

# Nonoperative treatment for anterior cruciate ligament injury in recreational alpine skiers

Iftach Hetsroni · Demetris Delos · Greg Fives ·  
Brian W. Boyle · Kaitlyn Lillemoe ·  
Robert G. Marx

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## Abstract

**Purpose** The purpose of this study was to test whether low-grade Lachman test (i.e. Grade 0–1+) and a negative pivot shift at 6–12 weeks post-ACL rupture in recreational alpine skiers can be used to predict good function and normal knee laxity in nonoperated patients at minimum 2 years after the injury.

**Methods** Office registry was used to identify 63 recreational alpine skiers treated by the senior author within 6 weeks of a first-time ACL injury between 2003 and 2008. Of these, 34 had early ACL reconstruction but 29 patients were observed and re-evaluated. Office charts and MRI were reviewed. Inclusion criteria for this study were as follows: ACL rupture documented on MRI after the injury, and minimum 2-year follow-up. Exclusion criterion was contralateral knee ligament injury. Of the 29 patients treated nonoperatively, 17 had low-grade Lachman and negative pivot shift tests within 6–12 weeks after the injury and were recommended to continue follow-up without surgery. Of these 17 patients, 6 were lost to follow up, but 11 patients were recalled and evaluated at more than 2 years after the injury. They completed Marx and Tegner activity level and IKDC subjective scores, physical

examination of the knee and KT-1000 anterior laxity assessment.

**Results** Median age at injury was 43 years (range 29–58). Median follow-up was 42 months (range 30–68). Mean IKDC subjective score at latest follow-up was  $91.6 \pm 6.7$ . Median Tegner score was 6 (range 6–9) before the injury and 6 (range 4–6) at latest follow-up ( $p = \text{n.s.}$ ). Median Marx score was 6 (range 0–16) before the injury and 4 (range 0–12) at latest follow-up ( $p = 0.03$ ). Ten patients had Lachman Grade 0–1+, and one had Lachman Grade 2+ at latest follow-up. KT-1000 showed mean side-to-side difference of  $0.8 \pm 1.6$  mm, and less than 3 mm difference in the 10 patients with Lachman Grade 0–1+.

**Conclusion** Recreational alpine skiers who sustain ACL injury should be re-evaluated at 6–12 weeks after the injury rather than being operated acutely. If they have negative Lachman and pivot shift tests at that point, they can be treated without surgery since good outcome and normal knee anterior laxity at more than 2 years after the injury is expected.

**Level of evidence** Case series, Level IV.

**Keywords** Skiing · Recreational · Alpine · ACL rupture · MRI · Lachman test · KT-1000

I. Hetsroni (✉)

Department of Orthopedic Surgery, Meir General Hospital,  
Sapir Medical Center, Tsharnichovski Street 59,  
44281 Kfar Saba, Israel  
e-mail: iftachhetsroni@gmail.com

I. Hetsroni

Sackler Faculty of Medicine, Tel Aviv University,  
Tel Aviv, Israel

D. Delos · G. Fives · B. W. Boyle · K. Lillemoe · R. G. Marx  
Hospital for Special Surgery, Weill Medical College of Cornell  
University, New York, NY, USA

## Introduction

Despite increasing knowledge of anterior cruciate ligament (ACL) anatomy and the development of improved surgical techniques for reconstruction, uncertainty still remains regarding optimal indications for ACL reconstruction in active individuals [12, 15]. While data support ACL reconstruction for young athletes in order to allow sports participation and reduce the risk of damage to the articular

cartilage and menisci as a result of recurrent giving way [4], less active patients may be better treated nonoperatively [14, 16]. Recently, a prospective randomized trial in young active adults with ACL tears concluded that a strategy of initial nonoperative treatment for all patients along with optional delayed ACL reconstruction can reduce significantly the need for reconstruction compared to a strategy of early ACL reconstruction [6]. Yet, this study also showed that the group initially treated nonoperatively with only optional delayed ACL reconstruction underwent significantly more meniscal procedures and had significantly higher frequency of subjective or clinical knee instability [6]. This indicates that a strategy of early nonoperative management for all active adults with ACL tears may result in suboptimal outcomes for some patients due to recurrent instability [11]. While some patients demonstrate normal knee stability and good outcome without reconstruction following ACL injury, knowledge about how to identify patients who can be managed nonoperatively without risking future instability is still lacking.

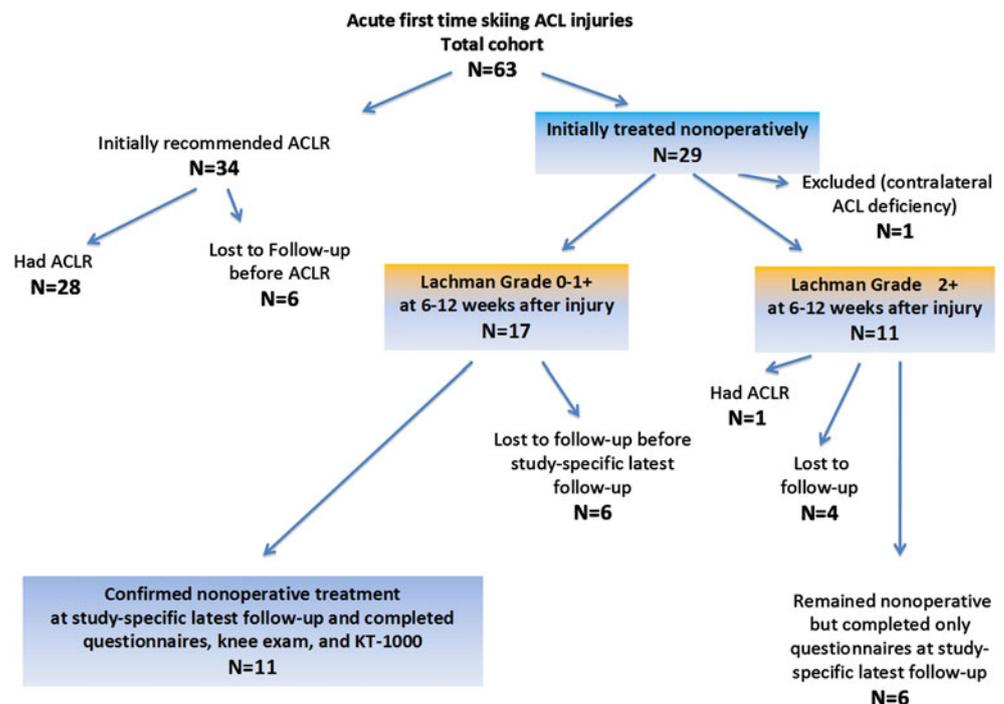
In the senior author's practice, some recreational alpine skiers were found to have normal laxity and a negative pivot shift examination at 6–12 weeks after ACL injury. These patients were treated without surgery. The purpose of this study was to evaluate the outcome of these nonoperated recreational skiers. We hypothesized that negative Lachman and pivot shift tests at 6–12 weeks after an ACL injury in recreational alpine skiers can be used to predict good outcome and normal laxity at more than 2 years after the injury, thereby helping to optimize surgical indications for this injury.

## Materials and methods

Office registry was used to identify patients treated by the senior author Robert G. Marx within 6 weeks of a first-time ACL injury that occurred with recreational alpine skiing between 2003 and 2008. Office charts and MRI were reviewed. Data collected included sex and side of injury, age at time of injury, MRI findings and knee examination during the first 6–12 weeks after the injury which were all performed by the senior author. Inclusion criteria for this study were as follows: ACL rupture documented on MRI after the injury and minimum 2-years follow-up. Exclusion criterion was contralateral knee ligament injury, since side-to-side laxity difference measurements were needed to assess outcome.

Sixty-three recreational alpine skiers were identified. Thirty-four were treated with early ACL reconstruction for a variety of reasons (associated injuries, patient preference, etc.), but 29 were observed and re-evaluated (Fig. 1). Of the 29 remaining patients, 1 was excluded due to a contralateral ACL injury, 11 were found to have high-grade Lachman (i.e. Grade 2+ or above) at 6–12 weeks after the injury, and 17 had low-grade Lachman (i.e. Grade 0–1+) with negative pivot shift at 6–12 weeks after the injury. Six of the eleven patients with high-grade Lachman tests (who elected to not have surgery initially) completed questionnaires at follow-up, whereas four were lost to follow-up and one underwent ACL reconstruction. The six patients (1 male, 5 females) had a median age of 43 years (range 19–56) and were followed for a median of 62.5 months (range 41–77). Two of them returned to skiing and four did

**Fig. 1** Flowchart of the study cohort



**Table 1** Patient demographics and injury characteristics

Variable	Total number of patients = 11
Men/women (number of patients)	6/5
Median age at injury, range (years)	43, 29–58
Median follow-up time, range (months)	42, 30–68
Accompanying injuries on MRI (number of patients)	
Small posterior horn medial meniscus tear	3
Small posterior horn lateral meniscus tear	1
Medial collateral ligament sprain Grade I–II	3
Fibular collateral ligament sprain Grade I	1
Isolated ACL tear	4

**Table 2** Function and activity level scores

Score	Total number of patients = 11
IKDC subjective score [mean $\pm$ SD]	
At latest follow-up	91.6 $\pm$ 6.7
Tegner activity level score [median, (range)]	
Before the injury	6, (6–9)
At latest follow-up	6, (4–6) $p = \text{n.s.}$
Marx activity level score [median, (range)]	
Before the injury	6, (0–16)
At latest follow-up	4, (0–12) $p = 0.03$

not. Their mean IKDC subjective score at follow-up was  $80.7 \pm 11.5$ .

Seventeen patients with low-grade Lachman tests at 6–12 weeks after the injury (27 % of the initial cohort) were recommended nonoperative treatment. Of these 17, eleven patients returned for a study-specific follow-up evaluation at more than 2-year post-injury and the other six did not. They all completed questionnaires describing details of the injury [18], International Knee Documentation Committee [IKDC] subjective knee score [1] and Tegner [19] and Marx [13] activity level scores. The 11 patients who were evaluated in person then underwent physical examination of the knee and KT-1000 laxity measurements.

The knee examination was performed by a single investigator Iftach Hetsroni who was not involved in the treatment of the patients. ACL laxity was assessed with the Lachman test (graded as 0 for 0–2 mm side-to-side difference, 1+ for 3–5 mm difference, 2+ for 6–10 mm difference, 3+ for more than 10 mm difference) [8] and pivot shift test (graded as 0 for no pivot, 1+ for “glide”, 2+ for clear pivot, 3+ for jump).

KT-1000 (MEDmetric Corp, San Diego, Calif) anterior laxity side-to-side difference measurements under 30 lbs

loads in 30° and in 90° knee flexion were performed by another investigator Greg Fives who was also not involved in the treatment of these patients and who was blinded to the side of injury and to the physical examination findings.

### Statistical analysis

Descriptive statistics consisted of medians with ranges and means with standard deviations. Student *t* test was used to compare between preinjury and latest follow-up means relating to Tegner and Marx activity level scores. The *p* value to reject the null hypothesis was set at 0.05. Microsoft Excel software (Microsoft, Redmond, WA) was used for data analysis.

The study was approved by our Institutional Review Board and all participants signed informed consent.

### Results

All of the 11 patients that had negative or low-grade Lachman and negative pivot shift at 6–12 weeks post-injury recalled feeling a pop at the time of their fall. All initial post-injury MRI scans were interpreted as complete ACL tears. There were 5 cases of mid-substance, 4 cases of proximal and 2 cases of distal ACL tears. Questions related to their skiing level [18] disclosed that 1 skier was a beginner, 5 were intermediate level, and 5 were advanced level skiers, but none was an “expert” (i.e. a racer or ski instructor). Injury mechanism involved a forward or a backward fall with body rotation in 8 patients. The others involved a side fall. Snow conditions were icy in 5 cases but 6 patients recalled fresh snow conditions. Two patients recalled a snow fall on the day of the injury, while nine described sunny or overcast weather conditions. Four patients reported easy level slope, 3 patients recalled medium level slope, and 4 patients recalled difficult level slope at the time of their fall.

Patient demographics and injury characteristics are presented in Table 1.

Latest follow-up examination at more than 2 years revealed Lachman Grade 0–1+ in 10 of these 11 patients and Lachman Grade 2+ in only one patient. This was consistent with the KT-1000 measurements which showed a mean side-to-side anterior laxity difference of  $0.8 \pm 1.6$  mm in 30° knee flexion. Less than a 3-mm side-to-side difference was recorded in the 10 patients with Grade 0–1+ Lachman. In 90° knee flexion, mean side-to-side difference was  $0.6 \pm 0.9$  mm.

Function and activity level scores are presented in Table 2. None of the patients complained of instability and none underwent knee surgery. Eight returned to skiing

(without the use of a brace) and three did not (including the single patient with the positive pivot shift).

Two patients underwent MRI at 3 months post-injury (at their request) which demonstrated healing of the injured ligament (Figs. 2, 3).

## Discussion

The most important finding of the present study was that out of 11 recreational alpine skiers who had negative Lachman and pivot shift tests at 6–12 weeks after an MRI-documented ACL tear and did not have surgery, 10 patients had normal knee laxity and did not need ACL reconstruction at more than 2 years after the injury, and only 1 patient had an ACL-deficient knee with Grade 2+ Lachman and pivot shift tests. Of note, the latter patient did not complain of instability and did not undergo surgery. These findings thus support the study hypothesis that in patients with low-grade Lachman test and negative pivot shift at 6–12 weeks after an ACL rupture due to recreational alpine skiing injury, normal knee laxity can be expected at more than 2-year follow-up. Furthermore, viewing that normal knee laxity with stable KT-1000 test was accomplished in this group at their latest follow-up, the reduction of Marx activity level scores at a median of 3.5 years after the injury may be attributed to increasing age in patients at their fifth and sixth decades of life.



**Fig. 2** Sagittal T1 MRI taken at 5 days after the injury in a skier showing complete ACL tear



**Fig. 3** Sagittal T1 MRI taken at 12 weeks after the injury in the same patient as in Fig. 2 showing almost normal ACL fibres orientation. The patient had normal Lachman and negative pivot shift tests at that time

The injury mechanism recalled by these patients was consistent with previous descriptions in alpine skiing and related to knee rotation in a fixed boot where the ski rotates too far [2, 5]. The specific mechanism and speed with which this injury occurs may be different from noncontact injuries relating to sports such as soccer or basketball [9]. Therefore, the findings from the patients who were managed successfully without surgery are not generalizable to patients who sustain ACL injury in other sports or to ski racers who sustain this injury at high speed. It is possible that the successful nonoperative outcome with respect to knee laxity and functional stability is specific to recreational alpine skiers. Furthermore, it should be noted that only 17 recreational alpine skiers had negative Lachman and pivot shift tests at 6–12 weeks after MRI-documented ACL tears, which corresponded to 27 % of the total number of skiing ACL injuries treated by the senior author during the time of this study. Thus, despite the successful nonoperative treatment and normal knee laxity in 10 patients out of 11 which were available for a minimum 2-year follow-up, it is still a minority of patients of the overall group of injured skiers who were treated successfully without surgery. Also of note is that the median age of the eleven patients followed after nonoperative treatment was 43 years, limiting the generalizability of our findings to younger patients. Nevertheless, this is the first report to demonstrate that clinical examination (Lachman and pivot

shift) at 6–12 weeks following a skiing ACL injury, certain patients can be treated nonoperatively. This strategy can help physicians to identify patients who may benefit from nonoperative treatment after ACL injury while recreational alpine skiing.

MRI was not routinely performed at latest follow-up, so it is not possible to confirm anatomical healing of the ACLs in this nonoperated group, which could have provided an explanation for the normal laxity. However, a previous study showed that in a group of 23 nonoperatively treated ACL-injured knees, all patients who regained an end point on the Lachman test at 3 months showed reductions in the signal intensity of the ACL on MRI [7]. Another study showed that the ACL may heal with fibrous tissue at different points and against the posterior cruciate ligament (PCL), providing some stability [3]. Such scar formation was suggested to be responsible for the elimination of the pivot shift in a group of 25 subjects at 3 months after the injury [10]. In the series presented in this study, it can only be speculated that symmetric (or near symmetric) knee laxity at more than 2 years after the injury may have been related to healing of the ACL, either directly or indirectly by forming adhesions to the surrounding tissues.

Limitations of this study include the retrospective design, the small cohort, and the fact that the latest follow-up rate was 65 % (i.e. 11 out of 17 patients that had negative Lachman and pivot shift tests at 6–12 weeks after the injury). Also, KT-1000 measurements were not done with the Lachman tests at 6–12 weeks post-injury. However, it has been shown that good correlation exists between the Lachman test and KT-1000 arthrometer [17].

## Conclusion

Recreational alpine skiers who sustain ACL injury should be re-evaluated at 6–12 weeks after the injury rather than being operated acutely. If they have negative Lachman and pivot shift tests at that point, they can be treated without surgery since good outcome and normal knee anterior laxity at more than 2 years after the injury is expected.

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