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Determination of Predictive Isokinetic Indicators for Return to Sport at 6 Months after ACL Surgery with Semitendinous and Gracilis Tendons

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Abstract

Background: Numerous evaluation criteria are found in the literature to determine the resumption of sport in patients with anterior cruciate ligament (ACL) surgery. Nevertheless, no consensus can conclude today on precise indicators to determine the return to sport (RTS) at 6 months after ACL surgery.

Aim: The purpose of this study is to determine whether isokinetic evaluation has indicators representative of the functional status of the knee after ACL surgery with semitendinosus and gracilis tendons (STG) to RTS.

Methods: Twenty-two patients, 6.2 months after ACL surgery with STG participated in the study. A correlation was sought between the International Knee Documentation Committee (IKDC) subjective form and the following isokinetic parameters for flexors and extensors at angular velocities of 60°/s and 240°/s: Peak Torque (PT), Flexors /Extensors ratio, PT/kg, and the total work.

Results: The statistical analysis found significant correlations between the IKDC subjective form is PT/kg, PT and total work with the exception of 60°/s flexors. No correlation was found for the flexor / extensor ratio.

Conclusion: PT, PT/kg, total work of extensors and flexors at 240°/s and extensors at 60°/s appear to be the best indicators of knee functional status for sports recovery after ACL surgery

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Abbreviation

ACL: Anterior Cruciate Ligament, ACLR: Anterior Cruciate Ligament Reconstruction, ACL-RSI: Anterior Cruciate Ligament-Return to Sport after Injury, BMI: Body Mass Index, CI: Confidence Index, F/E: Flexors / Extensors, IKDC: International Knee Documentation Committee, KOOS: Knee injury and Osteoarthritis Outcome Score, PT: Peak Torque, RTS: Return To Sport, SD: Standard Deviation, STG: Semitendinous and Gracilis tendons.

Introduction

The evaluation criteria for the RTS of patients with ACLR remain non-consensual. Despite the use of forms (IKDC, KOOS, Lyshom, etc.) [1-19], it appears that the best indicators in terms of muscular strength, neuromotor abilities and psychosocial level give only a partial indication performance and fail to predict the most optimal risk of recurrence sometimes important [4,10].

Among these forms, the IKDC subjective addresses satisfactory reliability criteria, with a sensitivity of 0.82, a specificity of 0.88, a test-retest of 0.9412 and an ICC of 0.92 at 6 months after ACLR. [6,11,15,18,20-22]

Combined with the functional forms, isokinetic dynamometer testing is the gold standard for ligamentous knee muscle assessment, thanks to the safety of the examination and the reproducibility of the results [7,8,23,24]. If the literature evokes several angular velocities to evaluate different parameters of muscle strength, it seems that the use of slow speed (60°, 90°/s) associated with a small series of contraction (4 to 6 repetitions) and fast speed (180°, 240°, 300°/s) associated with a large series of contractions (15 to 20 repetitions), are the most appropriate tests in the evaluation after ACL surgery at 6 months, in a concentric mode [1,25,26].

However, there is no consensus on the speeds and parameters studied (PT, PT / kg, Total Work, etc.). Moreover, this evaluation in open kinetic chain is moving away from the functional aspect of the athlete rather accustomed to alternate the kinetic chain open and closed in his practice as well as contractions concentric and eccentric.

The purpose of this study is to determine whether the isokinetic evaluation has indicators representative of the functional status of the knee after ACLR with STG for RTS.

Materials and Method

Twenty-two subjects who underwent ACLR with STG for 6 months participated in the study. To integrate the study, the subjects had to meet the following inclusion criteria: be 18 to 50 years old [10,27], understand French, have benefited from ACLR with STG for 6 months (more or at least one month) [1-5,10,12,22,28,29]. Women and men are included in this study.

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In order to have comparable and analysable results, the following exclusion criteria were implemented: pain in the operated and non-operated limb, traumatic history of the lower limbs during the last six months [21], concomitant ligament lesions in the rupture of the ACL [27,29,30], operative history of knee [21]. The presence of suture or meniscal resection did not represent an exclusion criterion [2,8,22,29,31].

Before the isokinetic measurements were taken, each participant warmed up on a treadmill for 10 minutes at 5km/h [32].

Two tests were set up, in connection with the literature, to record measurements of the different muscular components. The first test was done at 60°/s [5,8,12,16,22,25,27,28,33,34], in concentric, and included 1 series of 4 repetitions on each limb. The second test was performed at 240°/s [5,33,34], in concentric, and included 1 series of 20 repetitions on each limb. A rest period of 30 s was set up between each of the two series. In addition, a series of 6 contractions were performed on each limb for learning purposes in order to have objective and exploitable results during the measurements.

The tests were always done in the same order, first at 60 °/s then at 240 °/s. All the subjects first performed the evaluation on the unoperated limb and then operated [25,35].

After performing the isokinetic tests, each subject was asked to answer the IKDC subjective form.

	Experimental Group (average±SD)
Age (a)	31,8±7,01
Size (m)	1,74±0,11
Weight (kg)	73,4±16,8
BMI (kg/m²)	23,9±3,7
Sex (M/F)	15/7
Operated Knee (Right/Left)	9/13

Table 1: Demographics of the population.

Statistical analysis

Statistical analyses were performed on the R® software (R Development Core Team 2011, Bell Laboratories, Murray Hill, NJ, USA) after collecting and exporting the data to Excel®.

Shapiro Wilk's test was used to assess whether the variables studied followed a normal distribution. Thus, the present study used the non-parametric Kendall Tau correlation statistical test to analyse the correlation between the IKDC subjective form score and the isokinetic measurements. The confidence level is predefined such that CI = 95% and the level of significance is $\alpha = 0.05$.

Results

The overall results are presented in Table 2.

Statistical analysis revealed significant correlations between IKDC subjective form and all PT/kg variables in extension and flexion, in concentric at 60 and 240°/s, all PT variables in concentric at 60 and 240°/s and the total work done at 60°/s in extension and at 240°/s in flexion and extension.

Variables	Correlation Coefficient	ρ-value
PT Ext/kg_60°/s	0.5339488	0.0005649
PT Flex/kg_60°/s	0.3640491	0.01894
PT Ext/kg_240°/s	0.5450668	0.0004529
PT Flex/kg_240°/s	0.3656423	0.01885
F/E_60°/s Ratio	0.07002607	0.6511
F/E_240°/s Ratio	-0.008753259	0.9549
Total Work Ext con_60°/s	-0.4201564	0.006665
Total Work Flex con_60°/s	-0.1312989	0.3965
Total Work Ext con_240°/s	-0.472676	0.002271
Total Work Flex con_240°/s	-0.437663	0.004711

Table 2: Results of the correlations obtained between the different variables and the subjective IKDC.

No correlation was found between the IKDC subjective score and the F/E ratio irrespective of the speed studied on the operated leg as well as for the total flexion work at 60°/s.

Discussion

Recall that the purpose of this study is to determine if the isokinetic evaluation has indicators representative of the functional state of the knee after ACLR for RTS.

The study by Haillotte et al, [9] found similar results in this study, concerning the flexor muscles of the knee. The latter found correlations between the IKDC subjective score and the hamstring PT deficits at a rate of 240°/s ($p < 0.01$), and no correlation was found with the quadriceps at 240°/s. However, various factors were different from the present study: the subjects were ACL operated with fascia lata, patellar tendon and STG graft, their muscle strength measurements were made at isokinetic speed was 90°/s (1 series of 8 repetitions). In view of the difference in protocol, it could be hypothesized that PT of knee extensors should be studied at different isokinetic angular velocities for ACLR.

With regard to the results found at the speed of 60% of the total work, various hypotheses can be emitted.

The first hypothesis is that total work better reflects the muscular endurance component. As a result, various authors [19,26] have suggested that in order to reflect the endurance component, high isokinetic velocity is required with an important number of repetitions. Thus, we can think that a speed of 60°/s with only 5 repetitions is not representative of the muscular endurance component. This is in agreement with the study by Kaminska et al. [34]. The latter found no significant difference in total work between an ACLR population (postoperative recruitment range of 4 to 12 months) and a healthy population at the angular rate of 60°/s. However, as in the present study, significant differences were found at the angular velocity of 240°/s. Kaminska et al. [34] therefore submitted the idea that a fast speed was needed to more accurately assess the total work deficits for ACLR, which is in line with the results of this study.

The second hypothesis is that subjective functional scores are more closely related to the functional level of the extensor apparatus as suggested by Logersted et al, [1,7]. Thus the IKDC subjective score would be more sensitive to assess the functional level of knee extensors than flexors.

In the present study no correlation was found between the IKDC subjective score and the F/E ratios of the operated limb. Our results are consistent with those of Lentz et al. [36]. The latter were interested in patients who had not yet resumed their sport at the same level as before the injury at 6 months. These results were even less correlated if, in addition to not having resumed activity, the patient was afraid to resume his activity.

No correlation was also found for differences in F/E ratio between operated and non-operated legs. As the ratios themselves had shown no correlation with the IKDC subjective score, it would have been unlikely that their difference would be.

With respect to the PT/kg, our results found significant correlations with the IKDC subjective score [1,31,37]. Lentz and al [36] evaluated the correlations between the PT kg of the quadriceps and the angular velocity of 60°/s at 6 months after ACLR and found significant correlations with all the groups studied. Kong et al., [22], investigated the correlation between PT/kg differences, at 60°/s angular velocity in concentric mode, and three different jump tests. Their study shows significant correlations between the results obtained in the 3 tests and the PT/kg of extensors and flexors.

Limitations

The present study was performed on a small sample and on a single population operated with STG, so it is not generalizable to all patients who have undergone ACL surgery. It would have been interesting to compare, in a future study, the functional indicators between the different grafts used and to determine their functional impact.

Similarly, the evaluation of the LCA on the criteria of strength, neuromotive and psychosocial agility, it would have been relevant to correlate our results at different hop tests or at the ACL-RSI scale.

Finally, the study of different speeds described in the literature would have made it possible to determine the choice of the optimal speed in the evaluation of the return to sport most representative of the function of the knee after ACL surgery.

Conclusion

Our results compared to those found in the literature show that the PT, PT/kg, the total work of extensors and flexors at 240°/s and extensors at 240°/s seem to be the best indicators of the functional status of the knee, view of the return to sport after ACL surgery. On the other hand, the ratio F/E and the total work of the flexors at 60°/s do not seem to provide specific indications for sports recovery. Although there are no consensus indicators to date, this study and the literature seem to agree on the joint use of force, neuromotive and psychosocial agility parameters to determine sport recovery appropriately for the patients undergoing ACLR.

Competing Interests

The authors declare that they have no competing interests.

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