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Research Article

Factors (Age, Sex, Sport, Level and Surgery) Influence Return to Sport after Anterior Cruciate Ligament Reconstructions -

Laboute E*, James Belin E, Ucay O and Verhaeghe E

C.E.R.S., Groupe Ramsay Santé, 83 av Maréchal de Lattre de Tassigny 40130 Capbreton, France

***Address for Correspondence:** LABOUTE Eric, C.E.R.S., Groupe Ramsay Santé, 83 av Maréchal de Lattre de Tassigny 40130 Capbreton, France, Tel: +33-055-848-8790; Fax: +33-055-848-8799; E-mail: e.laboute@gsante.fr

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ABSTRACT

Background: Low rates of return to sport are concerns after Anterior Cruciate Ligament (ACL) reconstruction in population at risk.

Objective: To evaluate the impact of various factors after ACL reconstruction for return to sport in athletes.

Methods: Athletes, who had undergone ACL autograft reconstruction between 2012 and 2015 and responded questions about return to sport by phone, during the second year after surgery, were included. Reponses were analyzed with a multivariate logistic model adjusted for baseline patient characteristics and an adjusted Cox model.

Results: Of the 1274 who were included in the analysis, younger age and involvement in higher level sporting activities were associated with a significantly higher frequency and a significantly shorter time to return to sport (running, training, competition; $p = 0.001$ to 0.028). Men returned to sport more rapidly than women, for both training ($p = 0.007$) and competition ($p = 0.042$). Although there was no difference return to sport between Hamstring (HT) and Patellar Tendon (PT) autograft, it was interessant to note that MacFL surgery (Mac Intosh modified with intra- and extra-articular autografts used the tensor fasciae latae muscle) were associated with a higher frequency ($p = 0.03$) and rapidity ($p = 0.025$) of return to training than HT. Sportspeople practicing non weight-bearing sports returned to training ($p < 0.001$) and competition ($p < 0.001$) more rapidly than other sportspeople. By contrast, the practicing pivoting sports with contact started running again sooner ($p < 0.001$).

Conclusion: Various factors (age, sex, level, sport, and surgery) after Anterior Cruciate Ligament (ACL) reconstruction influence return to sport. Younger age, male sex, higher level of sports, sportspeople practicing non weight-bearing sports, and MacFL surgery reduce time to return to sport.

Keywords: Knee; Anterior cruciate ligament; Return to sport; Sport; Athletes; Factors

INTRODUCTION

Ligament reconstruction for Anterior Cruciate Ligament (ACL) injury is one of the most common types of surgery in developed countries. In the US, the reported annual incidence of ACL reconstruction is 36.9 per 100 000 people [1]. Currently, two main reconstruction techniques are used: patellar tendon and hamstring autografts. In recent years, hamstring autografts have become the principal technique used, as reported in Denmark, where the proportion of hamstring autografts increased from 68% in 2005 to 85% in 2011 [2]. However very few differences [3-5] have been clearly demonstrated between these two reconstruction techniques [6,7]. Patellar tendon autografts are more frequently associated with anterior knee pain [6] whereas hamstring autografts tend to progress towards greater residual laxity [6,8]. For this reason, alternative surgical options exist, for which very few comparative studies have been performed. These alternatives include, in particular hamstring autografts using only the Semitendinosus (ST) with two tunnels (a femoral and a tibial tunnel) [9-11], hamstring autografts with an anterolateral graft tensor fasciae latae (HT +AL) with two tunnels (a femoral and a tibial tunnel) [12,13], muscle hamstring autografts with double bundle and four anatomic tunnels (2HT) [14], and intra- and extra-articular autografts with the tensor fasciae latae muscle (MacFL) [15,16]. Furthermore, increasing numbers of studies are focusing on the return to sport [17-19], but these studies do not sufficiently take into account morphotype data that may also have an impact on the return to sport [20-25]. No study specifies the frequencies and times to each chronological stage of the return to sport, in the same series, for a population of sportspeople practicing at different levels with multivariate analyses and adjustment for baseline patient characteristics. We therefore tested the hypothesis that baseline factors (age, sex, type and level of sport, and type of surgery) could influence return to sport. We investigated the influence of these factors on the frequency and time to return to sport after initial ligament reconstruction in a population of athletes, most of whom were performing at a competitive level.

MATERIAL AND METHODS

Design and setting

This was a retrospective study from an observationnel usual follow up of patients [21]. All athletes who had undergone ACL autograft reconstruction with rehabilitation at a specific center for sports rehabilitation (France) and who reponded to questions phone call are included.-

Ethical considerations

The study was approved by a scientific ethics committee (Groupement de Cooperation Sanitaire Ramsay Générale de Santé pour l'Enseignement et la Recherche, Paris, IRB N. COS-RGDS-2015-09-018). All their data were input into a computerized database that included complete surgical, medical, and sports-related data. All surgical informations were completely precised.

Participants

Patients were considered eligible for this study if they had undergone one of six different types of surgery for a first reconstruction and aged more than 16 years: 1) Patellar Tendon autografts (PT), involving transplantation of the patellar tendon (bone-patellar tendon-bone), and two tunnels (a femoral and a tibial tunnel); 2) Hamstring autografts (HT) requiring two hamstring muscles (semitendinosus and gracilis), folded over, with a single bundle and two tunnels (a femoral and a tibial tunnel); 3) hamstring autografts using only the Semitendinosus (ST) with two tunnels (a femoral and a tibial tunnel); 4) hamstring autografts with an anterolateral graft tensor fasciae latae (HT + AL) with two tunnels (a femoral and a tibial tunnel); 5) hamstring muscle autografts with a double bundle and four anatomic tunnels (2HT), or 6) Mac Intosh modified with intra- and extra-articular autografts used the tensor Fasciae Latae Muscle (MacFL).

Patients with osteotomy, bone fracture or chondroplasty, an associated medial/lateral ligament surgery, and iso +/- controlateral rupture were not included.

Sports were analyzed according to discipline and were grouped according to the Arpège classification [26]. For patients playing competitively, sport level was classified as regional, national, or international, whereas patients playing non-competitively were classified as recreational athletes, such as a sports teacher, coach or monitor.

Procedures

The operations were performed by French LCA specialist surgeons. Rehabilitation was based on post-operative recovery for articular extension at 0° and articular flexion at more than 120°, quadriceps contraction against gravity, and techniques for walking without assistance from three to six weeks post-surgery. A brace was worn for three to six weeks, as decided by the surgeon. Cardiovascular activity on a bicycle, step machine, or rowing machine was introduced progressively and swimming (crawl) was also introduced during this period. A return to running was introduced around the third or fourth month, at the decision of the surgeon. Return to the original activity was subject to the surgeon's approval.

Evaluations

Patients were contacted by telephone during the second year after surgery. All patients who did answer the call have reponded the questions. And all patients who did answer the call were analyzed. Data regarding return to sport (running, training, competitive sport, same level of competition), and the time to each of these events were collected.

Statistical analyses

Patient characteristics (sex, age at the time of surgery, type and level of sport practiced, surgery) were compared. Multivariate logistic regression analyses were performed to evaluate the effects of the various factors on the frequency of return to sport outcome (primary endpoint), with adjustment for baseline patient characteristics. A Cox multivariate model accounting for the same factors was performed on the time to return to sport, to establish the robustness of the results in terms of the primary endpoint. The alpha risk was fixed at 5%. Statistical analyses were performed with SAS® for Windows (Version 9.4, SAS Institute Inc., Cary, NC, USA).

RESULTS

In total, we screened 2171 athletes undergoing ACL autograft reconstruction between 2012 and 2015. Of the 2171 initial patients, 897 did not meet the inclusion criteria. The mean time between initial surgery and questionnaire completion was 19.5 months (±4.2).

Responses from 1274 athletes were thus analyzed for the six types of surgery (Table 1 and Table 2): 56% (N = 713) for the Hamstring group (HT), 19% (N = 242) for the Patellar Tendon autograft group (PT), 10.7% (N = 137) for hamstring autografts using only the Semitendinosus (ST), 4.1% (N = 52) for hamstring autografts with an anterolateral graft tensor fasciae latae (HT + AL), 6% (N=76) for hamstring muscle autografts with a double bundle and four anatomic tunnels (2HT), and 4.2% (N = 54) for autografts with the tensor Fasciae Latae Muscle (MacFL). Mean age was 26.2 years. The most common sport practiced was rugby (33.7%), followed by soccer, handball and skiing.

Table 1. Characteristics of patients (*N* = 1274).

Variable		All
Age at surgery	**n**	**1274**
	Mean (standard deviation)	26.2 (7.2)
Age group	n	1274
	Age < = 20	231 (18.1%)
	Age 20 to 25	457 (35.9%)
	Age 25 to 30	310 (24.3%)
	Age 30 to 35	149 (11.7%)
	Age > 35	127 (10.0%)
Sex	N	1274
	M	933 (73.2%)
	W	341 (26.8%)
Sport	N	1274
	Basketball	76 (6.0%)
	Soccer	205 (16.1%)
	Handball	144 (11.3%)
	Motocross	39 (3.1%)
	Rugby	429 (33.7%)
	Ski	106 (8.3%)
	Fight sports	71 (5.6%)
	Racket sports	57 (4.5%)
	Other	147 (11.5%)
Type of sport	N	1274
	Weight-bearing without pivoting	51 (4.0%)
	Pivoting non-contact sans contact	269 (21.1%)
	Pivoting with contact	940 (73.8%)
	Non weight-bearing	14 (1.1%)
Level	N	1274
	International	38 (3.0%)
	National	453 (35.6%)
	Regional	588 (46.2%)
	Recreational	195 (15.3%)
Surgery	HT	713 (56%)
	PT	242 (19%)
	MacFL	54 (4.2%)
	2HT	76 (6%)
	HT + AL	52 (4.1%)
	ST	137 (10.7%)

Classification ARPEGE [10]:
Pivoting-contact: Soccer, Rugby, Basketball, Handball, American Football, Ice Hockey, Combat Sports, Fencing, Bullfighting
Pivoting without contact: volleyball, racket sports, ice skating, dance, gymnastics, downhill skiing, water skiing, snowboard, surf, sailing, golf, motocross, rock, climbing, skate-board
Weight-bearing without pivoting: running, athletics, horse riding, mountain guide, bowling, cycling, shooting
Non-weight-bearing: kayaking, swimming, diving, rowing, underwater, hockey, water-polo

Influence of baseline factors on the return to sport outcome

A return to running was reported for 92.8% of patients, a return to training for 83.9%, a return to competition for 73.4% and a return to the same level of competition in 61.5%. The mean times for the return to sport were 4.8 months for the return to running, 7.9 months for the return to training, 9.5 months for the return to competition and 10.5 months for the return to the same level of competition.

Table 2: Frenquency and time to return to sport, according to type of surgery.

Variable		HT	2HT	HT + AL	ST	MacFL	PT
Time to return to running	n (n.c.)	573 (81)	62 (5)	45 (5)	114 (12)	46 (4)	194 (24)
(months)	Mean (standard deviation)	4.8 (2.3)	5.0 (2.2)	5.3 (3.3)	4.7 (2.2)	4.3 (1.7)	4.7 (2.2)
	Min ; Max	2 ; 20	3 ; 14	2 ; 18	2 ; 11	2 ; 10	1 ; 15
Time to return to training	n (n.c.)	516 (45)	63 (1)	46 (2)	118 (5)	45 (3)	190 (16)
(months)	Mean (standard deviation)	7.9 (2.6)	7.4 (2.0)	8.1 (3.2)	7.9 (3.2)	7.3 (2.5)	8.1 (2.6)
	Min ; Max	2 ; 24	3 ; 12	4 ; 20	4 ; 22	1 ; 15	3 ; 20
Time to return to competition (months)	n (n.c.)	450 (29)	42 (1)	38 (1)	102 (4)	35 (3)	175 (8)
	Mean (standard deviation)	9.5 (2.7)	9.4 (2.8)	9.6 (3.5)	9.3 (2.7)	7.9 (2.2)	9.9 (3.1)
	Min ; Max	3 ; 24	6 ; 18	6 ; 22	6 ; 17	4 ; 14	5 ; 24
Time to return to same level of competition (months)	n (n.c.)	375 (26)	28 (3)	31 (2)	79 (4)	31	135 (7)
	Mean (standard deviation)	10.5 (3.0)	10.3 (3.1)	10.5 (3.6)	10.4 (3.1)	9.1 (2.7)	10.7 (3.0)
	Min ; Max	5 ; 24	6 ; 20	6 ; 21	6 ; 20	4 ; 18	6 ; 24

N.C: Not Concerned

Various factors (age, sex, type of sport and type of surgery) affected return to sport, but in different ways, depending on the chronology of the steps in the return to sport.

Age

A younger age (<25 years versus >25 years) was associated with a significantly higher frequency of return to sport (Table 3): for running (p = 0.006), training (p = 0.026), competition (p = 0.008), and return to the same level of competition (p = 0.005). Being younger was also associated with a shorter time to return to sport (Table 4): for running (p = 0.002), training (p = 0.076), competition (p = 0.028), and return to the same level of competition (p = 0.015).

Sex

Women returned to sport significantly less rapidly than men, for training (p = 0.007) and competition (p = 0.042) (Table 4).

Sport level

Higher sport levels (Table 3) were associated with a significantly higher frequency of return to sport: for running (p = 0.01), training (p = 0.007), competition (p <0.001), and return to the same level of sport (p = 0.001). Being higher sport level was associated with more rapidly return to sport (Table 4): for running (p = 0.018), training (p <0.001), competition (p <0.001), and return to the same level of competition (p <0.001).

Type of sport

Sportspeople practicing sports involving pivoting with contact, who are used to running, starting running again sooner than those practicing other types of sport (Table 4; p <0.001). Sportspeople practicing non weight-bearing sports, which make less demands on the knee, returned to sport more rapidly (Table 4) for training (p <0.001) and competition (p <0.001).

Type of surgery

MacFL surgery (Table 3) was associated with a higher frequency of (p = 0.03) and a faster (p = 0.025) return to training than HT (Tables 4).

DISCUSSION

The most important finding of the study was that baseline factors (age, sex, level, sport, and surgery) can influence return to sport.

In this study, the frequency of return to sport was 92.8% for running, 83.9% for training, 73.4% for competition and 61.5% for return to the same level of competition. Ardern reported [18] a total frequency of 55% for return to the same level of competition, and Czuppon [27] found a frequency of return to sport of 50.7% in a meta-analysis. Our study is of interest because it specifies the frequencies and times to each chronological stage of the return to sport, in the same series, for a population of sportspeople practicing at different levels. The mean times recorded were 4.8 months for the return to running, 7.9 months for the return to training, 9.5 months for the return to competition and 10.5 months for the return to competition at the same level. These times are consistent with published results for a return to the same level of competition: 10.7 months for basketball players in the NBA [28], 10.2 months for the soccer players of the MLS [29], and 9.8 months for ice hockey players [30].

We showed here that age influences the frequency and time to return to sport, for all the chronological stages considered (running, training or competition). Arden also reported a small effect of being younger, favoring a return to preinjury level sport (effect size, 0.3) [18]. Those over the age of 25 years are 50% less likely to return to playing at their preinjury level of sport than their younger counterparts (OR, 0.5; 95% CI, 0.3-0.8) [19], and two thirds of athletes over the age of 32 years do not return to

Table 3: Multivariate model for the frequence of return to running, training, competition, and same level.

Variable	Comparaison	*p*-value	Running OR multivariable IC 95% (N=1255)	*p*-value	Training OR multivariable IC 95% (N=1237)	*p*-value	Competition OR multivariable IC 95% (N=1163)	p-value	Same Level OR multivariable IC 95% (N=1131)
Surgery	HT *vs* MacFL	0.828	0.656 [0.103, 2.315]	0.030*	0.380 [0.112, 0.967]	0.433	0.898 [0.435, 1.737]	0.987	1.000 [0.532 , 1.831]
Age group	Age > 25 *vs*. age <= 25	0.006*	0.481 [0.283, 0.8]	0.026*	0.694 [0.502, 0.958]	0.008*	0.694 [0.529, 0.911]	0.005*	0.700 [0.546 , 0.899]
Level		0.010*		0.007*		<0.001*		<0.001*	
	International *vs*. Recreational		3.250 [0.87, 21.24]		4.681 [1.297, 30.093]		5.817 [2.147, 20.434]		3.375 [1.481 , 8.478]
	International *vs*. National		1.255 [0.331, 8.266]		2.476 [0.71, 15.667]		2.105 [0.803, 7.244]		1.705 [0.785 , 4.128]
	International *vs*. Regional		1.457 [0.391, 9.524]		4.129 [1.2, 25.989]		3.649 [1.4, 12.514]		2.636 [1.213 , 6.38]
	Recreational *vs*. National		0.386 [0.204, 0.721]		0.529 [0.319, 0.885]		0.362 [0.237, 0.554]		0.505 [0.338 , 0.756]
	Recreational *vs*. Regional		0.448 [0.251, 0.8]		0.882 [0.556, 1.422]		0.627 [0.421, 0.938]		0.781 [0.528 , 1.156]
	National *vs*. Regional		1.161 [0.649, 2.116]		1.668 [1.159, 2.427]		1.734 [1.278, 2.365]		1.545 [1.178 , 2.033]
Sex	W *vs*. M	0.335	0.784 [0.482, 1.298]	0.051	0.702 [0.494, 1.006]	0.174	0.808 [0.595, 1.101]	0.925	0.986 [0.744 , 1.312]
Type of sport		<0.001*		0,079		0.893		0.168	
	Weight-bearing without pivoting *vs*. pivoting without contact		0.616 [0.283, 1.414]		NS		NS		NS
	Weight-bearing without pivoting *vs*. pivoting with contact		0.244 [0.109, 0.577]		NS		NS		NS
	Weight-bearing without pivoting *vs*. non weight-bearing		1.353 [0.307, 5.294]		NS		NS		NS
	Pivoting without *vs*. with contact		0.396 [0.228, 0.691]		NS		NS		NS
	Pivoting without contact *vs*. non weight-bearing		2.194 [0.555, 7.343]		NS		NS		NS
	Pivoting with contact *vs*. Non weight-bearing		5.540 [1.383, 18.672]		NS		NS		NS

NS: Non Significative, Significative (*p* <0.05)*

their preinjury level [17]. NHL players injured after the age of 30 years were found to be less likely to return to play at least one full season [30], and younger French alpine skiers at the time of injury were found to be more likely to improve their performance after returning to sport [31].

In this study, we found that sex influenced the time to return to training and competition, with men returning more rapidly than women. Arden found that men were about 1.5 times more likely than women to return to the preinjury level of sport (OR, 1.4; 95% CI, 1.2-1.7) and to competitive sport (OR, 1.7; 95% CI, 1.2-2.3) [18].

We have also shown that sport level [32] influences the possibilities for returning to sport and the time to return to sport, with those practicing at higher levels more likely to return, and more rapidly, than others, whether running, training or competition is considered. This confirms published results, as Ardern showed that elite athletes were 2.5 times more likely to return to their preinjury level (OR, 2.5; 95% CI,2.0-3.1) and six times more likely to return to competitive sport (OR, 5.9; 95% CI, 4.6-7.5) than nonelite athletes [18]. In our study, the frequency of return to competition was 89.5% at international level, and the frequency of return to the same level of competition was 78.4%, a value similar to that reported by Lai [24], who found, in a meta-analysis, that 83% of elite sportspeople returned to the same level of competition.

Our results show that the type of sport influences the frequency of return to running, but also the time to the return to running, training and competition. Participants in non-weight-bearing sports returned to running less rapidly than those involved in pivoting sports. By contrast, they returned to training and competition more rapidly. Those involved in contact sports returned to training less rapidly than those participating in

Table 4: Adjusted multivariate analysis of the time to return to running, training, competition, and same level.

Variable	Comparaison	*p*-value	Running OR multivariable IC 95% (N=1124)	*p*-value	Training OR multivariable IC 95% (N=1179)	*p*-value	Competition OR multivariable IC 95% (N=1163)	p-value	Same Level OR multivariable IC 95% (N=1131)
Surgery	HT *vs* MacFL	0.828	NS	0.025*	0.679 [0.504, 0.937]	0.557	0.768 [0.551, 1.106]	0.988	0.863 [0.607 , 1.275]
Age group	Age <= 25 *vs.* age >25	0.002*	1.224 [1.075, 1.395]	0.076	1.129 [0.988, 1.291]	0.028*	1.175 [1.018, 1.357]	0.015*	1.224 [1.041 , 1.441]
Sex	W *vs.* M	0.227	0.913 [0.787, 1.056]	0.007*	0.813 [0.699, 0.943]	0.042*	0.845 [0.717, 0.992]	0.533	0.945 [0.79 , 1.126]
Level		0.018*		<0.001*		<0.001*		<0.001*	
	International *vs.* Recreational		1.451 [0.968, 2.113]		2.069 [1.382, 3.018]		2.527 [1.648 3.792]		2.213 [1.382 , 3.459]
	International *vs.* National		1.038 [0.712, 1.463]		1.510 [1.038, 2.126]		1.427 [0.977, 2.014]		1.327 [0.877 , 1.93]
	International *vs.* Regional		1.148 [0.787, 1.617]		1.950 [1.338, 2.751]		1.943 [1.327, 2.75]		1.762 [1.16 , 2.573]
	Recreational *vs.* National		0.716 [0.576, 0.885]		0.730 [0.58, 0.903]		0.565 [0.434, 0.726]		0.600 [0.448 , 0.791]
	Recreational *vs.* Regional		0.792 [0.64, 0.974]		0.943 [0.761, 1.16]		0.769 [0.592, 0.986]		0.796 [0.595 , 1.05]
	National *vs.* Regional		1.106 [0.962, 1.27]		1.291 [1.119, 1.489]		1.362 [1.171, 1.582]		1.328 [1.123 , 1.569]
Type of sport		<0.001*		<0.001*		<0.001*		0.06	
	Weight-bearing without pivoting *vs.* pivoting without contact		0.953 [0.647, 1.363]		1.065 [0.721, 1.526]		1.293 [0.83, 1.936]		NS
	Weight-bearing without pivoting *vs.* pivoting with contact		0.685 [0.471, 0.963]		1.317 [0.902, 1.857]		1.249 [0.816, 1.828]		NS
	Weight-bearing without pivoting *vs.* non weight-bearing		1.173 [0.582, 2.621]		0.210 [0.111, 0.427]		0.226 [0.109, 0.514]		NS
	Pivoting without *vs.* with contact		0.719 [0.599, 0.858]		1.237 [1.036, 1.469]		0.966 [0.791, 1.173]		NS
	Pivoting without contact *vs.* non weight-bearing		1.230 [0.667, 2.6]		0.198 [0.114, 0.377]		0.175 [0.093, 0.373]		NS
	Pivoting with contact *vs.* Non weight-bearing		1.712 [0.936, 3.596]		0.160 [0.093, 0.304]		0.181 [0.098, 0.382]		NS

NS: Non Significative, Significative (*p* <0.05)*

pivoting sports without contact. We were unable to identify any similar published studies with which to compare our results.

We found no significant difference in the rates of return to competition between HT (70.8%) and PT surgery (77.8%) (adjusted OR = 0.718; 95%CI [0.50;1.02]), consistent with most published findings [21,33,34]. By contrast, the frequency and time to return to training were significantly higher for MacFL (92.3%, and 7.3 months, respectively) in our study after adjustment for the various factors in the multivariate analysis, making it possible to limit the bias linked to this group being composed of soccer players practicing at a relatively higher level at inclusion. It would be interesting to confirm these results in larger populations. Savalli [34] followed a cohort of 969 patients with similar results, with a more rapid return to competition for MacFL (7.67 ± 1.87 months) than for HT (9.69 ± 2.58 months) and PT (9.65 ± 3 months).

LIMITATIONS OF THE STUDY

In terms of methodology, this study is subject to several biases, including, in particular, selection biases, as in all retrospective studies. The different surgeons operating on the patients is a potential source of bias worthy of inclusion in analyses. Nonetheless, any associated bias was limited, given that the inclusion of patients was nationwide and there was a large number of participating surgeons, all of whom are specialists in knee reconstruction. Randomization was not performed at inclusion, but the large population, similar baseline characteristics, and adjusted analyses would have reduced potential bias. As the adjusted comparisons take into account confounding factors, they are thus interpretable with good quality.

For this study, a telephone questionnaire was performed a mean of 19 months after the autografting procedure. This is a shorter postoperative time than in other studies, but our methodology was otherwise very similar to that of Wright, et al. and Shelbourne, et al. [35-37]. Furthermore, our population included a large series of athletes, most practicing competitively, whereas most of the other reports have tended to focus on sports as leisure activities. The impact of the different sports practiced, along with their relationship to the level of sport practiced, was evaluated.

CONCLUSION

The factors considered (age, sex, type and level of sport and type of surgery) influence the outcome of anterior cruciate ligament reconstruction. For the return to sport, younger athletes were more likely to return to sport but did so more rapidly. Higher sport levels were associated with a higher frequency of return to sport and a faster return. Men also returned to sport more rapidly than women. Although there is no difference in the principal surgery (HT and PT), it is interessant to observe that MacFL led to a higher frequency of and a faster return to training than HT. Sportspeople practicing non weight-bearing sports returned to training and competition more rapidly than those practicing weight-bearing sports. However, those practicing pivoting contact sports returned more rapidly to running. Future studies should take these factors, which can modify the results to predict the return to sport.

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