



An evaluation of knee ligament injuries encountered in skiers at the Uludağ Ski Center

Uludağ Kayak Merkezi'nde kayakçılarda görülen diz bağ yaralanmalarının değerlendirilmesi

Burak DEMİRAG, Tefik ÖNCAN, Kemal DURAK

Uludağ University Medical School Department of Orthopaedic Surgery

Amaç: Uludağ'da bir kış sezonunda kayak sırasında meydana gelen diz bağ yaralanmalarının sıklığı, anatomik tipleri ve yaralanma riski oluşturan etkenler değerlendirildi.

Çalışma planı: Çalışmaya 2003-2004 kayak sezonunda Uludağ Üniversitesi-Sabancı Sağlık Merkezi'ne kayak sırasında meydana gelen diz bağ yaralanması nedeniyle başvuran 215 hasta (240 diz) alındı. Hasta grubunda ortalama yaş 31 (dağılım 9-55) idi. Bağ yaralanmaları AOSSM (American Orthopaedic Society for Sports Medicine) ölçütlerine göre derecelendirildi. Kümülatif veriler hasta kayıtlarından ve kontrol grubunda yer alan sağlıklı 100 kayakçıya sorulan sorularla toplandı.

Sonuçlar: Genel diz yaralanma oranı her bin kayakçı gününde 1.14 idi. Diz yaralanmalarının arasındaki süre ortalama 875 kayakçı günüydü. En sık yaralanan bağların iç yan bağ (%35.4) ve ön çapraz bağ (%27.1) olduğu saptandı. Malzeme açısından, diz bağ yaralanmalarının kayakta "snowboard"a göre daha fazla meydana geldiği görüldü (odds ratio 6.83, $p<0.001$). Kayak pistinin zorlu olması diz bağ yaralanma olasılığını iki kat artırmaktaydı (odds ratio 2.28, $p<0.001$). Yaralanmaların oluşması açısından cinsiyet ve yaş açısından anlamlı farklılık görülmedi.

Çıkarımlar: İç yan bağ ve ön çapraz bağ kayakçılarda dizde en sık yaralanma görülen bağlardır. Ekipman (kayak) ve kayak alanı (zor pist) ile ilgili risk faktörleri diz yaralanmalarının oluşmasında anlamlı rol oynamaktadır.

Anahtar sözcükler: Ön çapraz bağ/yaralanma; atletik yaralanma/fizyopatoloji; diz yaralanması/fizyopatoloji; ligaman, artiküler/yaralanma; kayak sporu/yaralanma.

Objectives: We evaluated the frequency, anatomic types, and predisposing factors of knee ligament injuries that occur in skiers during a winter season at the Uludağ Ski Center, Bursa, Turkey.

Methods: A total of 215 patients (240 knees) presented to the Uludağ University-Sabancı Health Center after sustaining a skier knee injury during the 2003-2004 winter season. The mean patient age was 31 years (range 9 to 55 years). Knee ligament injuries were assessed according to the AOSSM (American Orthopaedic Society for Sports Medicine) criteria. Cumulative data were collected from patient records and from a questionnaire administered to 100 healthy skiers.

Results: The mean knee injury rate was 1.14 injuries per 1000 skier-days. The mean length of time between the occurrence of knee injuries was 875 skier-days. The most frequently injured ligament was the interior cruciate ligament (35.4%) followed by the anterior cruciate ligament (27.1%). Knee ligament injuries were significantly more common in skiers than in snowboarders (odds ratio 6.83, $p<0.001$). Hard and steep pist were associated with a two-fold risk for knee ligament injuries (odds ratio 2.28, $p<0.001$). For the occurrence of knee injuries, no significant differences were found with respect to sex and age.

Conclusion: The interior and the anterior cruciate ligaments are the most commonly injured ligaments in skiers. Two risk factors concerning the equipment (ski) and the environment (hard pist) play a significant role in the occurrence of knee injuries.

Key words: Anterior cruciate ligament/injuries; athletic injuries/physiopathology; knee injuries/physiopathology; ligaments, articular/ injuries; skiing/injuries.

The rate of injuries occurring in skiers is between 2 and 5 per thousand skier days⁽¹⁾ with an increase of knee injuries constituting about 30% of the total.⁽²⁾ These injuries most commonly occur in medial collateral ligament (MCL) and anterior cruciate ligament (ACL).^(3,4) For example, rupture of ACL was observed 50-70 per hundred thousand of alpine discipline skiers.⁽⁵⁾

In this current study, frequencies, anatomical types and predisposing factors of knee ligament injuries which occurred at Uludag Ski Center in 2003-2004 winter season were evaluated.

Patients and methods

215 patients (240 knees) who attended the Uludag University-Sabancı Health Center after sustaining a skier knee injury during the 2003-2004 winter season were included in the study. The mean patient age was 31 years (range 9 to 55 years). Patients with other major injuries besides a knee injury were excluded. Information such as the mechanism of the injury, the piste condition and equipment used by the patient was also taken from witnesses of the event, gendarme patrol, and transporting personnel.

First treatment of all cases was done immediately after physical examination. Causes associated with the injury and predisposing factors were evaluated. Diagnosis of ligament injury made by history and by tests done in the physical examination such as varus - valgus stress instability, Lachman, and posterior drawer tests. Injuries were grouped as injuries of MCL, LCL, ACL, and PCL; and were assessed according to the AOSSM (American Orthopedic Society for Sports Medicine) criteria.⁽⁶⁾ When examined in one plane, if there was no displacement, the patients were considered as normal; if there was displacement up to 0.5 cm, between 0.5 and 1 cm, and more than 1 cm, the patients were categorised into group I, II, and III respectively. Grade I injuries were included in the same group, regardless of the injured ligament type.

In order to define factors associated with knee ligament injury, a control group of 100 non-injured skiers was established, and asked to complete the inquiry form that was applied to the patients (including information about gender, age, the equipment used, and preferred piste)

"Injuries per thousand skier days" and "mean days between injuries" were calculated.^(7,8) A skier day is defined as a day in which a skier says "I have skied". Total skier days were calculated by data obtained from hotels and ticket sales. Mean days between injuries were calculated as the total number of skier days divided by the total number of specific injuries seen.⁽⁸⁾ As they have a steeper gradient than the others, Tutyeli, Kuşaklıkaya, OsmanYüce, and Italyan were considered as difficult pistes.

Cumulative data was retrieved from records and inquiry forms. "Odds Ratio" values of a factor calculated by the injury rate in the presence of this factor divided by the rate in its absence. The effect of these factors on the injury was assessed by univariate logistical regression analysis. The values of the study and control groups were compared using a chi-square test. The upper and lower limits were calculated between 95 per cent confidence interval. Statistical significance was accepted at $p < 0.001$.

Results

210 thousand skier days during the study period, consisted of 165 thousand "skier" days, and 45 thousand "snowboarder" days. Throughout the season a total of 810 skiers attended Uludag University-Sabancı Health Center with an injury. The injury rate was 3.8 per thousand skier days with a knee injury

Table 1. Distribution of study and control groups.

		Study (n=215)		Control (n=100)	
		number	percentage	number	percentage
Gender	Male	96	44.7	53	53.0
	Female	119	55.4	47	47.0
Age	<18	45	20.9	14	14.0
	18-30	78	36.3	37	37.0
	30-45	60	27.9	31	31.0
	>45	32	14.9	18	18.0
Equipment	Ski	205	95.4	75	75.0
	Snowboard	8	3.7	25	25.0
	Bigfoot	2	0.9	-	
Piste	Difficult	123	57.2	37	37.0
	Easy	92	42.8	63	63.0
Side	Left	133	61.9	-	
	Right	82	38.1	-	

Table 2: Distribution of anatomical types of knee injuries, according to equipment.

Anatomical Location	Ski		Snowboard		Bigfoot		Total	
	n	%	n	%	n	%	n	%
Type I Ligament Injury	72	88.9	7	8.6	2	2.5	81	33.8
Medial Collateral (II-III)	84	98.8	1	1.2	–	–	85	35.4
Lateral Collateral (II-III)	9	100.0	–	–	–	–	9	3.8
Anterior Cruciate (II-III)	65	100.0	–	–	–	–	65	27.1
Total	230	95.8	8	3.3	2	0.8	240	100.0

rate of 1.14 per thousand skier days. The mean days between knee injuries were 875. The cumulative data of the study and control groups is shown in Table 1.

MCL (35.4 %) and ACL (27.1 %) were the most commonly injured ligaments. We did not see any grade II and III PCL injury.

When equipment is considered, knee injuries were seen more frequently with skis rather than snowboards (OR 6.83; 2.96-16.7 in 95 % confidence interval, $p < 0.001$). On difficult pistes, knee ligament injuries were twice as frequent (OR 2.28; 1.36-3.82 in 95 % confidence interval, $p < 0.001$). Although knee ligament injuries were found to be a little bit higher when gender (female) and age (< 18) were considered; these differences were not statistically significant (OR 1.4 $p > 0.05$ and OR 1.63 $p > 0.05$ respectively). (Table 3)

Discussion

There are some problems in evaluating knee ligament injuries in our country. It is difficult to calculate the real frequencies of knee ligament injuries, because not all knee injuries were recorded. It is also difficult to determine the actual total skier days as there are incomplete skier days. The frequency of ski injuries is accepted as 2-5 per thousand skier days^(1,9). In recent studies it has been reported that

knee injuries are 25-30 % of total ski injuries and 9 out of 10 knee injuries are an injury to one of the ligaments.^(9, 10)

Deibert et al.⁽³⁾ reported that the ACL and MCL are the most frequently injured ligaments and we found this to be so in our study with ACL (27 %) and MCL (36 %). As we do not have MRI in Sabanci Health Center, it was not possible to calculate the frequencies of associated meniscal injuries. Barber studied the ACL and MCL injuries and found that if they occur together, lateral and medial meniscal injuries were found to be 43 % and 13 % respectively. In a study conducted in Aspen Ski Center when meniscal injuries are associated with ligament injuries it was reported that ACL, MCL and lateral meniscal injuries were seen nine times more frequently than ACL, MCL and medial meniscal injuries. This is primarily because of the forward external movement of the leg so the lateral meniscus becomes compressed and injured between posterolateral tibia and lateral femoral condyle.

We found that more than half of the injuries took place on the difficult pistes (57.2 %). We think this is as a result of the gradient and icy nature of these pistes.

There are few results concerning LCL injuries; Cimino⁽¹³⁾ reported LCL injury together with ACL as 3 %. In our study we found 3 % isolated LCL injury.

Table 3: Factors in knee ligament injuries, and results of univariate regression analysis.

Factor	Study (%)	Control (%)	OR	%95 OR	χ^2	p
Equipment (ski)	95.4	75.0	6.83	2.9-16.07	28.62	< 0.001
Piste (difficult)	57.2	37.0	2.28	1.36-3.82	11.15	< 0.001
Age (< 18)	20.9	14.0	1.63	0.81-3.3	2.15	> 0.05
Gender (Female)	55.4	47.0	1.4	0.84-2.31	1.90	> 0.05

*OR: Odds Ratio; **95% OR: between 95% confidence interval

PCL rupture was not observed among our cases and PCL injuries were also reported to be infrequent in Taos Ski Center.⁽¹⁰⁾ The mechanism of this injury is anteroposterior forces acting on the tibia. Knee dislocation was reported in one case and it is extremely rare.⁽¹⁴⁾ In our study one patient with knee dislocation was excluded because of associated injuries.

Ski bindings are also very important in reducing injuries. Non-release of one foot from the ski during a fall increases the injury risk 2.3 fold, and non-release of both feet increases the risk 3.3 fold.⁽¹⁵⁾ Gouled et al. reported that 47 % of bindings were inappropriate and it increases the injury risk 2.1 times.

In addition to equipment, the role of piste conditions and personal factors cannot be denied in knee injuries. The condition of the skier, muscle strength, flexibility, durability, and agility could prevent knee injuries. Another important point is giving up skiing before becoming over-tired. Inexperienced skiers are injured 2-4 times more than experienced ones.⁽⁹⁾

Skier knee injuries have their peculiar epidemiology and mechanisms. Designating skier knee injuries at a popular ski centre like Uludag is very important in our opinion. In our study we found that MCL and ACL were the most frequently injured ligaments and concluded that difficult pistes increased the risk of knee ligament injuries.

References

1. Langran M, Selvaraj S. Snow sports injuries in Scotland: a case-control study. *Br J Sports Med* 2002;36:135-40.
2. Hunter RE. Skiing injuries. *Am J Sports Med* 1999;27:381-9.
3. Deibert MC, Aronsson DD, Johnson RJ, Ettlinger CF, Shealy JE. Skiing injuries in children, adolescents, and adults. *J Bone Joint Surg [Am]* 1998;80:25-32.
4. Warne WJ, Feagin JA Jr, King P, Lambert KL, Cunningham RR. Ski injury statistics, 1982 to 1993, Jackson Hole Ski Resort. *Am J Sports Med* 1995;23:597-600.
5. Feagin JA Jr, Lambert KL, Cunningham RR, Anderson LM, Riegel J, King PH, et al. Consideration of the anterior cruciate ligament injury in skiing. *Clin Orthop* 1987;(216):13-8.
6. Giles RS, Scott WN, Insull JN. Injuries of knee. In: Rockwood CA Jr, Green DP, Bucholz RW, Heckman JD, editors. *Fractures in adults*. Vol. 1, 5th ed. New York: Lippincott; 2001. p. 1844-931.
7. Davidson TM, Lalotitis AT. Alpine skiing injuries. A nine-year study. *West J Med* 1996;164:310-4.
8. Johnson RJ, Ettlinger CF, Shealy JE. Skier injury trends: 1972 to 1994. In: Johnson RJ, Mote CD Jr, Ekland A, editors. *Skiing trauma and safety*. Vol. 11, Philadelphia: American Society for Testing and Materials; 1997. p. 37-48.
9. Koehle MS, Lloyd-Smith R, Taunton JE. Alpine ski injuries and their prevention. *Sports Med* 2002;32:785-93.
10. Rossi MJ, Lubowitz JH, Guttman D. The skier's knee. *Arthroscopy* 2003;19:75-84.
11. Barber FA. Snow skiing combined anterior cruciate ligament/medial collateral ligament disruptions. *Arthroscopy* 1994;10:85-9.
12. Duncan JB, Hunter R, Purnell M, Freeman J. Meniscal injuries associated with acute anterior cruciate ligament tears in alpine skiers. *Am J Sports Med* 1995;23:170-2.
13. Cimino PM. The incidence of meniscal tears associated with acute anterior cruciate ligament disruption secondary to snow skiing accidents. *Arthroscopy* 1994;10:198-200.
14. Siegmeth A, Menth-Chiari WA, Amsuess H. A rare case of irreducible knee dislocation in a seventy-three-year-old male. *J Orthop Trauma* 2000;14:70-2.
15. Bouter LM, Knipschild PG, Volovics A. Binding function in relation to injury risk in downhill skiing. *Am J Sports Med* 1989;17:226-33.
16. Goulet C, Regnier G, Grimard G, Valois P, Villeneuve P. Risk factors associated with alpine skiing injuries in children. A case-control study. *Am J Sports Med* 1999;27:644-50.