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ORIGINAL RESEARCH

Previous ankle sprain as a predictor for anterior cruciate ligament injury in male athletes: a descriptive study

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Abstract

The literature reveals a relationship between previous injury and re-injury in the lower extremities. The present study aimed to retrospectively describe the frequency of previous ankle sprain (AS) in subjects with anterior cruciate ligament (ACL) injury in professional (Pro) and recreational (Rec) athletes. Two hundred male subjects (100 Pro and 100 Rec) who had sustained an ACL tear and undergone ACL reconstruction completed a comprehensive questionnaire about previous ankle sprain, rehabilitation from an ankle sprain, and regular participation in preventive training, such as strength, proprioceptive and plyometric training. The results demonstrated a high frequency of AS injury preceding ACL tears in both Pro (97%) and Rec (98%) subjects ($p<0.05$). The time between AS and ACL injuries was 68.1±39.7 (±SD) days for Pro and 77.7±44.1 days for Rec. Pro subjects did not follow a regular proprioceptive or eccentric training program. In conclusion, previous AS may represent an important risk factor for ACL injury and further research on this relationship is warranted. Regular participation in a preventive training program, such as proprioceptive or eccentric training, seems to be crucial for avoiding ACL injury.

Keywords. Athlete, injury, rehabilitation, risk factors, training.

Introduction

Anterior cruciate ligament (ACL) injury is one of the most common injuries in sports. It is frequently disabling and painful, results in time lost from sport, usually requires surgery, and is associated with early onset osteoarthritis of the knee, regardless of the type of treatment (Friel & Chu, 2013). Moreover, ACL injury is not only costly from financial and health standpoints but can also have devastating consequences for patients' activity levels (e.g. return to sport) and quality of life.

Knowledge regarding causes and risk factors is crucial for the prevention of ACL injury, and to date, a number of studies have been conducted to identify the possible risk factors and thereby provide a number of prevention strategies and recommendations. These studies have demonstrated that the causes of non-contact ACL injuries are likely multifactorial, and a combination of external rotation of the tibia and knee valgus reportedly increases the risk of ACL injury (Dai et al., 2012). Moreover, many external and internal factors contribute to the risk of ACL injury. Examples of external risk factors include the type of competition (Myklebust et al., 1998), shoe/surface interface (Dowling et al., 2010; Drakos et al., 2010), and knee bracing (Rishiraj et al., 2009).

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The internal factors include lower-extremity alignment (Shambaugh et al., 1991), femoral intercondylar notch size (Simon et al., 2010), posterior tibial plateau slope (Simon et al., 2010; Stijak et al., 2008), and neuromuscular control-related biomechanical factors (Chappell et al., 2002).

The literature showed that ACL injury was linked to a successive injury of the same ACL and other injuries in the lower extremities (Fulton et al., 2014). To the authors' knowledge, no research focused on the possible links between previous AS and ACL injury, and most of the recent research on ACL injury risk factors focused primarily on knee and hip mobility, with less focus on ankle mobility (Fulton et al., 2014). Recently, it has been shown that limited ankle dorsiflexion may prevent movement of the knee forward over the foot, resulting in a compensatory displacement of the knee in the frontal plane (Malloy et al., 2015). In the same context, individuals with less ankle dorsiflexion show a greater knee valgus during landing than those with greater ankle dorsiflexion (Dill et al., 2014). Also, Wahlstedt & Rasmussen-Barr (2015) found a lower degree of ankle dorsiflexion in subjects with an ACL injury than in uninjured controls, suggesting that a functional test measuring ankle dorsiflexion with a goniometer may be one way of identifying individuals at increased risk of ACL. The aim of the present study was to describe the frequency of previous AS in Pro and Rec subjects with ACL injury and to describe their participation in regular ACL injury-prevention training programmes.

Methods

Participants

The subjects comprised 100 healthy professional and 100 healthy recreational male athletes. The mean age of the healthy group was 23.4±4.5 and of the recreational group 24.8±5.3. To be eligible for inclusion in the study, all subjects had to have sustained an ACL injury and undergone ACL reconstruction. All the subjects visited the National Center of Medicine and Sciences in Sport (CNMSS) 2 weeks after the ACL reconstruction surgery.

Measurements

Data from 200 subjects about age, sports participation, mechanism of ACL injury (contact or non-contact injury), previous AS, rehabilitation from previous AS, and previous strength training were obtained and analyzed. All the participants were informed that completion of the questionnaire was on a voluntary basis and that all information given would be treated confidentially. Furthermore, the study was approved by the committee of the National Center of Medicine and Sciences in Sport (CNMSS), Tunis.

Design and Procedure

We conducted a 5-year descriptive epidemiological study to examine the possible links between ACL injury and previous AS in trained and untrained subjects. Throughout the 5 years, any subjects who sustained an ACL injury underwent ACL reconstruction surgery and came to the center completed a general questionnaire.

Statistical Analysis

Statistical analysis was performed using SPSS Version 20.0 (IBM, Armonk, New York, USA). Results are presented as means and standard deviations. The assumption of normality was confirmed by the Kolmogorov-Smirnov test. An alpha value of $p<0.05$ was accepted as statistically significant. A student t-test for independent groups was used to assess the difference between both groups.

Results

Previous AS and ACL Injury for the Operated Knee

The results showed that for both trained and untrained subjects, the percentage of previous AS in the operated knee was above 97%, with no difference between the trained and untrained groups ($p>0.05$; Table 1).

The time between AS and ACL injuries was non significantly different between trained and untrained participants (P=0.1, 95% CI [-11.70: 11.70]).

Table 1

Frequency of AS, ankle rehabilitation, and time between AS and ACL injuries in Pro and Rec subjects.

	Previous AS		Ankle rehabilitation		Time between AS and ACL injuries
	Yes (%)	No (%)	Yes (%)	No (%)	Time (days)
Pro (n = 100)	97	3	7	92	68.1±39.7
Rec (n = 100)	98	2	3	97	77.7±44.1

Table 2
Frequency of participation in preventive training programs in Pro and Rec subjects.

	Strength training		Eccentric training		Proprioceptive training		Plyometric training	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Pro (n = 100)	62	38	0	100	2	98	59	41
Rec (n = 100)	8	92	0	100	0	100	0	100

Rehabilitation after the Sustained AS
Most of the subjects who sustained an AS did not follow a proper rehabilitation program (92% and 97% for Pro and Rec subjects respectively), with no significant difference between the two groups.

Regular participation in preventive training programs (proprioceptive, eccentric, strength, and plyometric training)
All subjects reported that they did not follow any specific eccentric training program (100%). All the Rec (100%) and 98% of the Pro subjects reported that they did not follow any specific proprioceptive training program (Table 2).

Discussion

The aim of the present descriptive study is to describe the possible links between previous AS, proprioceptive and strength training and ACL injury. The results demonstrated a very significant and high percentage of AS before ACL injury in both trained and untrained male subjects. The time between AS and ACL injuries was 70 days in both trained and untrained subjects. Most of the previous AS injuries were not followed by appropriate rehabilitation, and most of the subjects did not follow regular strength and proprioceptive training.

It has been demonstrated that previous injury represents an important risk factor for injury (Hagglund et al., 2006). For example, ACL injury is linked to successive injury of the same ACL, hamstring injury is associated with subsequent ipsilateral hamstring and knee injuries, and Achilles tendon rupture increases the risk of an analogous injury on the contralateral side (Fulton et al., 2014). However, most previous studies relating to ACL injury and biomechanics have focused on the knee and hip, with less attention devoted to the ankle. The present results showed that the frequency of previous AS was very high for Pro and Rec athletes who sustained an ACL injury, and most of these AS injuries had not healed properly or been subjected to proper rehabilitation.

The present results, together with new results, demonstrate that a smaller amount of ankle dorsiflexion displacement during landing is associated with less knee flexion displacement and greater ground reaction forces, and greater ground reaction forces are associated with greater knee valgus displacement (Fong et al., 2011). Similarly, Fong et al. (2011) found in 35 healthy, physically active volunteers that greater dorsiflexion ROM was associated with greater knee flexion displacement and smaller ground reaction forces during landing, thus inducing a landing posture consistent with reduced ACL injury risk and limiting the forces that the lower extremity has to absorb. It can be concluded that the loss of normal ankle dorsiflexion usually observed at the talocrural joint after lateral AS may represent a risk factor for ACL injury. This hypothesis is supported by the fact that more than 95% of the subjects in our study reported that they did not follow a proper rehabilitation programme after their ankle injury. It has been shown that patients need to know that inadequate treatment and rehabilitation of an AS sprain has a large likelihood of leading to future problems (Chinn & Hertel, 2010).

Another factor explored in the present study was implementation of a preventive training programme before the ACL tear. For eccentric training, the results showed that all the trained (100%) and untrained (100%) subjects did not follow a regular training programme. There were similar results for proprioceptive training, with 100 of the untrained and 98% of the trained athletes not following a regular training programme. However, the trained group adopted regular strength (62%) and plyometric training (59%) programmes. It has been shown that sports-specific proprioceptive, plyometric and strength training programmes are an effective training strategy for the prevention of injuries and can consistently reduce the incidence of ACL injuries (Mandelbaum et al., 2005; Hewett et al., 1999).

The present descriptive results are consistent with previous studies showing that subjects not adopting regular preventive training programmes were at high risk of sustaining an ACL injury. For

example, the study of Mandelbaum et al. (2005) showed that during a single season there was an 88% decrease in ACL injury in female athletes participating in regular proprioceptive sports-specific training compared to the control group. Hence, it seems that using a neuromuscular training programme may have a direct benefit in decreasing the number of ACL injuries. The same results have been found for plyometric and strength training. It has been shown that these training methods can decrease hip abduction and adduction moments during landing, increasing the muscle power to stabilize the knee joint, increase lower extremity muscle power and thereby decrease the incidence of serious knee injuries (Mandelbaum et al., 2005; Hewett et al., 1996).

In conclusion, the present results show that a high frequency of AS injury preceded the ACL tear in both trained and untrained subjects. The study also found a high frequency of subjects who indicated no regular rehabilitation programme after the AS. A short period was also noticed between the AS and ACL injuries. Furthermore, most of the trained and untrained subjects did not follow regular proprioceptive and eccentric training programmes. It can be concluded that previous AS may represent an important risk factor for ACL injury and that further research on this relationship is warranted.

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Conflict of interest

No potential relevant to this article was reported.

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