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Long-Term Effects of Knee Injuries in Former Ski Racers

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Abstract

Aim: Ski racing has always been associated with a high risk of knee injuries. The aim of this study was to assess, the long-term consequences of knee injuries in former alpine skiers.

Materials and methods: The study is limited to former ski racers who actively participated in FIS ski racing between 1996 and 2006 and it has been longer than 10 years since retirement from ski racing.

Results: Total of 275 ski racers from seven different countries took part in the study. Majority (206.75%) of the ski racers had suffered at least one knee injury. 49% skiers had undergone at least one ACL reconstruction and 23% had suffered more than one ACL rupture. In ski racer group the mean Lysholm score was 90.7(34-97). In the reference group the average Lysholm score was 97(86-100). The Lysholm score among skiers that had suffered on or more ACL-injuries had significantly lower Lysholm scores mean 81.

Conclusion: In this cohort of ski racers the slight majority of those who sustained an ACL- had injury had fair or poor knee scores. The common assumption that former ski racers have bad knees seems to be true.

Keywords: Knee injury; Trauma; Long term effects; Ski injury

Introduction

Alpine skiing is one of the most popular winter sports in the world. Nevertheless, it has always been associated with a high risk of knee injuries. Limited studies regarding the occurrence of injuries in competitive alpine ski racers have been carried out. Previous studies show that 72-83% of ski racers have had at least one serious injury during their career [1,2]. Flørenes et al. found that the injury rates in the FIS World Cup during 2006-2008 were found to be 36.7 per 100 athletes [3]. All the studies conducted on ski racing, reported that the knee joint was the most commonly injured body part with a high number of ACL injuries, accounting for 28%-36% of all injuries [3-8].

During the last decades the equipment of ski racers have undergone great changes. The new, highly shaped, short, and wide type of skis, have statistically proven to be a risk factor for ACL-injury [8]. With the new type of skis, the "Slip- catch" injury mechanism has become the most common reason for ACL injury among elite skiers [6]. In the Slip- catch situation the skier becomes out of balance in the backward and inward direction, and loses snow contact and pressure on the outer ski [9]. Subsequently, the inside edge of the outer ski abruptly catches the snow surface, leading to excessive knee joint compression, knee valgus, and internal rotation. The general consensus is that the flexion-internal rotation injury mechanism is especially related to the skiing equipment [10]. Other ACL injury mechanisms have been described in the literature among ski racers. These are the Boot-Induced Anterior Drawer (BIAD), [6] the valgus external rotation mechanism, Phantom Foot and the dynamic snow plow [11].

A knee injury, will often have difficult short-term consequences such as an interrupted skiing career. Haida et al. however found that ski racers sustaining an ACL rupture, returned to preinjury or even higher level of performance after the injury. They also had longer careers compared to athletes who had never had an ACL rupture [12]. The risk of knee osteoarthritis with onset at a young age, resulting in life-long sequel, is a reality after a major knee injury. Posttraumatic OA was present in 50% of patients 15 years after a major knee injury, and was similarly noted in 50% of the participants in a long-term follow up study after an isolated meniscus tear and total meniscectomy [13-15]. The objective of this study was to assess, the long-term consequences of knee injuries in former alpine skiers.

Methods

This is a retrospective survey involving former ski racers. The reference population consisted of former athletes in similar ages of various other sports. The Reference group was used for comparison with the results of the questionnaire and Lysholm score provided by the study population. Study population was further divided into two subgroups regarding to possible ACL injury (subgroup one had ACL and subgroup two did not have ACL injury during active career).

The study is limited to former ski racers who actively participated in International Ski Federation (FIS) ski racing (Skiers older than 15 years who are participating in international ski federation regulated competitions) between 1996 and 2006 and it has been longer than 10 years since retirement from ski racing. Former ski racers who have suffered an ACL-injury after their skiing career were not included in the study. Patient recruitment was done via Facebook online survey. The questionnaire, elicited information possibly relevant to the outcome of the injury, such as surgical procedures on the knee since the initial injury/injuries, number of surgeries and whether the patient is able to participate in recreational sports today. The patients also did the Lysholm knee score. The Survey was posted on several ski racing and national teams and authors Facebook™ pages and shared by authors numerous ex-skiracer friends to reach as many ex-ski racers as possibile. According to Facebook's statistics 79% of 18-40 year olds have a Facebook page.

In the Lysholm knee score, an overall score of 0 to 100 is calculated and graded based on 8 domains: limp, locking, pain, stair climbing, support, instability, swelling, and squatting. It is a condition-specific, subjective outcome score used by physicians to determine improvement in the injured or postsurgical knee. A score of 95 to 100 is considered excellent, 84 to 94 is good, 65 to 83 is fair, and <65 is poor.

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The number of injuries and subjective outcome, and Lysholm score were compared between study and control groups, and between study group subgroups regarding the ACL injury (subgroup 1 and 2). Statistical analysis. Continuous data between 2 groups were analyzed using the Mann-Whitney U test. Binary data in 2 × 2 tables (Tables 1-3) were evaluated with Fisher's exact test. A confidence interval of 95% (95% CI) was used when comparing the study population with the reference groups for the results. Statistical program SPSS 22 (IBM Corp. released 2009. IBM SPSS Statistics for Windows, version 13.0. Armonk, NY: IBM Corp.) was used for analyzes.

Results

Total of 275 former ski racers from seven different countries took part in the study (Table 2). There was a male dominance in the study population (79% vs. 21%). The length of the ski career was more likely to be either 4 years (21%) or 10 or more years (21%) with the median length of 6 years (1-13 years).

The reference group (n=52), comprised of former athletes of various sports (ice hockey 40%, Soccer 40%, 10% Football, 6% Tennis and 4% Swimming) (mean age 29 years (range 26–35 years). In the reference group only one athlete had suffered an ACL- injury and 60% had not suffered any knee injuries and only 20% had undergone a knee operation.

Majority (206.75%) of the former ski racers had suffered at least one knee injury that resulted in at least a 3-week pause from skiing and 165 (60%) had undergone at least one knee surgery. Almost half of skiers (134.49%) had undergone at least one ACL reconstruction and 23% had suffered more than one ACL rupture. All the females in the study had undergone at least one ACL reconstruction. ACL rupture occurrence was higher among those who had skied over 10 years. The prevalence of ACL re-injury of a previously injured knee was 17% (15.9% of the women, 17.2% of the men). One male had 4 ACL injuries (re-injuries of both knees), two skiers (one male, one female) had 2 re-injuries of the same knee (total of 3 injuries).

Thirty-eight percentages of all former ski racers did not experience any discomfort in skiing at the time of the study where as 7% suffered significant discomfort in skiing but everyone are able to ski at the time of the study. There rest of the study population experiences mild (27.5%) or moderate (27.5%) discomfort while skiing. Only 30% of the former ski racers reported to be able play other sports without discomfort and 40% experiences mild and 21% moderate discomfort. Results were worse among those who had suffered one or more ACL-ruptures. All suffered at least mild discomfort while skiing, 45% experiences mild, moderate 41% discomfort while skiing and 14% experienced significant discomfort while skiing. Similar results were found in playing other sports.

Knee score

In the former ski racer group the average Lysholm score was 90,7 with a range of 34 to 97. The Lysholm score median was 90. In the reference group the average Lysholm score was 97 with a range 86 to 100. The Lysholm score among skiers that had suffered on or more ACL-injuries had significantly lower Lysholm scores mean 81.4 (range 34-91). There were no significant differences between males and females. More detailed information on Lysholm scores are presented on Table 4.

Age at time of survey	Sex	Years of FIS racing	Country of origin	Participation in skiing high school	Number of knee injuries resulting in training pause longer than 3 weeks
Number of knee operations	ACL injury Yes=1 No =2	Total Number of ACL injuries	Number of ACL injuries in same knee	Discomfort in skiing >10 years after 1=None, 2=Slight, 3=Moderate, 4=Significant, 5=Not able to ski	Discomfort in sports 10 years after 1=None, 2=Slight, 3=Moderate, 4=Significant, 5=Not able to participate

Table 1: Questionnaire sent to former ski racers.

	n	%
Patients	275	
Female	58	21%
Male	217	79%
Age, years Mean (range)	31	(26-42)
Years of ski racing Mean (range)	5,8	(1-13)
Nationality		
Finland	86	31%
Norway	72	26%
Sweden	49	18%
USA	34	12%
Austria	23	8%
France	6	2%
Slovenia	5	2%

Table 2: Patient characteristics.

		Ski racers n= 275				
	None	1	2	3	4	5 or more
Number of knee injuries	66 (24%)	47 (17%)	55 (20%)	40 (15%)	25 (9%)	42 (15%)
Number of knee operations	110 (40%)	38 (14%)	50 (18%)	38 (14%)	7 (9%)	32 (12%)
Number of ACL injuries	140 (51%)	72 (26%)	54 (20%)	8 (3%)	1 (0.3%)	0

Table 3: Number of knee injuries, knee operations and ACL- injuries among former ski racers. Percentage of the study population in parenthesis.

Limp		**Support***		**Pain**		**Instability**	
None	89%	None	100%	None	63%	None	55%
Slight	9%	Stick or crutch	0	Slight during exertion	17%	Rarely during athletics	31%
Severe	2%	Weight bearing impossible	0	Marked during exertion	13%	Frequently during athletics	8%
Constant	0			Marked on or after walking >2 km	5%	Ocassionaly in daily activities	4%
				Marked on or after walking < 2km	1.50%	Often in daily activities	2%
				Constant	0.50%	Every step	0
Locking		**Swelling**		**Stair-climbing**		**Squatting**	
None	63%	None	55%	No problems	77%	No problems	57%
Catching sensation but no locking	23%	On severe exertion	38%	Slightly impaired	22%	Slightly impaired	37%
Locking occasionally	14%	On ordinary exertion	6.50%	One step at a time	1%	Not beyond 90°	6%
Frequently	0	Constant	0.50%	Impossible	0	Impossible	0
Locket joint	0						

Table 4: Former ski racers distribution of answers for each item of the Lysholm score.

Majority (70%) of former skiers had excellent or good Lysholm scores.

Among Ex-skiers with ACL-injury (n=134) 48% (65) showed excellent or good results (100–84 points) in Lysholm score, 44% (59) as fair and 8% (10) as poor.

The former ski racers scored worse (P>0.001) in all but one dimensions of the Lysholm Knee Scoring than the reference group, none of the former ski racers needed support while walking even though 3 former skiers are in need of knee brace during regular activities. Largest differences were seen in pain and squatting, 43% of the skiers had problems with squatting and 45% with mean score of 4 and 45% experiences instability where as in the reference group none had problems with squatting or experiences instability.

When comparing the ACL-injured skiers with reference group and skiers without ACL-injury, the ACL-injured skiers scored significantly worse (P<0.001) in all dimensions of the Lysholm score. The largest differences were seen in pain, with mean scores of 15 among the ACL injured and mean scores of 23 for other skiers in the reference group mean result was 25. The large differences were found in instability and squatting as well (19 vs. 25 vs. 25).

Discussion and Conclusion

To our knowledge this is the first study on long-term effects of knee injuries in former ski racers. In this cohort of 26–42-year-old former ski racers the 33% of the 275 former skiers had knee symptoms that substantially affected their knee-related quality of every day life, and slight majority (52%) of those who sustained an ACL- had injury had fair or poor knee scores. The common assumption that former ski racers have bad knees seems to be true.

The data by Pujol et al. [16] showed that elite-level alpine skiing had a very high incidence of primary ACL injury, bilateral ACL injuries (30.5%), and re-injuries (19%). Both Pujol and Haida found that he incidence of ACL rupture was related to the performance level, where better skiers injure they ACL- more often. In our data 49% of the former ski racers had at least one ACL injury and 23% had had more than one ACL rupture and among skiers that had raced longer than 5 years ACL injury was more common than among those who had skied less than 4 years. Majority of the former racers had suffered at least one knee injury that and 60% had undergone at least one knee surgery. We were not able to estimate incidences due to multi-nationality and retrospective nature of the study. The literature is inconsistent when it comes to gender differences regarding the incidence of ACL injury in competitive alpine skiers but several studies showed results that ACL injuries occur in a younger age in female athletes than in their male counterparts [7,17].

In this study all the female subjects had suffered ACL-injury [4,7,16-19]. The present study reflects the consequences of an ACL injury in athletes, with results being consistent with those from other long-term studies on ACL injury in other sports [13,14,20]. The already high prevalence of functional limitations in conjunction with pain among these young former ski racers, now at ages 26–42 years, is alarming. Surprisingly skiers without ACL-injury had worse scores than former athletes in the reference group. For many of these former skiers pain and ADL functional limitations can be expected to progress over years, and the need for a knee arthroplasty may arise in many of the former skiers when taken into consideration their ages today.

In order to prevent ACL ruptures in alpine skiers the literature recommends that ACL and knee injury prevention programs should be developed for each sport and the intervention must be based on the sport specific injury mechanism and specific risk factors [21-24]. For these 275 formers ski racers it is already too late but to prevent injuries in current and future ski racers is utterly important. Unfortunately, there is very little data on injury prevention programs in ski racing so far and to our knowledge. However, statistical evidence has been proven for only five of the risk factors, and only one prevention measure has been demonstrated to significantly reduce injury risk: Insufficient core strength [17], female sex [5,17-19], high skill level' [16]; 'unfavorable genetic predisposition' [22]; and the combination of highly shaped, short, and wide skis [8]. To date, only the combination of less-shaped and longer skis with reduced profile width was statistically confirmed to have a positive effect on ACL-injury risk in alpine ski racing [8].

Westin et al. conducted a study in Sweden on ACL-injury prevention but we will know the long term effects in the future. But the most important find in their study was the reduced overall rate of ACL-injuries by 45% in alpine ski students attending a Swedish ski high school. This indicates that ACL-injury prevention programs should be implemented in all ski clubs and ski high schools.

This was a retrospective, observational cohort study, with the limitations associated with such studies. Some selection bias may

have occurred, in which the presence of knee symptoms among those subjects invited into the study could have generated a greater interest to participate. Because of anonymity of subjects we were not able to get knee x-rays from the patients and therefor estimate the presence of radiological osteoarthritis. Were not able to access patient journals either and it is impossible to the used surgical technique or nonsurgical treatment. Furthermore, the subjects were not randomized with regard to treatment of their ACL-injury, and bias may thus have directed patients with more functional or mechanical instability or more severe associated injuries to undergo surgical treatment. We didn't record the time of ACL-injuries and most of the athlete's career coincides with the time when SL and GS ski's became shorter and more aggressive. Shorter and more aggressive skis are more likely to cause an ACL-injury.

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