energy collision resulting in a posterior glenohumeral dislocation associated with a contralateral anterior glenohumeral dislocation and proximal humeral fracture. In the review of 70 dislocations by Weaver25 and the review of 660 dislocations by Kuriyama et al.,13 all the shoulder injuries were anterior. The majority of shoulder dislocations in this study were primary; however, only half of the patients in the series by Kuriyama et al. had primary dislocations. Six percent of the dislocations in our series were associated with minimally displaced greater tuberosity fractures, which is similar to the incidence in prior series (range, 3% to 10%).13,22 The majority of dislocations were reduced in the clinic without intravenous sedation. The ease of reduction in the clinic correlated with the common finding that these patients experienced minimal pain or muscle spasms if seen within the 1st hour after dislocation. The problem of recurrent dislocation in young, active skiers is difficult to manage. Kuriyama and colleagues used arthrograms to characterize the associated capsular lesions of dislocated shoulders during skiing. They found that patients with capsular detachment-type injuries had a higher rate of redislocation than those with capsular tear-type injuries. Thus, they recommended repair of the capsular detachment in this subset of pa-
Patients prone to redislocation. For this population with recurrent dislocations, Metheny designed an orthosis to prevent abduction and external rotation of the shoulder during skiing.

Epidemiologic investigations of skiing injuries are fraught with inherent difficulties, including ambiguity of injury definition, underreporting, and design limitations. The definition of a “skiing injury” must be logical and understandable because it can greatly affect the interpretation of data. Too broad of a definition can result in overreporting, with the inclusion of all incidental scratches and bruises, whereas too narrow of a definition can result in underreporting, with the exclusion of significant, morbid injuries. We chose to define a “skiing injury” as any injury received during alpine skiing that required medical attention from health care providers at the Teton Village Clinic. This definition inevitably leads to underreporting because some patients do not seek medical care even for significant injuries, some patients seek medical care elsewhere, and some injuries are not immediately apparent. In fact, for some injuries, such as game keeper’s thumb, it is estimated that only 20% to 25% of the injured patients seek immediate medical care at their ski resort.

There are also limitations in reporting the incidence of injuries as injuries per 1000 skier-days. This assumes that a skier-day is equivalent in terms of the number of hours of skiing and of skiing style. In addition, it assumes that the population at risk can be adequately estimated by ticket sales. Ticket sales ignore some frequent skiers who ski without tickets, such as season pass holders, multiday pass holders, instructors, patrollers, and employees. Thus, the actual population at risk is underestimated. This may have contributed to the slightly higher incidence of overall injuries and shoulder injuries observed in our series. Because of the retrospective, observational nature of this study, we could not assess the effect of any interventions and we could not gather certain demographic information concerning risk factors, such as skier ability, fitness level, equipment, and environmental conditions. In addition, we studied only alpine skiing injuries. Snowboard, telemark, and mono-ski injuries were excluded. There is evidence to suggest that the causes of the injuries associated with these modalities are different. For example, snowboard riders appear to have an increased incidence of overall injuries and a higher proportion of upper extremity injuries.

CONCLUSIONS

The relative ratio of upper extremity injuries to lower extremity injuries appears to be increasing in alpine skiing, and certain shoulder injuries can be accompanied by significant morbidity to overall upper extremity function. Thus, the prevention of shoulder injuries during skiing through interventions in skiing surfaces, technique, education, exercise, and bracing is worthy of further consideration and study.

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