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Abstract

Background. After anterior cruciate ligament reconstruction (ACLR), the decision to allow a return to running is empirical, and the post-operative delay is the most-used criterion. The Quadriceps isokinetic-strength Limb Symmetry Index (Quadriceps LSI), with a cutoff of 60%, could be a useful criterion.

Objective. To determine the association between a Quadriceps LSI ≥60% and return to running after ACLR.

Methods. Over a 10-year period, we retrospectively included 470 patients who underwent ACLR. Four months after ACLR, participants performed an isokinetic test; quadriceps concentric peak torque was used to calculate the Quadriceps LSI at 60°/s. With a Quadriceps LSI ≥ 60%, a return to running was suggested. At 6 months after ACLR, participants were clinically evaluated for a return to sport and post-operative middle-term complications. A multivariable predictive model was built to assess the efficiency diagnosis of this cutoff in order to consider cofounding factors. Quadriceps LSI cutoff ≥ 60% was assessed with sensitivity, specificity and the area under the receiver operating characteristic curve (AUC).

Results. According to our decision-making process with the 60% Quadriceps LSI cutoff at 60°/s, 285 patients were authorized to return to running at 4 months after ACLR and 185 were not, but 21% (n=59) and 24% (n=45), respectively, were not compliant with the recommendation. No iterative autograft rupture or meniscus pathology occurred at 6 months of follow-up. On multivariable logistic regression analysis, a return to running by using the 60% Quadriceps LSI cutoff was associated with undergoing the hamstring strand procedure

(odds ratio 2.60, 95% confidence interval [CI] 1.75-3.84; P<0.0001) and the absence of knee complications (1.18, 1.07-1.29; P=0.001) at 4 months. The sensitivity and specificity of the 60% Quadriceps LSI cutoff were 83% and 70%, respectively. The AUC was 0.840 (95% CI 0.803-0.877).

Conclusions. Using the 60% cutoff of the isokinetic Quadriceps LSI at 4 months after ACLR could help in the decision to allow a return to running.

Keywords. anterior cruciate ligament reconstruction; running; prediction; isokinetic; limb symmetry index; quadriceps

Introduction

After anterior cruciate ligament reconstruction (ACLR), running is proposed to allow a progressive continuum to return to sport [1–4]. However, running leads to constraints on the knee, especially after surgery, even if constraints have not been clearly described at the graft level [5]. The knee contributes to about 20% of the lower-limb power development during walking and running, whatever the speed [6]. The knee joint work is raised from 2 to 5 while running as compared with walking and increases with speed [7].

Spencer et al. reported that the quadriceps strength was insufficient to control the knee during flexion in closed kinetic chain at 6 months after ACLR [8]. We hypothesized that a return to running without sufficient quadriceps strength recovery may lead to risk of knee complications (pain, swelling or graft failure). Consequently, the authorization to return to running should not be neglected and quadriceps strength recovery monitoring could be a criterion in this decision-making process. Physicians should base their advice to allow a return to running after ACLR on objective criteria (knee examination, clinical and instrumental validated tests) [4,9,10]. In a scoping review, Rambaud et al. reported that few authors used

strength parameters (15% of the studies) and only 11 of these 31 studies used isokinetic strength assessments. However, despite its interest after ACLR, no more studies used quadriceps isokinetic evaluation [11–15]. Although the quadriceps strength side-to-side symmetry (Limb Symmetry Index [LSI]) is sought to help authorize a return to running [16], to our knowledge, cutoffs are empirical and vary among studies [17–19]. Furthermore, no evaluation has been performed according to the auto-graft types, but the muscular recovery may differ accordingly [20,34].

Since 2000, some teams have proposed isokinetic evaluations at months 4 and 6 after ACLR [8]. At this time, no isokinetic cutoffs have been established to authorize a return to running. We used a decision-making process to authorize a return to running based on the Quadriceps LSI calculated at 60°/s with a cutoff of 60% [7]. The cutoff was based on empirical observations showing that patients with concentric Quadriceps LSI < 60% reported running impairment. Thus, we aimed to determine the association between a concentric Quadriceps LSI >60% and a return to running after ACLR.

Our report adheres to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement.

Materials and methods

Study design, setting and overall procedure

We conducted a retrospective analysis of a 10-year prospective cohort of patients who underwent ACLR from 2007 to 2017. At post-operative months 4 and 6, each included patient had a testing session that evaluated clinical features, quadriceps and hamstring muscle isokinetics, and a return to running. Ethical approval was obtained from the local committee

of ethics (Groupe Nantais d'Ethique dans le Domaine de la Santé). The data report form was declared to the French data protection authority (CNIL) and to the research department of the University Hospital.

Participants

Eligible participants were patients directly referred to the Nantes University Sports Medicine department by 13 different orthopedic surgeons from clinics or hospitals in the region around Nantes to perform an isokinetic evaluation at 4 months after ACLR during 2007 to 2017. We included in the study all patients who 1) were > 18 years old, 2) underwent an arthroscopic ACLR for the first time with a bone-patellar tendon-bone (BPTB) or hamstring strand (HS) procedure, 3) had at least 2 testing sessions including clinical and isokinetic evaluations at post-operative months 4 and 6, 4) did not return to running before the testing session at 4 months after ACLR, 5) had the will to return to running, and 6) performed an accelerated rehabilitation program after surgery (Appendix [29,35,36]). Exclusion criteria were ACLR revision, ACLR with osteotomy, posterior cruciate ligament reconstruction, multiple surgical procedures with collateral ligament reconstruction, contralateral ACLR < 24 months before the present ACLR [20] and clinical conditions avoiding the isokinetic evaluation (i.e., pivot shift, large knee swelling, knee locking, extension loss > 15° or walking with gait deviation). Patients who had their first testing session after post-operative month 5 and/or who did not attend the second testing session were not included [21].

Data collection and variables

During the first testing session at 4 months after ACLR, we collected baseline information on age, sex, height, body mass, type and level of sport before the ACL tear (with the Tegner score [22]), operated side, delays from ACL tear to ACLR and from ACLR to first testing

session, graft procedure with or without meniscal procedure, and knee function (with the Lysholm score [22]).

Isokinetic parameters were collected at 4 and 6 months after ACLR during the isokinetic evaluation (see below). We used as a variable the concentric peak torque Quadriceps LSI at 60°/s.

Complications such as anterior and posterior knee pain, arthrofibrosis, infection, or swelling were collected at 4 and 6 months after ACLR.

At 6 months after ACLR, information on the patient's return to running was collected. The return to running was considered done (i.e., successful return to running), if the patient had performed at least 50% of the running program sessions provided during the testing session at 4 months after ACLR during the 2 months (i.e., from the first to the second testing session). In case of non-compliance with at least 50% of the instructions, the return to running was considered unsuccessful and the cause was collected. For patients not initially allowed to run, a return to running was considered if they had declared running twice a week before 6 months after surgery. The primary outcome of the present study was the return to running with a binary result: yes or no.

Isokinetic evaluation procedure

Before isokinetic assessment, all participants underwent a clinical evaluation to authorize the isokinetic test to ensure knee stability and the absence of swelling. If the clinical evaluation revealed any contraindication to the isokinetic evaluation, the evaluation was not performed and the participant was not included in the present study (see inclusion criteria above).

After a 10-min cyclo-ergometer warm up, isokinetic strength was evaluated with a Cybex Norm dynamometer (Lumex Inc., Ronkonkoma, NY, USA). The dynamometer recalibration

was performed monthly in accordance with the manufacturer's instructions. All evaluation tests were conducted by the same physician specializing in sport medicine (MD). Each patient was seated with a hip angle of 85°. The mechanical axis of the dynamometer was aligned with the lateral condyle of the knee. The trunk and the thigh were stabilized with belts. The knee range of motion was 100°: 100° of knee flexion to 0° (corresponding to maximal knee extension). Torque was gravity-corrected at 45° of knee flexion. The knees were evaluated, beginning with the non-operated side after instruction and with verbal encouragements and visual feedback [18]. After familiarization with the isokinetic movement (5 concentric sub-maximal repetitions at 240°/s), the participants were tested over 3 repetitions in concentric mode at 60°/s followed by 5 concentric repetitions at 180°/s [23]. Thirty seconds of rest were provided between the 2 series and 2 min between the 2 sides.

For the present study, we used only the quadriceps (i.e., knee extensor muscles) concentric peak torque at 60°/s to calculate the Quadriceps LSI by using the following formula: (peak torque of operated side/peak torque of non-operated side) x 100. The Quadriceps LSI at 60°/s showed good reliability in active healthy individuals, with an intra-class correlation coefficient of 0.78 (95% confidence interval [CI] 0.59–0.90) and standard error of measurement 3.2% (95% CI 1.8–4.6) [24].

Decision-making to allow a return to running

At 4 months, we used the following decision-making process based on Quadriceps LSI calculated at 60°/s with a cutoff of 60% to authorize or not a return to running [25]:

If the Quadriceps LSI at 60°/s was ≥ 60%, a return to running was allowed at moderate intensity (70% of maximum heart rate), 3 times a week, from 15 to 30 min continuous per session the first month. The second month, 3 sessions were proposed: 2 sessions of 1- to 2-

min interval training up to 85% of maximal heart rate, and one session with 10 x 50- to 100-m progressive acceleration. A written program was given to the participant and they were encouraged to buy a heart rate monitor to self-monitor their running intensity. No physiotherapy sessions were prescribed if a return to running was allowed.

If the Quadriceps LSI was < 60%, a return to running was not allowed and the previously described running program was not proposed to the patient. If the Quadriceps LSI was 50% to 60%, only cycling was proposed. If the Quadriceps LSI was < 50%, only swimming, including breaststroke, was allowed. No physiotherapy was prescribed under both conditions.

Statistical analysis

Statistical analysis was performed with SPPS 23.0 (IBM Corp., Dublin, Ireland). The results were considered statistically significant at $p<0.05$. At 6 months after ACLR, participants were divided into 2 groups based on the primary outcome: one group with a return to running (RTR) and a group without a RTR (nRTR). Two subgroups were compared by the graft type (BPTB and HS). After verification of the normal distribution of continuous variables, univariate analysis (independent Student *t* test) was used to compare quantitative data between the RTR and nRTR groups. ANOVA with Bonferroni post-hoc test and chi-square test with proportion comparisons by the Bonferroni method were used to compare variables with 3 or more classes between RTR and nRTR. To determine the association between Quadriceps LSI ≥ 60% and a return to running, we first tested the association by a univariate analysis between different variables (i.e., sex, sport level before surgery [Tegner score], meniscal procedures and post-operative complications) and the primary outcome (i.e., a return to running). A multivariable model was then used with step-by-step Wald logistic binary regression (outcome: quadriceps LSI cutoff < 60% or ≥ 60%) to identify cofounding factors

(inclusion of variables from the univariate analysis with probability <0.10). Odds ratios (ORs) and 95% CIs were estimated. The validity of the 60% cutoff of the Quadriceps LSI was assessed by receiver operating characteristic (ROC) curves, sensitivity, specificity and likelihood ratios [26,27].

Results

Participants

A cohort of 711 patients was eligible for the study (Fig. 1); we excluded 93 with ACLR revisions, 5 with ACLR with osteotomy, 18 with multiple surgical procedures with collateral ligament reconstruction and 5 with contralateral ACLR < 24 months. In total, 590 patients had a primary ACLR; 10 did not perform the isokinetic tests because of knee swelling or had knee extension loss > 15° or walked with gait deviation, and 110 others were also excluded because they had not undergone the second testing session. Finally, 470 patients were included in the present study.

Comparison between RTR and nRTR groups

At 6 months after ACLR (mean [SD] 6.7 [1.4] months), 271 participants returned to running and were included in the RTR group; 199 did not return to running and were included in the nRTR group. At 6 months after ACLR, the proportion of men was higher in the RTR than nRTR group ($p < 0.01$), and patients were younger in the RTR than nRTR group ($p = 0.02$) (Table 1).

At 4 months after ACLR (mean 4.0 [0.5] months), the Lysholm score was higher in the RTR than nRTR group (mean 94.2 [8.4] vs 89.2 [9.7]; $p < 0.0001$) (Table 1). More complications were reported in the nRTR than RTR group ($p < 0.01$), and the frequency of anterior knee

pain with the BPTP procedure was greater in the nRTR than RTR group (p = 0.001) (Table 2).

Before ACLR, the most practiced sports were soccer (49%), basketball (18%) and handball (12%), but the 2 groups did not differ in sport levels (p = 0.06) (Table 3) or in meniscus surgery (p = 0.99) (Table 1). During follow-up, no patient had iterative autograft rupture or meniscus pathology, whatever the group.

Return to running according to the 60% cutoff of the Quadriceps LSI

According to our decision-making process using the 60% cutoff of the Quadriceps LSI (≥60%), 285 participants were authorized to return to running at 4 months after ACLR, but 21% (n=59) had not returned to running when interviewed at 6 months after ACLR (mean age 25.7 [5.7] years; 37 men; 37 HS and 22 BPTB procedures) (Table 4). The most common reasons were personal for 40 participants (lack of time or motivation, return to work or weather conditions), anterior knee pain for 12 (17% with anterior knee pain), posterior knee pain for 4 (11% with posterior knee pain) and arthrofibrosis for 3 (8% with arthrofibrosis) (Table 2).

Conversely, according to our decision-making process using the 60% cutoff of the Quadriceps LSI, 185 participants were not authorized to return to running at 4 months after ACLR, but 24% (n=45) said they had returned to running (mean age 26.4 [6.1] years, 37 men; 24 HS and 21 BPTB procedures) (Table 2). Overall, 29 of these 45 participants who returned to running without authorization (Quadriceps LSI < 60%) had no knee complications, 6 had anterior knee pain (9% with anterior knee pain) and 3 had posterior knee pain (8% with posterior knee pain). In the same way, 2 participants with knee infection (50% of all participants with knee infection), 2 participants with signs of arthrofibrosis and 1 participant with knee joint effusion had also returned to running without authorization (Table 2).

Association of the 60% cutoff of the isokinetic Quadriceps LSI with a return to running

A return to running based on the Quadriceps LSI ≥ 60% was significantly associated with young age (OR 1.04, 95% CI 1.01–1.07; p = 0.04), the HS procedure (OR 2.57, 95% CI 1.75–3.77; p = 0.001), high Lysholm score at 4 months (OR 0.96, 95% CI 0.94–0.98; p = 0.01) and the absence of knee complications (OR 1.56, 95% CI 1.37–1.79; p = 0.001). On multivariable analysis, only the absence of knee complications and the HS procedure were associated with Quadriceps LSI ≥ 60% allowing a return to running (Table 5). Participants with HS procedure were 2.6 times more likely to present a cutoff of the Quadriceps LSI ≥ 60% allowing a return to running. and those without knee complications were 1.18 times more likely to present a cutoff of the Quadriceps LSI ≥ 60%. So, the diagnosis efficiency of the 60% cutoff of the Quadriceps LSI for a return to running was 61%, and the model was well adjusted (Nagelkerke R^2 0.120).

The sensitivity and specificity of the 60% cutoff of the Quadriceps LSI were 83% and 70%, respectively (Table 6). The area under the ROC curve was 0.840 (95% CI 0.803–0.877) (Fig. 2). The positive and negative predictive values were 79% and 76%, and the positive and negative likelihood ratios were 2.8 and 0.23.

Discussion

This study is the first to evaluate the interest of a post-operative isokinetic evaluation in the decision-making process to allow a return to running after ACLR. From our present results, a Quadriceps LSI ≥ 60% at 60°/s seems a good parameter to help in the decision-making process to return to running 4 months after ACLR given its good sensitivity and specificity

without endangering the ACLR. This cutoff allowed us to identify a high number of individuals able to run (sensitivity 83%), and only few able to run had not been allowed (specificity 70%). However, the risk of not allowing a return to running, although individuals are able to run, increased with the HS procedure (specificity 63%) (Table 6).

This cutoff had not been previously proposed. The most-cited cutoff is the Quadriceps LSI ≥ 70% at 180°/s after ACLR with HS or BPTB despite the lack of scientific proof [18,28,29]. In practice, physicians have been relatively slow to use the angular speed of 60°/s in routine during the early follow-up of ACLR. Two particular explanations can be proposed. First, patients have difficulties developing strength at this slow isokinetic angular speed and second, many surgeons expressed apprehension in accordance with the autograft fragility during the first months post-surgery [18]. Not using the 60°/s angular speed before 6 months after ACLR was justified by the histologic fragility of the graft in animal and human studies [30–32]. However, for the last 2 decades, the feasibility of the measures at 60°/s has been frequently used for follow-up after ACLR [33]. Hence, in the present study, including 470 individuals at 4 and 6 months after ACLR, we report no complications due to the isokinetic evaluation at 60°/s. Thus, we suggest using this isokinetic velocity in post-ACLR isokinetic evaluations.

The advantage of using a Quadriceps LSI ≥ 60% was to authorize more patients to return to running in comparison to the 70% cutoff mostly cited in literature, without an increase in knee complications [4]. Yet, the 60% cutoff might expose patients to greater difficulties to return to running. So, the greatest risk would be to allow a patient to run when he/she is not able to. More than 20% of our participants were in this situation, many for personal reasons independent of ACLR, and only 19 for knee pain (7%). No graft failure or a meniscus lesion occurred during the return to running. Running is a well-tolerated physical activity [25,34]. However, the decision for a return to running should be made carefully in case of anterior knee pain after the BTPB procedure or posterior knee pain after the HS procedure because of

the donor site morbidity [12], even with a cutoff ≥ 60%. Indeed, these pains were responsible for no return to running despite authorization. In total, 20% of the patients with anterior knee pain did not return to running although they had been allowed to. Yet, return to running progressively does not seem dangerous for the knee between 4 and 6 months after ACLR. Concerning the most serious complications such as infection sequelae or arthrofibrosis, we think that decisions should be made individually because of the low number of patients concerned [35].

Some limitations should be discussed. First, the 60% cutoff of the isokinetic Quadriceps LSI was chosen according to experience and not according to a threshold using the Youden's index, established with an ROC curve. So, the prediction of a return to running was inconclusive in more than 20% of the cases in our participants. A grey-zone statistical approach to decision-making could have increased the utility of the 60% cutoff of the isokinetic Quadriceps LSI [36]. Yet, the lack of specificity of the 60% cutoff had no serious consequences on knee patients (no iterative autograft rupture). Second, this was a retrospective study and 19% of our patients had not been included because of lack of follow-up. For these 120 ACLR patients lost to follow-up, we do not know exactly whether they had returned to running or not according to the results of their first isokinetic testing and their graft procedure. So, the distribution of these patients in the 2 groups (RTR or nRTR) is not known. Thus, the results are not comprehensive, but they remain acceptable because of the high number of patients included. Third, the confounding factors such as age and sex were restrained because they are not modifiable. Yet, the complications may have been biased because the diagnoses were made clinically by the same physician. Therefore, with knee complications, a return to running was evaluated individually and not exclusively decided according the isokinetic cutoff. The confidence of the patients in their operated knee may have played a role for the patients who did not follow the advice concerning a return to

running [37]. Finally, the accessibility of isokinetic assessment remains restricted for many patients after ACLR, and many will return to running without knowing precisely their quadriceps recovery.

Conclusions

Isokinetic measures 4 months after ACLR can help in the decision-making process to allow a return to running for patients without a pivot shift, large knee swelling, knee locking, extension loss > 15° or walking with gait deviation. The cutoff of 60% of the Quadriceps LSI at 60°/s is a good parameter for the decision-making process because of its high sensitivity and specificity.

Conflict of interest. None declared.

Figure Legends

Figure 1: Flowchart of the study. ACLR, anterior cruciate ligament reconstruction; BPTP, bone-patellar tendon-bone; HS, hamstring strand; nRTR, no return-to-running; RTR, return-to-running

Figure 2: Receiver operating characteristic (ROC) curve for the 60% cutoff of the Quadriceps LSI at 60°/s. The diagonal line is the line of no discrimination. Area under the ROC curve 0.840 (95% CI 0.803–0.877).

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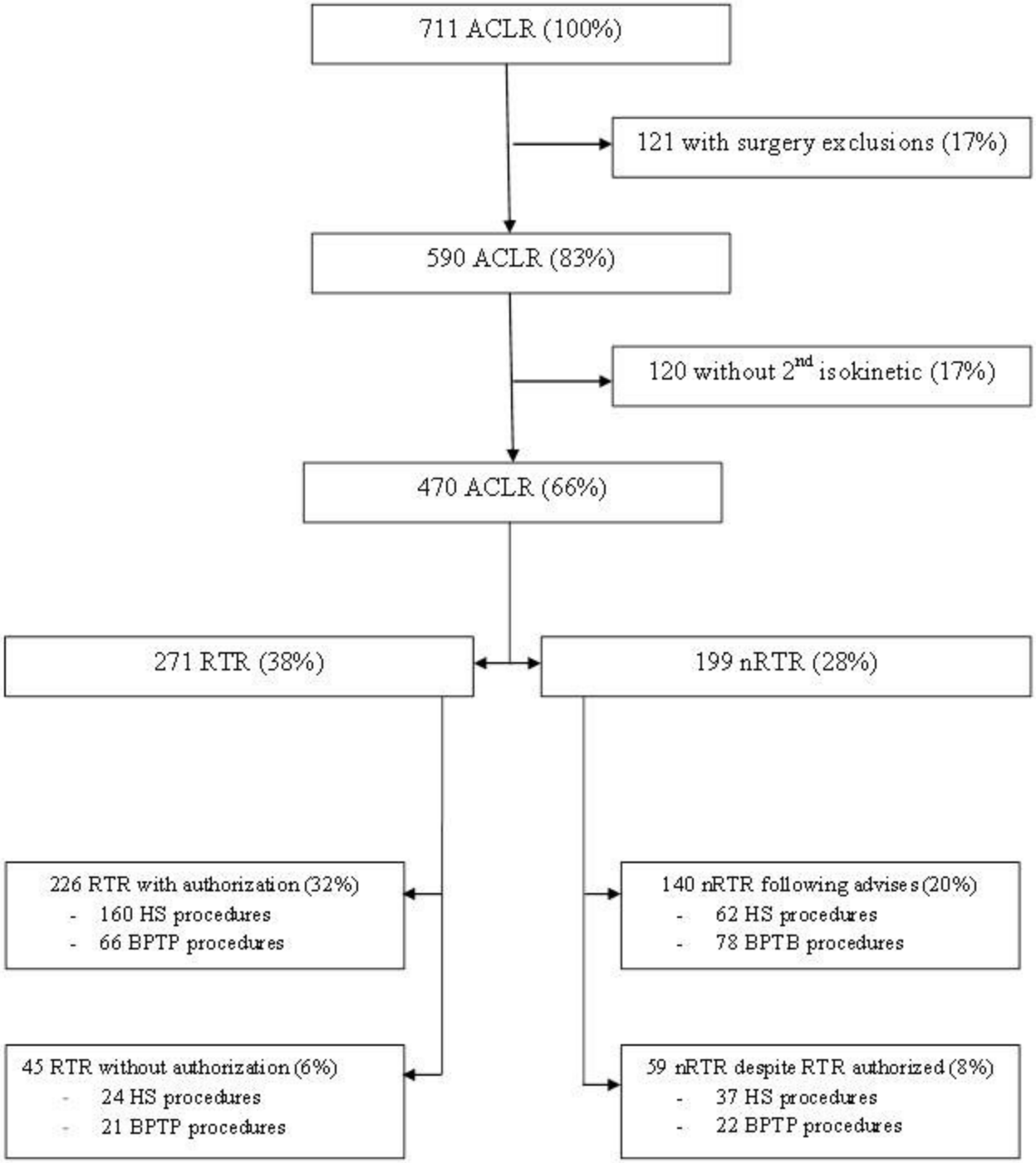
711 ACLR (100%)
121 with surgery exclusions (17%)
590 ACLR (83%)
120 without 2nd isokinetic (17%)
470 ACLR (66%)
271 RTR (38%)
199 nRTR (28%)
226 RTR with authorization (32%)
- 160 HS procedures
- 66 BPTP procedures
140 nRTR following advises (20%)
- 62 HS procedures
- 78 BPTB procedures
45 RTR without authorization (6%)
- 24 HS procedures
- 21 BPTP procedures
59 nRTR despite RTR authorized (8%)
- 37 HS procedures
- 22 BPTP procedures

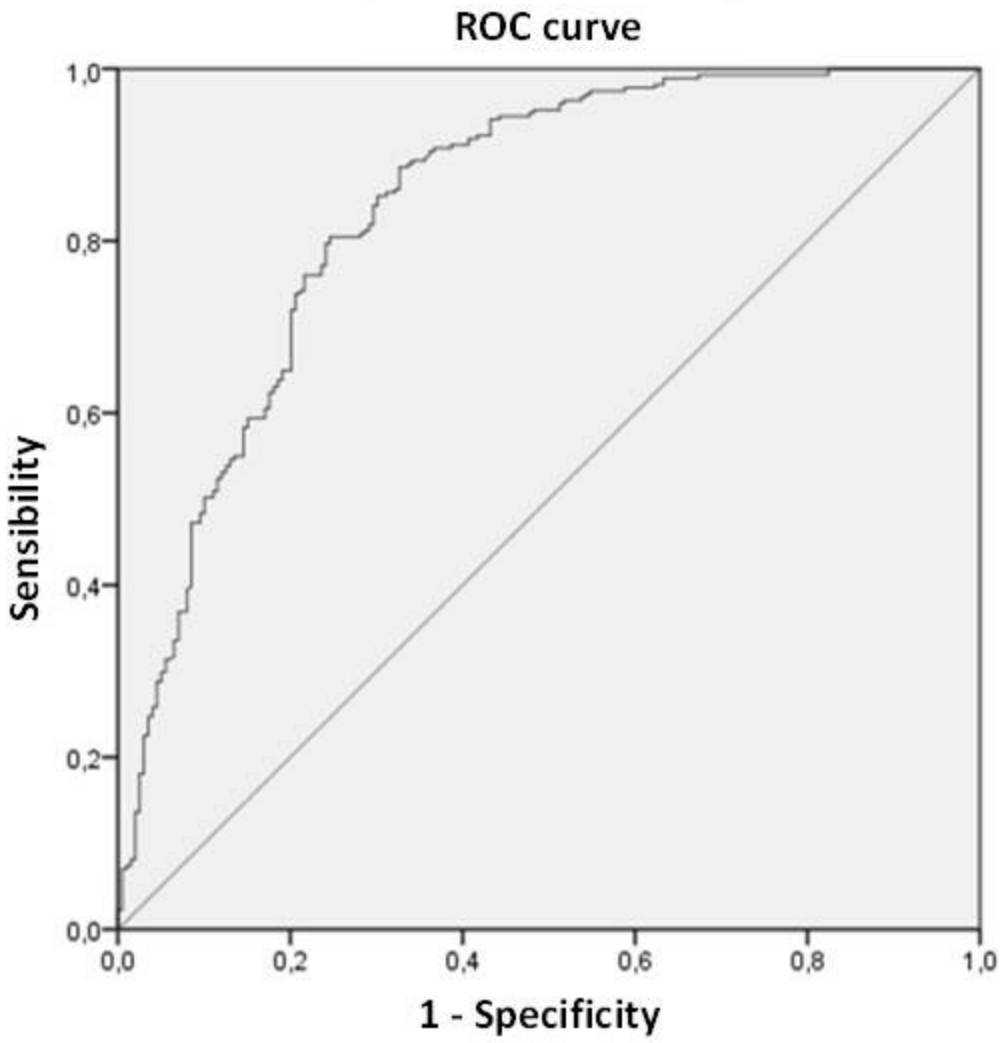
ROC curve
Sensibility
1 - Specificity
1,0
0,8
0,6
0,4
0,2
0,0
0,0
0,2
0,4
0,6
0,8
1,0

Table 1. Characteristics of return to running (RTR) and no RTR (nRTR) groups at 6 months.

	RTR (n=271)	nRTR (n=199)	p-value
Sex: male/female (n)	222/49	144/55	< 0.01[$]
Age (years)	25.5 (5.8) [18-52]	26.8 (6.7) [18-53]	0.02
Weight (kg)	73.5 (11.4) [48-112]	74.4 (14) [43-115]	0.44
Height (cm)	173.5 (8.5) [150-210]	174 (9) [153-208]	0.63
Delay ACL tear to surgery (days)	202 (290) [10-2021]	219 (310) [12-2509]	0.53
Delay surgery to 1st isokinetic follow-up (days)	119 (16) [70-150]	119 (15) [57-150]	0.83
Lysholm score at 4 months	94.2 (8.4) [70-100]	89.2 (9.7) [67-100]	< 0.0001
Delay surgery to 2nd isokinetic follow-up (days)	206 (36) [135-218]	213 (44) [122-220]	0.06
Surgical procedure (n)			
Bone-patellar tendon-bone	87	100	<
Hamstring strand	184	99	0.0001[$]
Meniscal procedure (n)			
No meniscus procedure	222	162	0.75[$$]
MM	29	22	
LM	19	14	
MM + LM	1	1	

Data are mean (SD) [range] unless indicated.

Student t-test, [$]chi-square test, [$$]ANOVA (2 running groups x 4 meniscal procedures)

ACL, anterior cruciate ligament; MM and LM, medial and lateral meniscus

Table 2. Comparison of RTR and nRTR groups by complications and type of ACL reconstruction.

	RTR		nRTR	
	HS	BPTB	HS	BPTB
No complication	139 (75%)	70 (81%)	55 (56%)	45 (45%)
AKP	12 (6%)	11 (13%)	13 (13%)	33 (33%)***
PKP	23 (13%)	1 (1 %)	11 (11%)	0 (0.0%)
Arthrofibrosis	3 (2%)	3 (3%)	14 (14%)	17 (17%)
Infection	3 (2%)	0 (0%)	1 (1%)	0 (0.0%)
Swelling	4 (2%)	2 (2%)	5 (5%)	5 (5%)

AKP, anterior knee pain; BPTB, bone-patellar tendon-bone; HS, hamstring strand; PKP, posterior knee pain.

*** $p<0.0001$, chi-square test with comparisons by Bonferroni method.

Table 3. Sport level before ACL reconstruction in RTR and nRTR groups.

Before-surgery Tegner score	RTR (n)	nRTR (n)
5	17	27
6	34	30
7	95	68
8	85	41
9	25	24
10	15	9

ACL, anterior cruciate ligament

No difference between the RTR and nRTR groups concerning sport level before surgery (χ^2 = 9.8; p = 0.06).

Table 4. RTR and nRTR groups by surgical procedure and Quadriceps Limb Symmetry Index (LSI).

Surgery	Quadriceps LSI (%)	RTR	nRTR
All ACLR	≥ 60	226 (79%)	59 (21%)
	< 60	45 (24%)	140 (76%)
Hamstring strand	≥ 60	160 (81%)	37 (19%)
	< 60	24 (28%)	62 (72%)
Bone-patellar tendon-bone	≥ 60	66 (75%)	22 (25%)
	< 60	21 (21%)	78 (79%)

ACLR, anterior cruciate ligament reconstruction

Table 5. Return to running model according to the cutoff ≥ 60% of the Quadriceps LSI.

	B	**Wald**	**OR**	**95% CI**	**p-value**
Hamstring stand procedure	0.955	22.9	2.60	1.75–3.84	0.0001
Absence of knee complications	0.169	12.6	1.18	1.07–1.29	0.0001
Constant	-2.031	42.3	0.13		

OR, odds ratio; 95% CI, 95% confidence interval

Table 6. Sensitivity, specificity, and positive and negative predictive values and likelihood ratios of the 60% cutoff of the Quadriceps LSI according to the ACL procedure.

Surgical procedure	Sensitivity, %	Specificity, %	Positive predictive value, %	Negative predictive value, %	Positive likelihood ratio	Negative likelihood ratio
All ACL procedures	83 [78-87]	70 [63-76]	79 [71-87]	76 [65-83]	2.8 [2.2-3.5]	0.23 [0.1-0.3]
Hamstring strand	87 [81-91]	63 [52-71]	82 [72-88]	72 [64-79]	2.3 [1.7-3.0]	0.20 [0.1-0.3]
Bone-patellar tendon bone	76 [65-83]	78 [69-85]	75 [64-82]	79 [70-86]	3.4 [2.3-5.0]	0.31 [0.2-0.4]

Data are value [95% confidence interval].