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ORIGINAL ARTICLE • KNEE - SPORT

Return to sport after ACL reconstruction: a survey between the Italian Society of Knee, Arthroscopy, Sport, Cartilage and Orthopaedic Technologies (SIGASCOT) members

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Abstract
Background A worldwide consensus for timing and criteria for return to sport after anterior cruciate ligament (ACL) reconstruction is lacking. The aim of the study was to survey among the Italian Society of Knee, Arthroscopy, Sport, Cartilage and Orthopaedic Technologies (SIGASCOT) members in order to evaluate their approaches to the return to sport after ACL reconstruction regarding timing and criteria.
Methods A web survey among the SIGASCOT members was performed, including 14 questions regarding technical and graft preferences, timing for return to training and competitive activity for contact and non-contact sports and criteria to allow return to sport.
Results Totally, 123 members completed the questionnaire. Return to training sports was allowed within 6 month by 87 % for non-contact sports and by 53 % for contact sports. Return to competitive activity was allowed within 6 months by 48 % for non-contact sports and by 13 % for contact sports. Full ROM (77 %), Lachman test (65 %) and Pivot-Shift test (65 %) were the most used criteria to allow return to sport. The 90 % used at least one clinical score.
Conclusion The SIGASCOT members showed various approaches in the return to sport after ACL reconstruction, with differences between return to training or competitive activity, and between contact and non-contact sports. Six months was generally considered adequate by most of the members for the most demanding activities. The most used criteria to allow return to sport were manual testing. A clear definition of sport activities and more objective criteria for the return to sport are needed.
Level of evidence Level V, expert opinion.

Keywords ACL reconstruction · Return to sport · Criteria · Rehabilitation

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Introduction

The decision to allow return to sport and unrestricted physical activity after anterior cruciate ligament (ACL) injury and reconstruction represents one of the most challenging and difficult decisions an orthopaedic surgeon has to make. Many factors such as surgical technique, graft choice, rehabilitation, sport activity and individual attitudes of the patient should be taken into account in order to guarantee a safe outcome [1]. It is in fact reported that only around 85 % of patients who underwent primary or revision ACL reconstruction were able to resume sports activity. The percentages were even lower when considering those who returned to their pre-injury level of participation (55–65 %) and those who returned to competitive sports (50–55 %), even though approximately 90 % of patients presented normal or nearly normal knee function [2, 3].

The 6 months has been globally accepted as temporal milestone for a safe return after accelerated rehabilitation [4, 5], despite several authors suggested to delay the

unrestricted physical activity after the 8th–9th months, especially in high-demanding athletes [6–8]. The worldwide current practice obtained from National and International surveys between orthopaedic surgeons [9–12] seems to reflect the global trends dictated by the clinical studies [5].

However, the greatest controversies in the "return to sport" field probably rely on the return to sport criteria. In fact, up to now, a widely accepted test battery that evaluates the capability of an athlete to safely perform sport activity is still lacking [7, 13], and therefore the critical decision of return to sport relies on the preference and experience of the single practitioner.

In Italy, the widest scientific society that assembles more than 850 practitioners of Orthopaedic Surgery and Sports Traumatology is represented by the Italian Society of Knee, Arthroscopy, Sport, Cartilage and Orthopaedic Technologies (SIGASCOT). The aim of the presents study was to perform a survey among the SIGASCOT members in order to evaluate their approaches to the return to sport after ACL reconstruction regarding both the timing and criteria, thus delineating the Italian trends. We hypothesized that the timing and criteria allowing patients to return to sport will be uniform among the SIGASCOT members.

Materials and methods

Survey preparation and administration

Between 30 June 2015 and 30 July 2015, a survey on return to sport after ACL reconstruction was performed among the SIGASCOT members. The survey, promoted by the SIGASCOT Sport Committee, was activated by four orthopaedic surgeons and one physiatrist; the drafting process included several iterations within the research team. The final survey comprised 14 questions, articulated in four sections (see Table 1 in Appendix):

1. General information regarding ACL reconstruction: ACL reconstruction performed per year, graft choice in general population or in athletes, preferred technique.
2. Timing for return to training after ACL reconstruction: non-contact, contact or high-impact sports.
3. Timing for return to competitive sports after ACL reconstruction: non-contact, contact or high-impact sports.
4. Criteria for return to sport after ACL reconstruction: objective evaluation, clinical scores, eventual investigations in professional athletes.

High-impact sports were defined as sport activities characterized by intense and frequent wear and trauma of the knee (e.g. Baseball, Basketball, Soccer, Football, Handball, Tennis).

An online open-source platform (https://drive.google.com) was configured to collect the responses anonymously.

All the members present in the official mailing list of the SIGASCOT association were contacted via mail. A first e-mail was sent to present the initiative and to invite to participate completing the online questionnaire, and a second e-mail was sent after 2 weeks to reminder to join the initiative.

Statistical analysis

Data obtained from the completed questionnaires were entered onto a comprehensive database developed using the Microsoft Excel Package Office 2013. The results of each question are expressed as the proportion of respondents. A Pearson Chi-square test and a Fisher exact probability test were utilized to compare the subgroups based on surgical experience and graft regarding the return to sport timing and criteria, and to compare the different timing according to sport activities. Statistical significance was set with $p < 0.05$. Statistical analysis was performed with MedCalc (MedCalc software, Acacialaan 22, Ostend, Belgium).

Results

Of the total of 778 members contacted, 123 completed the questionnaire (16 %). Three members reported not performing any ACL reconstruction per year, and therefore the total available questionnaires were 120. It is felt that the data obtained are representative of the trends seen in Italy.

General information regarding ACL reconstruction

Regarding the surgical experience in ACL reconstruction, more than 60 % reported performing more than 25 procedures per year (Fig. 1). The preferred graft for ACL reconstruction in both general population and professional athletes was the hamstrings (81 and 49 %, respectively; Fig. 2). However, the proportion of the members that used hamstrings and BPTB in professional athletes was similar (49 vs. 45 %) because 42 % of the members reported to perform the graft choice based on the patient's sport

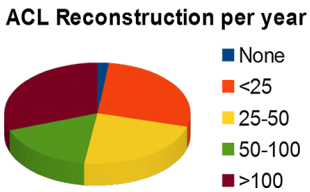

Fig. 1 Chart representing the percentage of surveyed members according to the number of ACL performed per year

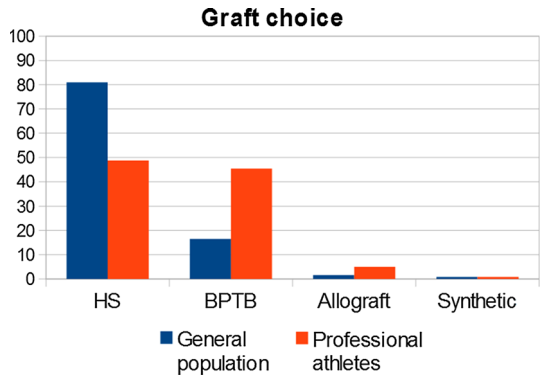

Fig. 2 Graft choice preferences for general population (*blue bars*) and professional athletes (*red bars*). *HS* hamstrings, *BPTB* bone-patellar tendon-bone (color figure online)

activity. The preferred technique of femoral tunnel execution was the trans-tibial (62 %) followed by antero-medial portal (39 %).

Timing for return to training after ACL reconstruction

Most of the members (89 %) allowed sport-specific rehabilitation within 6 months from ACL reconstruction, and 31 % of the total even before 4 months (Fig. 3). Also return to training for non-contact sports was allowed within 6 month by the majority of the members (87 %); however, only 20 % allowed it before 4 months (Fig. 3). Differently, return to training for contact sports was allowed before 6 months only by 43 % of the members, as most of them (49 %) allowed it between 6 and 8 months and 8 % waited even 8 months or longer (Fig. 3). A significant difference ($p < 0.0001$) was found between the timings for return to training non-contact and contact sports. No differences in the return to training timing were found based on surgical experience or graft used.

Timing for return to competitive sports after ACL reconstruction

Most of the members (92 %) allowed return to competitive practice of non-contact sports within 8 months, and 48 % of the total even before 6 months (Fig. 4). Similarly, return to competitive practice of contact sports was allowed within 8 month by the majority of the members (72 %); however, only 13 % allowed it before 6 months (Fig. 4). A similar behaviour was reported regarding the return to competitive practice of high-impact sports; however, in this case, 12 % of the members reported to wait at least 10 months (Fig. 4). A significant difference ($p < 0.0001$) was found between the timings for return to non-contact and contact sports, but not between contact and high-impact sports ($p = 0.3014$). Significant differences were present between return to train and return to full sport resumption for both non-contact ($p < 0.0001$) and contact sports ($p < 0.0001$). No differences in the return to sport timing were found based on surgical experience or graft used.

Criteria for return to sport after ACL reconstruction

Regarding the objective criteria for the return to sport, the most used were full ROM (77 %), Lachman test (65 %) and Pivot-Shift test (65 %). The combination of these three criteria was used by the 48 % of the members. Muscle

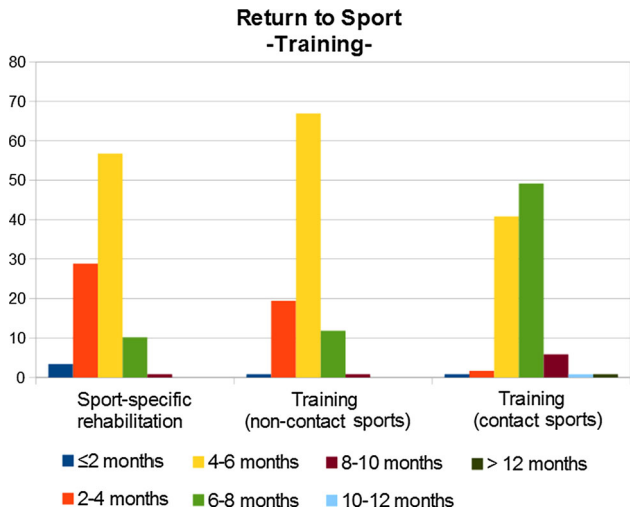

Fig. 3 Trends of the timing of return to training for sport-specific rehabilitation (*left*), non-contact sports (*centre*) and contact sports (*right*)

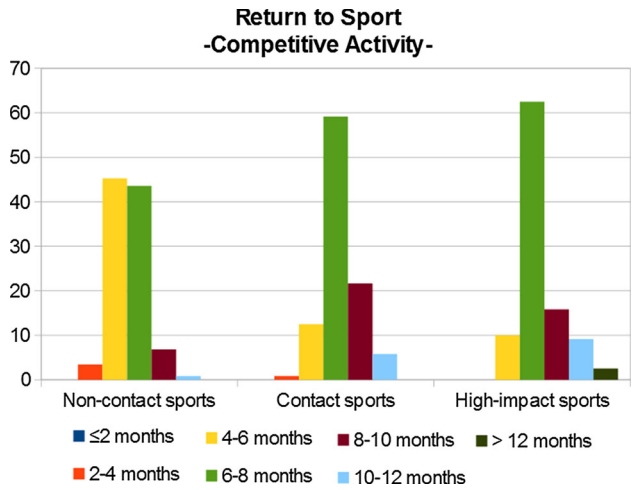

Fig. 4 Trends of the timing of return to competitive activity for non-contact sports (*left*), contact sports (*centre*) and high-impact sports (*right*)

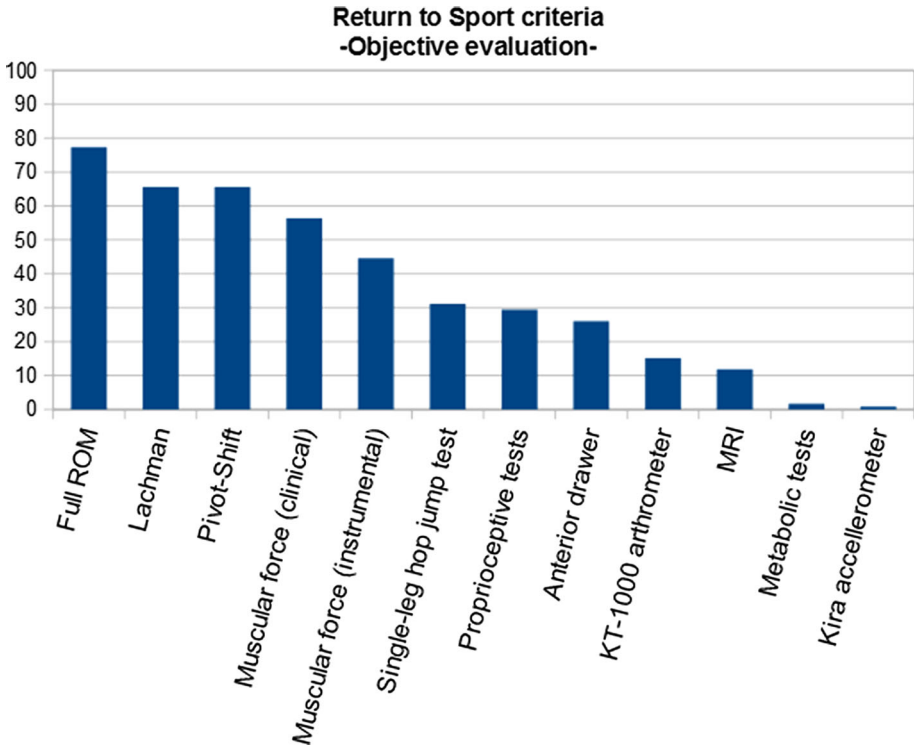

Fig. 5 Trends of the use of objective criteria to allow return to sport after ACL reconstruction

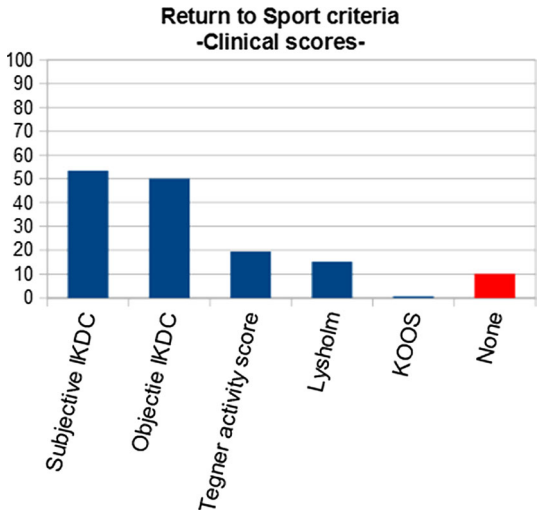

Fig. 6 Trends for the use of the clinical scores in the return to sport decisional process

force evaluation was performed by almost the half of members (44–56 %), while functional and proprioceptive tests were used by almost one-third of the members (29–31 %). Instrumental laxity evaluation was used only by 16 % of the members and MRI by 12 % (Fig. 5). Finally, 90 % of the members reported to use at least one clinical score, mostly the subjective (53 %) or objective (50 %; Fig. 5). Only 11 % utilized further specific evaluations in professional athletes (Fig. 6).

No difference in the return to sport criteria was found based on surgical experience or graft used.

Discussion

The most important finding of the present study is that most of the Italian SIGASCOT members that completed the survey used objective and subjective criteria to allow return to sport after ACL reconstruction and considered the 6th month as an adequate landmark for a safe sport resumption. Moreover, differences were present between the various typologies of activities investigated (training vs. full sport resumption, contact vs. non-contact sports), thus underlining the need of a precise definition of the "return to sport" outcomes. The SIGASCOT members reported to allow return to contact and high-impact sports before 6 months only in 13 and 10 % of the cases, respectively. The trends delineated by the present survey seem in line with what recently reported by other National and International Societies. In a survey between the attendants of the 2010 Brazilian Congress of Orthopaedic and Traumatology, Astur et al. [14] reported that the 86 and 95 % of public and private Brazilian Orthopaedic Surgeons, respectively, considered the 6th month as an adequate time point for unrestricted activity after ACL reconstruction. A similar trend was presented by the Major League Soccer Team physicians that allowed return to soccer before 6 months

only in 9 % of cases [11], and by the high-volume Turkish ACL surgeons that waited <6 months for the return to contact sports in only 16 % of the cases [15]. A similar short timing for return to unrestricted activities was used by 14 % of the surveyed members of the Canadian Orthopaedic Association [16]. A slightly more aggressive approach seemed to emerge from the results of a survey among the Croatian Orthopaedic and Traumatology Association members, which used to allow sports activity before 6 months from ACL reconstruction in almost a quarter of the cases [17]. However, in the former survey, no specific distinction between contact and non-contact sports activity was provided. In fact, when an adequate distinction is performed, an early return for non-contact sports was reported. Similarly to what reported in the present study, return to non-contact sport was considered safe before 6 months in almost 50 % of the cases also by Turkish surgeons [15]. These findings confirm the need of precise and univocal definition of the "return to sport"-related outcomes based on training, competitive activity and contact or non-contact sports, as different approaches or results could be related to each different situation [2, 17, 18].

Differently from the global trends aforementioned, the experienced German, Austrian and Swiss AGA instructors adopted a more cautious approach, as they allowed sport activity before 6 months in only 2 % of cases and waited 12 months in even 20 % of the cases [9]. The reason of this discrepancy remains unknown, as the graft choice (predominance of hamstrings autograft, except for the USA) and the preferred techniques appear to be consistent among the different surveys.

Regarding the return to training, the tendency of the present study resulted more aggressive from what reported by Feller et al. [10]: they reported return to train for contact or non-contact sports before 6 months in around 60 % of the Australian surveyed members for both hamstrings and bone-patellar tendon-bone (BPTB). These findings differed considerably from the near 90 % reported in the present survey. As the Italian trend was more similar to another recent survey performed in 2014 [11], it could be argued that the different approach was due to the improved consciousness of safe return to athletic gestures and improvement of rehabilitation techniques occurred in the last decade rather than to cultural differences. A systematic review of 264 studies evaluating ACL reconstruction outcomes reported a time criteria for return to sport in 60 % of the cases. Among them, 138 reported 6 months or more as time landmark, while only 20 allowed sports before 6 months, confirming the trends of worldwide practitioners [5]; moreover, n substantial differences were noted between the various grafts.

Postoperative time thus seems to be relevant factor for the return to sport. The rationale behind the importance of timing is represented by the remodelling process that graft undergoes intra-articularly. Animal studies reported an initial necrosis phase, followed by a phase of proliferation and lastly by a ligamentization phase with restructuring of the graft towards the properties on an intact ACL [19]. During this process, a dramatic decrease of the tensile strength in the early phases has been reported and a restoration to the time-zero properties has been reported to occur after 24 weeks [20]. Although these results could represent a background for an early return to sport, it should be underlined that findings from animal studies cannot be applied directly to the humans, due to the different biology and graft size. Therefore, the remodelling process may take longer time in humans than in animals, thus suggesting a return to vigorous activities for the ACL after at least 6 or even 8 months.

The other relevant issue emerged from the present survey was the use of different objective criteria and clinical scores to allow return to sport. The SIGASCOT members, similarly to the AGA instructors, mostly employed simple manual tests such as ROM evaluation, Lachman and Pivot-Shift, or the combination of them [9]. Only half of them used instrumental evaluation of muscle strength, and 30 % of them utilized functional tests. This approach, despite generally shared by other countries practitioners [9, 12, 15, 21], could be considered a suboptimal evaluation, thus exposing the patient\athlete to the risk of return to sport in a condition of incomplete recovery. In fact, recent studies aimed to develop test batteries for the return to sport clearance (based on stability tests, jumps and plyometric training) and showed that more than 80 % of athletes that underwent ACL reconstruction still presented functional deficits compared to an healthy age- and gender-matched subjects even 8 months after surgery [6, 7]. The Delaware group [22, 23] reported that around 50 % of athletes were not able to fulfil their return to sport criteria (based on muscle strength, hop tests and questionnaires) 6 months after ACL reconstruction, showing significantly abnormal knee kinematic and gait pattern, asymmetrical tibiofemoral contact forces and patterns similar to acute ACL injuries. Therefore, in order to identify and correct all the abnormalities before allowing a safe return to sport, a comprehensive evaluation, possibly with instruments and devices, should be recommended. Interestingly, the graft features on MRI such as graft volume and signal intensity have been demonstrated to correlate with functional and clinical status of patients 3 and 5 years after ACL reconstruction [24]. Therefore, MRI could be proposed as a tool to be integrated in the return to sport decisional process, as already reported by the 12 % of the SIGASCOT members.

Finally, most of the SIGASCOT members implemented the objective evaluation with validated questionnaires, differently from the 14 % reported by Petersen and Zantop [9]. Lynch et al. [25] have in fact recently defined the patient-reported outcomes (PROs) as important measures to consider a "successful outcome" after ACL reconstruction.

The present study has several limitations, first of all, the low response rate (16 %). This issue, despite possibly producing a heavy non-response bias, could be due to the high number of non-active members, surgeons not involved in knee surgery, residents and non-orthopaedic members. Moreover, even other surveys involving large populations reported response rates ranging from 12 to 22 % [17, 26, 27]. Further, other national and international surveys presented the results of <50 respondents [10, 11, 15, 17, 28]. Another limitation relies on the fact that the survey was performed between practitioners with different levels of experience and that these results do not represent guidelines for return to sport but only the current trends of the Italian ACL surgeons.

Conclusions

The SIGASCOT members showed various approaches in the return to sport after ACL reconstruction, with significant differences between return to training and competitive activity, and between contact and non-contact sports. Generally, the return to competitive non-contact sports was allowed after 6 months in 52 % of the cases, while contact and high-impact sports in 87–90 % of the cases, respectively. Similar differences were reported also in the return to training decision. The most used return to sport criteria were manual testing (Lachman, Pivot-Shift and ROM evaluation) in 77–65 % of the cases, and instrumental muscle strength evaluation or functional tests in only 44 and 31 %, respectively. The present survey highlights the need for a univocal and clear definition of sport activities when evaluating the return to sport outcomes, and the need for more objective and well-structured criteria for the return to sport to be implemented in the daily clinical practice.

Compliance with ethical standards

Conflict of interest None.

Appendix

See Table 1.

Table 1 Survey questions and results

Section 1: general information regarding ACL reconstruction	
Question 1: How many ACL reconstructions do you perform each year?	
None	3 %
Less than 25	35 %
Between 25 and 50	29 %
Between 50 and 100	22 %
More than 100	11 %
Question 2: Which is your preferred graft for general population?	
Hamstrings	81 %
Bone-patellar tendon-bone	16 %
Allograft	2 %
Synthetic	1 %
Question 3: Do you utilize the same graft independently from the patient sport activity?	
Yes	58 %
No	42 %
Question 4: Which is your preferred graft for professional athletes?	
Hamstrings	49 %
Bone-patellar tendon-bone	45 %
Allograft	5 %
Synthetic	1 %
Question 5: Which is your preferred technique for femoral tunnel drilling	
Trans-tibial	62 %
Antero-medial portal	29 %
Outside-in	9 %
Section 2: timing for return to training after ACL reconstruction	
Question 6: When do you allow the beginning of "sport-specific" rehabilitation?	
≤2 months	3 %
2–4 months	29 %
4–6 months	57 %
6–8 months	10 %
8–10 months	1 %
10–12 months	0 %
>12 months	0 %
Question 7: When do you allow return to training for non-contact sports?	
≤2 months	1 %
2–4 months	19 %
4–6 months	67 %
6–8 months	12 %
8–10 months	1 %
10–12 months	0 %
>12 months	0 %
Question 8: When do you allow return to training for contact sports?	
≤2 months	1 %
2–4 months	2 %
4–6 months	40 %

Table 1 continued

6–8 months	49 %
8–10 months	6 %
10–12 months	1 %
>12 months	1 %
Section 3: timing for return to competitive sports after ACL reconstruction	
Question 9: When do you allow return to competitive activity for non-contact sports?	
≤2 months	0 %
2–4 months	3 %
4–6 months	45 %
6–8 months	44 %
8–10 months	7 %
10–12 months	1 %
>12 months	0 %
Question 10: When do you allow return to competitive activity for contact sports?	
≤2 months	0 %
2–4 months	1 %
4–6 months	12 %
6–8 months	59 %
8–10 months	22 %
10–12 months	6 %
>12 months	0 %
Question 11: When do you allow return to competitive activity for high-impact sports?	
≤2 months	0 %
2–4 months	0 %
4–6 months	10 %
6–8 months	62 %
8–10 months	16 %
10–12 months	9 %
>12 months	3 %
Section 4: criteria for return to sport after ACL reconstruction	
Question 12: Which criteria do you utilize to allow return to sport after ACL reconstruction? (multiple choices allowed)	
Full ROM	77 %
Lachman test	65 %
Pivot-Shift test	65 %
Muscular force (clinical)	56 %
Muscular force (instrumental)	44 %
Single-leg hop jump test	31 %
Proprioceptive tests	29 %
Anterior drawer	26 %
KT-1000/2000 arthrometer	15 %
MRI	12 %
Other: metabolic tests	2 %
Other: kira accelerometer	1 %

Table 1 continued

Question 13: Which validated clinical score do you utilize to allow return to sport after ACL reconstruction? (multiple choices allowed)	
Subjective IKDC	53 %
Objective IKDC	50 %
Tegner activity scale	19 %
Lysholm	15 %
KOOS	1 %
None	10 %
Question 14: Do you utilize further criteria in professional athletes? (multiple choices allowed)	
No	89 %
Yes: physiatric evaluation	2 %
Yes: metabolic tests	2 %
Yes: MRI	2 %
Yes: muscle force (isokinetic test)	3 %
Yes: sport-specific tests	3 %

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