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Research Article

Knee Function of Four Alpine and One Freestyle World Cup Skiers 30 Years after Serious Knee Injuries

Arne Ekeland* and Stig Heir

Orthopaedic Department, Martina Hansens Hospital, Sandvika, Norway

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ABSTRACT

Objective: Serious knee injuries have ruined many skiing careers. The purpose of this study is to report the knee function of five Norwegian world cup skiers 30 years after a serious knee injury.

Methods: The five skiers with anterior cruciate ligament (ACL) and concomitant serious knee injuries were treated at Oslo University Hospital in the period 1989-92. The median age at the time of injury was 25 (19-26) years. Three of the alpine skiers regained their world cup ranking. About 30 years after their injuries, the skiers were asked about later injuries, competition activity and evaluated by Tegner activity scale and the knee injury and osteoarthritis outcome score (KOOS).

Results: The skiers participated in median 4 (0-5) world cup seasons after their knee injuries and did not suffer new acute knee injuries. Thirty years after the knee injury the tegner score was higher (more activity) and the KOOS score was lower (more symptoms) than those of a normal population of corresponding age group.

Conclusion: Thirty years after a serious knee injury the five world cup skiers are still living an active life with higher tegner and lower KOOS scores than the normal population. Functional knee scores should therefore be related to the degree of activity.

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Introduction

The risk of a severe injury is high in alpine world cup skiers with 9.8 injuries per 1000 runs [1]. The risk is reported to be highest in downhill, followed by super G, giant slalom and slalom, suggesting the risk increases with increasing speed [1, 2]. Males had a higher risk for injury than females, but there was no sex differences in the risk of knee/anterior cruciate ligament (ACL) injuries [3]. Knee injuries were the most common with ACL disruption being the most significant in terms of time loss from sport [4]. The injury risk is also high among world cup freestyle skiers where 291 acute injuries were recorded in 662 skiers during three successive seasons (2006-2009), and 32% of the injuries were severe in nature [5]. The most frequently injured part was the knee, and half of these injuries were severe [5].

A serious knee injury may ruin a skiing career, but some skiers may return to ski competition after appropriate treatment and even regain their ranking in the world cup [6, 7]. Little is known about sports

activities in the long run of such skiers. The purpose of this study is to report the knee function of five Norwegian alpine world cup skiers 30 years after a serious knee injury.

Patients and Methods

Four alpine and one freestyle mogul world cup skiers with anterior cruciate ligament (ACL) and concomitant serious knee injuries were treated at Oslo University Hospital in the period 1989-92. Three male downhill racers suffered respectively ACL and medial collateral ligament (MCL) rupture, ACL and patellar tendon rupture, and ACL rupture with previous sutured ACL rupture in both knees (Table 1). The first skier was treated with reconstruction of ACL with patellar tendon graft and suture of the MCL. The second with suture of the ACL and augmentation with iliotibial band tenodesis according to Steadman, and suture of the patellar tendon with temporary patellofemoral cerclage augmentation [8]. The third was treated with suture and iliotibial band augmentation.

*Correspondence to: Arne Ekeland, M.D., Ph.D., Orthopaedic department, Martina Hansens Hospital, Box 823, NO-1306 Sandvika or Fagerstrandveien 64, NO-1363 Høvik, Norway; Tel: +4790821092; E-mail: arekelan@online.no

The freestyle mogul skier suffered ruptures of both cruciate ligaments and the lateral structures of the knee including the lateral collateral ligament (LCL), the iliotibial band and the biceps tendon, and a compression fracture of the medial tibial condyle. He was treated with plate osteosynthesis of the tibial condyle, screw fixation of the lateral biceps tendon and the iliotibial band, suture of the LCL and the proximal posterior cruciate ligament (PCL). The distal ACL was attached to a bone fragment and was stabilized with the tibial osteosynthesis. The pressure on the PCL was relieved by temporary olecranonization of the patella [9].

The only female of the five skiers suffered ruptures of ACL, PCL and MCL in giant slalom. The ACL was sutured and augmented with the medial third of the patella tendon. The PCL was sutured, and the suture pressure relieved by temporary olecranonization of the patella. The proximal MCL was stabilized with a screw. Postoperatively she suffered arthrofibrosis and was reoperated three times removing scar tissue to regain full range of motion. The median age at of the skiers at injury was 25 (19-26) years. The preinjury world cup ranking was median 7 (2-85) and the ranking 1-2 seasons after the injury 13 (2-34) [7].

About 30 years after the injury the skiers were asked about later injuries, physical and competition activities, and evaluated by Tegner activity scale (1-10) [10]. Ten is the best ranking and only includes soccer players on international levels, whereas downhill and freestyle mogul skiers are ranked 8. The five skiers were also evaluated by the knee injury and osteoarthritis outcome score (KOOS) (1-100) [11]. KOOS includes the five subscores pain, symptoms, activity of daily living (ADL), sport and recreation and quality of life. The best score is 100. The study was performed according to the Helsinki declaration with informed patient consent. The results are presented as median or mean (KOOS) with range.

Results

The first downhill skier regained his world cup ranking and won the silver world champion medal in downhill the season after the injury. He suffered anterior knee pain, and MRI disclosed hypertrophy of the patellar tendon in the operated knee. A ventral resection of the tendon was made at the end of the season with good effect on the pain [9]. He participated in five world cup seasons after the knee injury and won the world cup in super G and two gold world champion medals in super G before he retired because of pain due to cartilage injuries in the other previous uninjured knee. The second downhill skier improved his world cup ranking, participated in four more world cup seasons, and retired because of spine pain. Presently the left hip restrains him more than the previous injured right knee. Also, the third downhill skier improved his world cup ranking and participated in four more world cup seasons after his last ACL rupture. He still participates in alpine competitions for veterans and in orienteering races.

The freestyle mogul skier did not quite regain his world cup ranking the season after his serious knee injury (Table 1) but regained his national championship. The next season he reached the final in the olympic moguls. He participated in 6 more national seasons and 9 more seasons for veterans. Twenty years after the injury he had a high tibial valgus osteotomy due to medial knee osteoarthritis, and 6 years later a total knee arthroplasty. He still skis, paraglides and is an active deer hunter.

The female giant slalom skier did not participate more in the world cup but gained the sixth place in the national championship in giant slalom two seasons after the injury. After years with bicycle training, she still skis and play tennis. The median preinjury tegner score dropped from 8 to 6 after 30 years (Table 1). Mean KOOS 30 years after the knee injury was mean 75 (56-94) for pain, 60 (43-82) for symptoms, 88 (75-99) for activity of daily living, 45 (25-90) for sport and recreation and 53 (44-81) for quality of life (Figure 1).

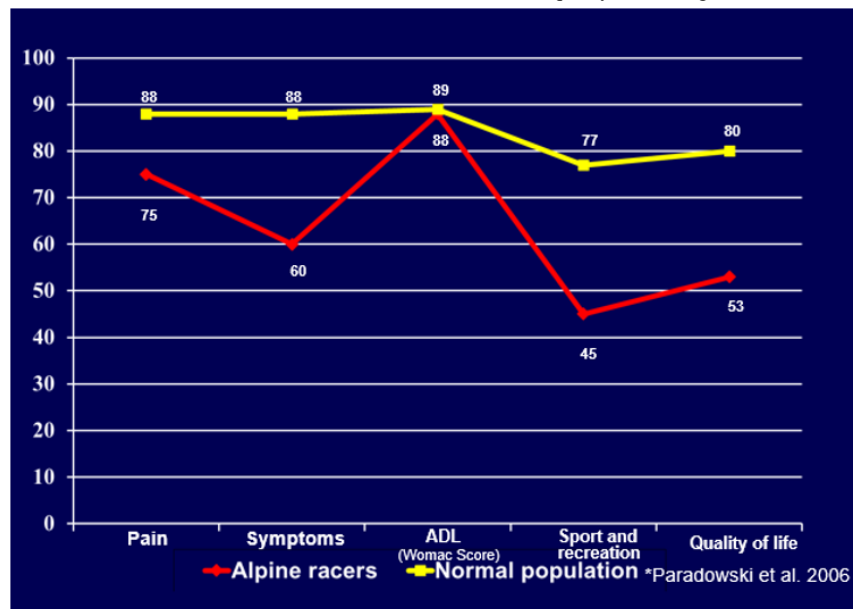


Figure 1: Mean knee injury and osteoarthritis outcome score (KOOS) of five alpine world cup skiers 30 years after serious injuries compared to a normal population of the same age group [13].

ADL: Activity of Daily Living.

Table 1: Type of world cup competition, gender, age, type of knee injuries, world cup ranking before and after the injury, Tegner score before and 30 years after the injury and follow-up time of four alpine and one freestyle mogul skiers.

Competition	Gender	Age at injury	Injury type	World cup ranking before injury	Highest World cup ranking after injury
Downhill	Male	25	ACL, MCL	2	2
Downhill	Male	22	ACL, PL	85	27
Downhill	Male	26	ACL, previous bilateral ACL	20	11
Freestyle	Male	25	ACL, PCL, MCL tendons, fracture	2	15
Giant slalom	Female	19	ACL, PCL, MCL	7	-
Median		25		7	13
Range		(19-26)		(2-85)	(2-27)

Tegner score before injury	Tegner score 30 Years after injury	Follow-up Time (years)
8	6	30
8	4	29
8	7	31
8	6	30
8	6	31
8	6	30
(8-8)	(4-7)	(29-31)

ACL: Anterior Cruciate Ligament; MCL: Medial Collateral Ligament; PL: Patellar Ligament; PCL: Posterior Cruciate Ligament; LCL: Lateral Collateral Ligament.

Discussion

This study showed that it is possible to regain the ranking in the alpine world cup after a serious knee injury, but the injury may impact the length of the world cup skiing career. The Tegner activity score was median 6 (4-7) 30 years after the injury, compared to 4(3-6) for a normal population of corresponding age group with no previous knee surgery or recent injury [12]. The mean KOOS was, however lower than KOOS in the normal population of corresponding age group retrieved from the Swedish population register (Figure 1) [13]. This suggests that these racers may tolerate more discomfort or pain to maintain their relative high activity compared to the normal population. Functional knee scores should therefore be related to the degree of activity.

All the five skiers had ACL rupture and concomitant knee injuries. ACL injuries are very common in alpine ski competitions being 48.6% of the severe injuries among Austrian ski racers, and 31% of alpine olympic skiers had previously suffered an ACL rupture [14, 15]. Contralateral ACL tears also contribute to high rates of secondary ACL injuries in professional ski racers [16]. All the three downhill skiers in this study regained or improved their world cup ranking after their injuries, including the skier who had suffered ACL rupture three times. The reason for this was probably related to that they were young with improving racing results when their injuries occurred [6].

Overuse injuries in knee, back and hip are common in ski racers, even after the end of the skiing career [17, 18]. The first and second downhill skiers in this study stopped racing because of pain in the contralateral knee and back-pain respectively. Both claimed that they put more pressure on the contralateral leg after the injury to relieve the pressure

on the operated knee. The second downhill skier later developed pain in the contralateral hip in addition to the back-pain.

The first downhill racer was subjected to heavy training after the knee injury and developed hypertrophy of the patellar tendon following the mid third of the tendon was resected and used as a graft for the new ACL [9]. Hypertrophy of the patellar tendon has also been observed in an experimental study in rats exposed to mid third resection of the patellar tendon and trained postoperatively on a treadmill [19].

The freestyle mogul skier suffered the most serious knee injury and ended up with a total knee arthroplasty 26 years after the injury. Even though he has lived an active life with skiing, parachuting, and paragliding. He still skis and is an active deer hunter. Also, the female giant slalom skier who was reoperated for arthrofibrosis three times recovered after years with cycle training to a life with recreational skiing and tennis. World cup skiers on this level have a strong determination in reaching their goals, and this might also be important in the process of recovering from a serious injury.

The population of the current study is small, describing the outcome after serious knee injuries in five world cup skiers, but to our knowledge there are no previous studies published of alpine world cup skiers with such long follow-up.

Conclusion

Alpine world cup skiers may return to skiing on the same level the first years after serious knee injuries, but some may overstrain the other leg to reduce the strain on the injured knee. Thirty years after their serious

knee injuries they are still living an active life with higher Tegner activity score but lower KOOS score (more knee symptoms) than the normal population of corresponding age group. Functional knee scores should therefore be related to the degree of activity.

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Declaration of Interests

None.

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