Skiing

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18.1 Introduction

Skiing and other snow sports activities are enjoyed worldwide. Accessibility is increasing with expansion of ski areas, better ski lifts, and the use of snow machines. The Winter Olympics being held in Asian countries has expanded skiing globally. Skiing is performed in nature, subjected to climate changes and a cold environment. It is a physical activity with a risk of injury as speed and falling are part of the sport. Several risk factors are associated with accidents such as crowded resorts, lack of risk awareness at high speeds, and technically challenging maneuvers.

Alpine skiing implies a risk of injury. Risk of dying is very low, but risk of sustaining an anterior cruciate ligament (ACL) injury is 365 times higher than that of the general population, being similar to American Football (30–70 injuries per 100,000 skiers per day) [1]. Injury incidence has not changed significantly over time [2].

18.2 Injury Distribution

The distribution of skiing injuries has been extensively studied. Most series find a predominance of lower extremity injuries as opposed to snowboarding where upper extremity injuries are more frequent [3, 4]. ACL injury is the most frequent diagnosis in most series [5].

Injury incidence could be similar between sexes, as opposed to other sports. ACL injury incidence is similar in men and women in the World Cup [6], with a slight higher incidence in women in their late teens [7]. A genetic predisposition to injury could be present in ACL injuries with affected skiers having a higher risk of having parents with ACL tears [8].

Injury pattern could be different in adult and adolescent skiers. The prevalence of shoulder and knee injuries is higher in adults than in children. In contrast, the prevalence of skiing lower leg fractures is higher in children than in adults. More children than adult alpine skiers suffer their injury in terrain parks [9].

In the hand, ulnar collateral ligament "skier thumb" injuries can account for up to 80% of all upper extremity injuries in skiers [10].

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18.3 Serious Injuries in Skiing

The risk of traumatic death while skiing has not changed over the past 30 years [11]: 0.71 deaths per million event days of exposure. The risk of death expressed as the number of fatalities per million hours of exposure seems to be on the same order of magnitude as death by car or bicycle, in the range of approximately 0.1 deaths per million hours of exposure. Data from 22 fatalities occurred while skiing shows that the main cause is craniocerebral and chest trauma [12].

Head injury is the most frequent reason for hospital admission [13] and the most common cause of death among skiers and snowboarders, with an 8% fatality rate among those admitted to hospital with head injuries [14]. Freestyle skiers have a twofold risk of sustaining a head injury compared to alpine skiers [15].

Helmets are mandatory for competitive skiers in the International Ski Federation (FIS) World Cup events in all disciplines. In contrast, ski resorts do not typically require helmet use. The use of helmets has increased among recreational skiers and snowboarders [16], and their use is higher among children [17].

Opponents of mandatory helmet use even claim that helmets may increase the risk because they may lead to a reduced field of vision, impaired hearing, or increased speed through a false feeling of security and thus increase the incidence of collisions, which are the cause of many severe injuries [17].

Using a helmet was associated with a 60% reduction in the risk for head injury when comparing skiers with head injuries with uninjured controls [18]. Helmet use has increased from 6% in 1996 to 84% in 2013 [19].

The most frequent among these was traumatic brain injury, followed by spinal injuries [20]. Spinal injuries frequently occur in combination with other body regions. While the overall injury rate seen with skiing and snowboarding has decreased, the rate of spinal injuries has plateaued or slightly increased. The most frequently observed spinal injuries among skiers and snowboarders are vertebral fractures [21]. Less than 1% of sports-related spinal cord injuries fully recover by hospital discharge. Reported fatality rates for skiing and snowboarding injuries range from 0.8 to 3% [22].

Death of cardiac origin should be considered in older skiers presenting risk factors, and therefore proper previous work-up is recommended in these skiers [23]. Avalanches should be considered when back country skiing, where asphyxia is the main cause of death (75%) followed by trauma [24].

18.4 Equipment-Related Factors

Improvement in the ski boot-binding interface in the 1960s and 1970s included high plastic boots as opposed to low leather boots and self-releasing bindings. This change drastically reduced the incidence of ankle injuries in skiing with an important increase in knee injuries [24].

Ski geometry has been related to injury incidence. So called "carving" skis introduced to market in the 1990s have become the mainstay in the ski industry. The higher side cut and lower turn radius allows easier turns with less slippage or drag and more speed. Being more reactive and having less energy dissipation these types of skis could increase the injury incidence, as was apparent after the introduction in the World Cup. In the 2012/2013 season, FIS changed the regulation on ski geometry including longer skis with less side cut and higher turn radius. Following these changes, injury incidence decreased in upper extremity and minor injuries, but ACL injury incidence was not changed [25]. In the 2017/2018 season, FIS changed regulations again allowing bigger side cut and lower turn radius (Fig. 18.1).

In younger skiers, equipment could have a high impact on injury incidence. Poor boot fit is a major factor leading to lower leg fractures and sprains, especially among children [26, 27]. If the foot can easily move within the boot, then the binding release function is compromised. Children have a greater risk of these injuries and therefore need the best-fitting equipment [28].

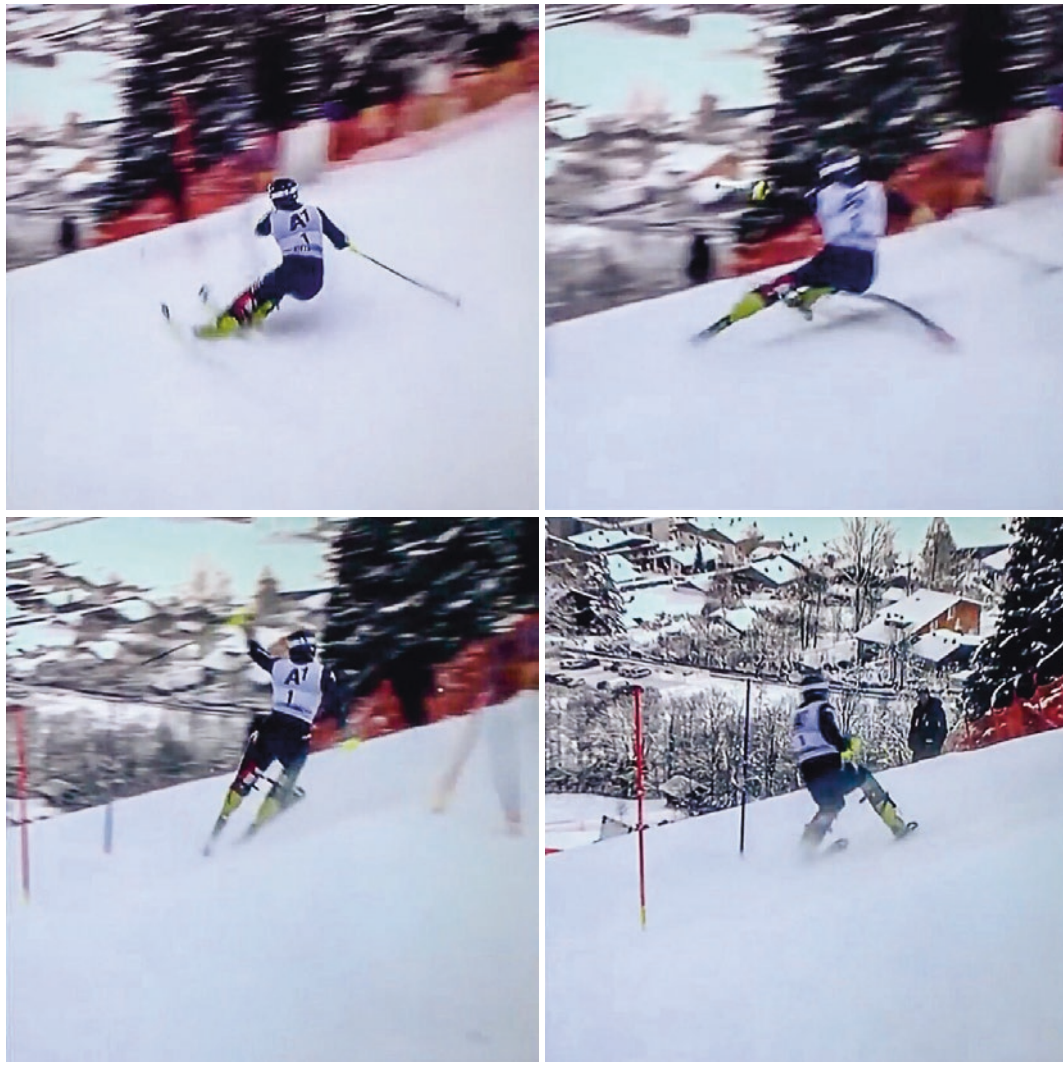

Fig. 18.1 Typical "slip-catch" ACL injury mechanism in alpine skiing, including sudden internal rotation of the knee

18.5 Competitive Versus Recreational Skiing

In 2006, the FIS together with Oslo Trauma Research Center began an injury surveillance system (ISS) [3]. Anterior cruciate ligament injury mechanisms have been well described and documented in competitive alpine skiing by means of video analysis [6].

Injury incidence is 36.7/100 skiers per season. It increases from Slalom 4.9/1000 runs) to Downhill (17.2/1000 runs). If adjusted to exposure time, related to length of the run, these incidences are similar [1]. Injury incidence is higher during race runs (45%) compared to training runs (25%). This difference could be higher if the number of race runs is compared to training runs during the season [29].

Knee injuries are the most frequent, representing 35.6% of all injuries in FIS Ski World Cup. ACL injury is the most frequent diagnosis representing 13.6% of all injuries [3] and 50% of knee injuries [29]. Most knee injuries are not related to fall but to indirect injury to the knee as a result of sudden internal rotation of the knee.

Fig. 18.2 ACL injury in recreational skiers could be related to jumps

Pujol et al. found a 28% prevalence of ACL injury in competitive elite alpine skiers with a 19% of re-ruptures and 30% of contra lateral ACL tears [2].

The main mechanisms are slip–catch, landing back-weighted, and dynamic snowplough. Differences between competitive alpine skiing and recreational skiing are obvious. Jumps and non-jump related to landing back-weighted could be the main injury mechanisms in recreational alpine skiing [30] (Fig. 18.2).

18.6 Risk Factors

The retrospective analysis performed did not reveal a link between the physical fitness of an athlete and the incidence of ACL injury. Generally, it remains questionable to what extend fitness tests can be related to injury prediction with sufficient accuracy [31]. A slight decrease in incidence of ACL injury has been found with higher "core" strength [7].

Multiple risk factors have been related to snow quality and weather. Cold temperatures have a relation with injury incidence and competition is limited to temperatures above −24°. Bad visibility has been found to increase injuries [32].

Similar to other sports, the type of surface where practice occurs has an influence on injury incidence. Not only jumps, bumps, or other features can have an effect but also the quality of snow itself can raise the reactivity and ground reaction forces transmitted to the knees and increase injuries [33]. Harder and icier snow will give place to more slip and energy dissipation lowering the risk of "slip–catch" mechanism in ACL injuries [4].

18.7 Prevention Strategies

Specific prevention strategies have proven to reduce injury incidence in other sports [34]. One study showed a decrease in injury incidence in trained skiing professionals working at ski resorts [24].

The use of knee braces has been debated. It is unclear if it has a role in primary prevention of ACL injury. Some studies have proven a decrease in ACL re-rupture after reconstruction and less giving-way episodes in ACL deficient skiers [35, 36].

Unfortunately, injury is inherently related to skiing. ACL injury incidence has not changed significantly throughout the years. It is important to know the epidemiology and risk factors associated with injury in skiing. Future actions should be taken to make skiing safer for both competitive and recreational skiers.

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