



# Hamstrings substitution via anteromedial portal with optional anterolateral ligament reconstruction is the preferred surgical technique for anterior cruciate ligament reconstruction: a survey among ESSKA members

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## Abstract

**Purpose** The objective of this study was to report on a worldwide web-based survey among the ESSKA community developed to investigate current recommendations regarding ACL reconstruction surgical procedures.

**Methods** All contacts in the official mailing list of the ESSKA were contacted to investigate preferences regarding graft type, anterolateral ligament reconstruction, femoral tunnel drilling technique, single-bundle vs double-bundle technique, femoral and tibial fixation methods.

**Results** Eight-hundred and twenty responses were analyzed. Hamstrings autograft was the graft of choice in male patients for 634 (79%) and in female patients for 674 (84%) responders, while its preference for ACL reconstruction in professional athletes was for 401 (50%). 480 (63%) surgeons surveyed would include anterolateral ligament reconstruction only if diagnosed and remaining instability after ACL surgery or revision. 598 (75%) respondents were in favor of anteromedial portal for femoral tunnel drilling. The most popular femoral fixation technique was found to be cortical suspension (500–66%), while a compression system was preferred on the tibial side by 537 (71% of the sample).

**Conclusions** This survey study found that HT autograft, single-bundle reconstruction, anteromedial portal for femoral tunnel drilling, cortical suspension systems for femoral fixation and compression systems for tibial fixation represent the current standard of ACLR in a large community of orthopedic surgeons. The present study performed with surgeons who are members of the ESSKA community will help to comprehend the actual ACLR worldwide practice patterns. Due to low response rate, these results should be interpreted with caution and not to be intended to represent the state of the art of ESSKA community.

**Level of evidence** III.

**Keywords** Anterior cruciate ligament · Graft · Surgical technique · Survey

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## Introduction

Anterior cruciate ligament reconstruction (ACLR) is one of the most frequently performed surgical procedures, to restore knee stability and prevent further damage after ACL rupture [15, 31]. Excellent results have been widely reported for ACLR [25, 28], but controversy remains over the most effective surgical method. Recommended femoral tunnel position, graft type, and graft fixation for ACLR have evolved over time as a result of research regarding ligament anatomy and biomechanics, and device development [26, 31].

During the past decade, there has been interest in other femoral tunnel drilling technique than transtibial to achieve a more anatomic ACLR, which could improve rotational knee stability and knee function. Better clinical outcomes of ACLR executed with the transtibial technique, both on knee functional outcome scales and knee laxity tests [24], have led the anteromedial technique to gain popularity in the recent years [31].

The most commonly utilized autografts for ACLR are the bone–patellar tendon–bone (BTB) and hamstring tendons (HT), both with advantages and drawbacks [31]. BTB has been considered the gold standard because of faster graft incorporation, reliable graft size and a lower risk of graft rupture, but in recent years there has been a shift in the graft choice from BTB to HT autograft due to lower donor site morbidity, anterior knee pain and extensor strength deficit [30].

Graft fixation choice depends on ease of use, biomechanical strength, potential complications, and ease of revision [31]. Among these, initial fixation strength is of great importance for safe and early rehabilitation, and revision ACLR rate has been purposed as a measure of failure of the graft fixation implant [9]. Interestingly, suspension systems for femoral fixation have gained great popularity due to their simplification of graft implantation, despite higher rates of tunnel widening and failure rate when compared with intra-tunnel fixation of the same graft type [9, 19].

Studies on surgical technique practice patterns can help in understanding attitudes and behaviors of physicians, and if common practice is supported by recent research. Several recent survey-based investigations performed to delineate physicians trends in ACLR have been mostly restricted to national surveys [13]. An international survey in 2013 identified a trend toward the use of HT autografts and the anteromedial portal approach for drilling the femoral tunnel, although geography affected surgeon preferences, as demonstrated by distinctly different choices of North American surgeons compared to others worldwide [3]. Moreover, neither the use of HT grafts nor of the anteromedial portal was supported by contemporary evidence-based data.

The aim of this study was to develop an updated worldwide survey among the European Society of Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA) community to investigate current preferences regarding surgical procedures. Furthermore, surgical applications that gained the broadest preference are discussed to highlight the support of evidence-based medicine.

## Materials and methods

### Questionnaire design

The project consists in the worldwide extension of a survey carried previously out in Italy to investigate the attitudes of members of a national association specialized in sports traumatology and knee surgery (SIGASCOT) regarding surgical techniques, routine postoperative applications, rehabilitation approaches and starting time of specific activities and exercises following ACLR [32].

Using the questionnaire utilized by Vascellari et al. as a guide [32], a new questionnaire was generated to evaluate ACLR surgical methods of the ESSKA community. With the support of the European Sports Medicine Associates (ESMA), the questionnaire was evaluated and implemented by a task force of five orthopedic surgeons and one physiotherapist, all highly experienced in managing patients after ACL injuries. The new questionnaire included a pool of items assessing indications for ACL and anterolateral ligament (ALL) reconstruction. The surgical technique was assessed in detail, including graft type utilized in male patients, in female patients and in professional athletes. Surgeons were also asked to rate single-bundle vs double-bundle technique, femoral tunnel drilling techniques, femoral and tibial fixation methods (“Appendix” section).

A web-based survey tool (Survey Monkey, survey-monkey.com, Portland, OR) was configured to collect the responses.

### Study sample

The ESSKA, an international association specialized in sports traumatology and knee surgery with 3440 active members and 6334 non-member followers, was chosen as the sample group. ESSKA non-members (so-called friends of ESSKA) have access to the ESSKA academy and other ESSKA scientific facilities.

The ESSKA was contacted, and authorization to contact all members in the official mailing list was gained without prior consent. The final questionnaire was sent to all ESSKA members via email. One reminder was sent 3 months later to join the initiative only to those members who had not responded to the survey by that time. On the basis of the

mailing list, 9774 personalized invitations were sent (target population). The survey was kept open from the 13th of September 2018 to the 15th of January 2019.

### Statistical analysis

Data obtained from the completed questionnaires were entered into a custom database developed in Microsoft Excel Package Office 2013 (Microsoft, Redmond, USA). Response rates are summarized in terms of number and proportions of respondents. The Pearson Chi-square test and Fisher's exact test were used to study the association between number of reconstruction operations performed, geographic location by continent and selection of treatments. A  $p$  value lower than 0.05 ( $p < 0.05$ ) was considered statistically significant. Statistical analysis was performed using PSPP software (Free Software Foundation, Inc.) for Windows.

### Results

Eight-hundred and twenty completed questionnaires were collected (517 [63%] from ESSKA members and 303 [37%] from non-members). Responders were from 86 different countries worldwide, most of them were from European countries (517–63%).

Of the respondents, 156 (19%) performed less than 25 ACLR per year, 240 (29%) performed 25–50 ACLR per year, 248 (30%) performed 51–100 ACLR per year, and 153 (19%) more than 100 ACLR per year.

The survey results are summarized in “Appendix”.

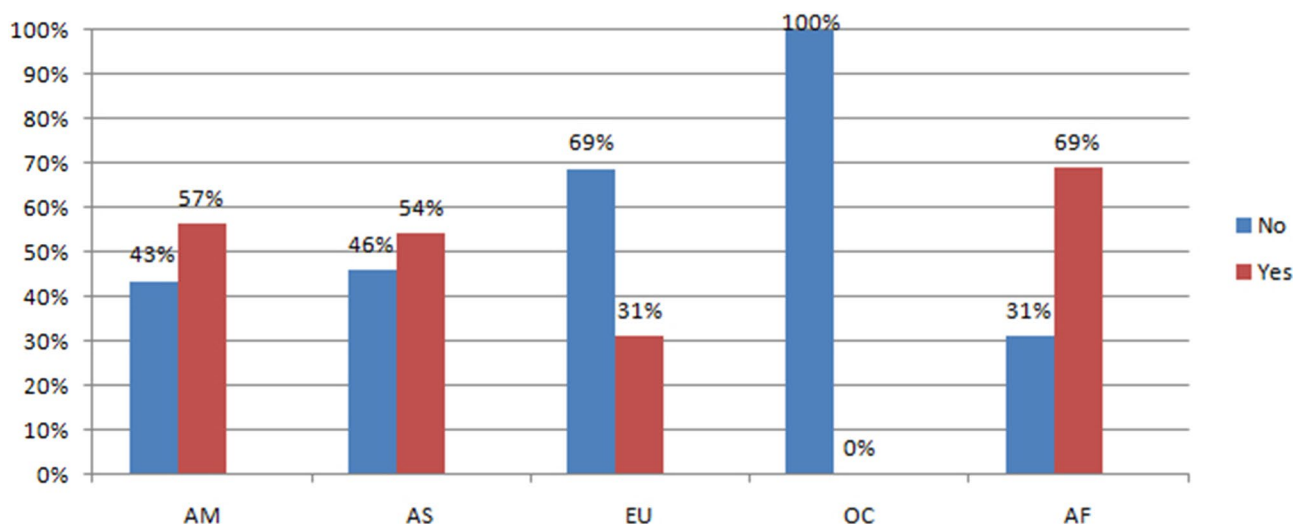
Overall, 494 responders (61%) of the sample reported that they would not always perform surgery, with higher

rates in surgeons from Oceania (100%) and Europe (69%) not always performing surgery, while a slight majority of surgeons from Africa (69%), America (57%) and Asia (54%) stated they always performed surgery ( $p < 0.00001$ ) (Fig. 1). There was no significant association with the number of ACLR performed per year. Age, sport type and cooperating profile were the most popular factors for ACLR decision, while gender was indicated only by 24% of responders. Importantly, the majority of surgeons surveyed (480–63%) would include ALL reconstruction only if diagnosed and remaining instability after ACL surgery or revision.

HT autograft was the graft of choice for most of the surveyed participants (634 [79%] in male patients and 674 [84%] in female patients), while its preference was lower (401–50%) when ACLR in professional athletes was considered. In total, 440 (55%) surgeons use the same graft regardless of the sport practiced. There was no statistically significant association between graft choice and number of reconstruction operations performed or geographic location by continent.

A total of 598 (75%) of respondents were in favor of anteromedial portal for femoral tunnel drilling and the single-bundle technique was preferred to the double-bundle technique.

Cortical suspension was the femoral fixation technique of choice by 500 (66%) responders, while a compression system was preferred on the tibial side by most of the surveyed surgeons (537–71%).



**Fig. 1** Correlation between geographic location by continent and preference to perform surgery always. AF Africa, AM America, AS Asia, EU Europe, OC Oceania

## Discussion

The most important finding of the present study was that a well-delineated trend among ESSKA responders favors ACLR with HT autograft, single-bundle reconstruction, anteromedial portal for femoral tunnel drilling, cortical suspension systems for femoral fixation and compression systems for tibial fixation.

Thirty-eight percent of responders declared they would always perform ACLR if clinically indicated, while the majority of clinicians surveyed would consider patients' characteristics such as age, sport type and cooperating profile to perform surgery. There is insufficient evidence to support whether ACLR reconstruction should be a mandatory part of ACL injury treatment algorithms. Some clinicians advocate early ACLR to prevent knee instability, and subsequently, new injuries to the menisci and cartilage [1, 23]. However, evidence that incidence of new meniscal tears is lower if ACL injury is treated with surgery is too low to guide surgical treatment decisions [5]. For these reasons, a treatment strategy tailored to the individual patient's needs and risk profile (activity level, instability/coping ability, additional injuries) has been advocated [5].

As hypothesized, HT autograft remains the graft of choice for ACLR. These results agree with the data from national ACLR registries (HT graft used in 92% of primary ACLR in Sweden, 84% in Denmark, [12] and 78% in New Zealand [21]) and national surveys [13]. The fact that the HT is the most utilized graft does not reflect the recent evidence of 1.4–2.5 times higher risk of revision observed with the HT graft compared with the PT graft among studies performed by nationwide ACLR registries [6, 12, 16, 18, 21, 22]. This higher failure rate of HT than PT grafts probably explains why HT grafts peaked to 84% for ACLR in Norway in 2010, declining to 77% in 2012, to 56% in 2014 and to 34% in 2016 [6].

When ACLR in professional athletes was considered, the preferences of respondents to the present survey were distributed almost evenly between PT and HT graft. Higher popularity of PT graft for professional athletes has been previously observed in two survey-based studies of National Football League (NFL) and National Collegiate Athletic Association (NCAA) Division-I team surgeons, with 86% stating that they would use a PT autograft for a starting running back [7], and of National Basketball Association (NBA) team physicians, with 81% reporting that they would use PT autograft in an NBA athlete [17]. A more recent study surveyed NCAA Division I football orthopedic team physicians in 2016, and compared responses with the same survey sent in 2008: the percentage of team physicians who preferred PT increased from 67 to 83% over the study period.[2]. It has to be

acknowledged that US clinicians historically support the PT utilization: conversely, ACLR with PT use rate in professional athletes has been observed to be 29.8% in France [27].

There was a clear majority of clinicians surveyed in favor of anteromedial portal for femoral tunnel drilling, in accordance with the trend highlighted by recent studies conducted using data on ACLR registries [9, 31]. The study by Tibor et al. showed that, between 2007 and 2014, surgeons from three states of the USA generally changed their femoral tunnel drilling technique from a transtibial approach to either an anteromedial portal or out-in approach [31]. The same trend has been observed in Europe, analyzing the Danish Knee Ligament Reconstruction Register, pointing out an important tendency to abandon the transtibial technique for the anteromedial one; the authors showed that the anteromedial technique has gone from being used in 11% of all ACLR in 2007 to 87% in 2015 [8]. Numerous studies have been published on postoperative clinical outcomes after primary ACLR when comparing different femoral hole techniques to support this relatively new trend [8, 24]. Regarding graft survivorship, while a few meta-analyses showed a trend toward lower failure rates when using the transtibial technique [4], the recent study by Eysturoy et al. compared the revision rates and clinical outcomes of anteromedial and transtibial techniques, using the Danish Knee Ligament Reconstruction Register, from two historical periods (2007–2010 and 2012–2015). The study found an increased risk of revision ACLR and rotational and sagittal instability 1 year postoperatively for the anteromedial technique in the period from 2007 to 2010; however, there was no significant difference in revision surgery and objective measures between the techniques from 2012 to 2015. The authors stated that these results could indicate that the higher revision rate in the period 2007–2010 may have been caused by a new technique learning curve [8].

Cortical suspension systems for femoral fixation and compression systems for tibial fixation were the preferred solution for the surveyed ESSKA members. The incidence rate of suspensory femoral fixation is consistent with recently described trends, with suspensory metal fixation for HT autograft ACLR increased 13% per year, from 37% in 2007 to 77% in 2014, according to the Kaiser ACLR registry [31]. A descriptive study of six national, regional and hospital-based ACL registries found that suspensory fixation was the most frequently used method of femoral fixation in Scandinavian countries and the UK, while interference fixation was more common in Luxembourg and the USA [20]. Suspensory fixation devices' popularity is mostly due to the simplicity of the graft implantation and excellent tensile strength afforded by the devices, associated with no difference in patient-reported outcome scores and knee laxity measures with other various fixation methods [29]. Conversely, suspensory fixation has been associated with higher rates of tunnel widening and

higher revision rates [9, 19]. A cohort study conducted using the Kaiser Permanente ACLR Registry found that crosspin or interference fixation on the femoral side coupled with an interference screw on the tibial side was associated with the lowest risk of aseptic revision [29]. Due to these findings, interference fixation devices on both the femoral and tibial sides may be the preferred method to mitigate the risk for outcomes requiring surgical intervention following ACLR. While these results correspond to the choices of the present survey responders from the tibial side, evidence-based femoral systems still have to be incorporated into clinical practice in the ESSKA members surveyed or more specific technical details should be investigated.

Another interesting data emerging from the survey, never explored in previous surveys, was that the majority of surgeons (63%) would perform an ALL reconstruction, when indicated. This represents an important adjustment of the surgical approach to the current biomechanical knowledge and clinical evidences. In fact, a recent multi-center international RCT showed that a lateral plasty associated with a standard ACLR is able to halve the risk of failure with respect to an isolated ACLR [11]. These results supported recent biomechanical studies that have demonstrated that normal knee kinematics are restored only by the addition of lateral extra-articular tenodesis or ALL reconstruction to the ACLR [10, 14], suggesting that anterolateral rotatory laxity results from a combination of injury to the ACL as well as the anterolateral complex and that in certain situations an ACLR alone may be unable to completely control anterolateral rotatory laxity. Therefore, lateral extra-articular tenodesis or ALL reconstruction may be necessary to restore rotation to normal.

This awareness of the European surgeon community confirms the attention to the new evidences and the readiness to accept the new insights to adapt surgical approaches and improve the patient's care. Further studies involving surgeons from different continents and with different backgrounds should confirm if the translation of emerging evidences into clinical practice is a global approach or is a more cultural/continental phenomenon.

The very low response rate constitutes the main limitation of the present survey study, with subsequent risk of a heavy non-response bias. The surveyed members and friends of ESSKA do not constitute the entire practicing orthopedic surgeons who perform ACLR, because only 8.4% of the target population responded to the survey. Therefore, the group that participated in this survey may not be representative of surgeons of the ESSKA community performing ACLR and the results of this study have to be considered a consensus opinion rather than the ESSKA current surgical practice patterns. However, it should be highlighted the higher number of responders when compared to recent surveys performed by the ESSKA, and surgeons not involved in knee surgery, non-orthopedic

members and no active members, this study may represent the best expression of the voice of the ESSKA community.

## Conclusions

This survey study found that HT autograft, single-bundle reconstruction, anteromedial portal for femoral tunnel drilling, cortical suspension systems for femoral fixation and compression systems for tibial fixation represent the current standard of ACLR in a large community of orthopedic surgeons. The present study performed with surgeons who are members of the ESSKA community will help to comprehend the actual ACLR worldwide practice patterns. Due to low response rate, these results should be interpreted with caution, and not to be intended to represent the state of the art of the ESSKA community.

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** This article does not contain any studies with human participants or animals performed by any of the authors.

## Appendix: Study questionnaire with summarized results

Q1 How many ACL reconstructions are you performing per year?		
Answer choices	Responses	
Less than 25	19.2%	156
25–50	29.5%	240
51–100	30.5%	248
More than 100	18.8%	153
I am not a surgeon	2.0%	17
Total		814
Q2 Do you always perform surgery?		
Answer choices	Responses	
Yes	38.6%	311
No	61.4%	494
Total		805

Q3 Which factors are important for your decision? (you can select more than one)

Answer choices	Responses	
Gender	24.2%	194
BMI	40.5%	325
Age	82.2%	660
Sport type	80.8%	649
Cooperating profile	63.6%	511
Psyche	44.1%	354
Total		803

Q4 When do you perform surgery?—Time criteria

Answer choices	Responses	
≤2 weeks	4.0%	32
2–4 weeks	16.7%	134
4–6 weeks	22.1%	177
≥6 weeks	24.0%	192
I do not refer to time criteria	33.2%	266
Total		801

Q5 When do you associate anterolateral ligament reconstruction?

Answer choices	Responses	
Always	23.8%	181
Never	13.2%	101
If diagnosed and remaining instability after ACL surgery or revision	63.0%	480
Total		762

Q6 What type of graft do you prefer to use in the reconstruction of the anterior cruciate ligament in male patients?

Answer choices	Responses	
Patellar tendon	16.0%	129
Hamstring tendons	78.9%	634
Quadriceps tendon	3.5%	28
Allograft	1.5%	12
Artificial ligament	0.1%	1
Total		804

Q7 What type of graft do you prefer to use in the reconstruction of the anterior cruciate ligament in female patients?

Answer choices	Responses	
Patellar tendon	10.7%	86
Hamstring tendons	84.0%	674
Quadriceps tendon	3.7%	30
Allograft	1.3%	10
Artificial ligament	0.3%	2
Total		802

Q8 What type of graft do you prefer to use in the reconstruction of the anterior cruciate ligament in professional athletes?

Answer choices	Responses	
Patellar tendon	39.4%	316
Hamstring tendons	50.0%	401
Quadriceps tendon	8.4%	67
Allograft	1.8%	14
Artificial ligament	0.5%	4
Total		802

Q9 Do you use the same graft regardless of the sport practiced?

Answer choices	Responses	
Yes	55.1%	440
No	44.9%	359
Total		799

Q10 What type of surgery you use preferably?

Answer choices	Responses	
Double bundle	8.0%	64
Single bundle	92.0%	737
Total		801

Q11 What type of surgery you use preferably to perform the femoral tunnel?

Answer choices	Responses	
Transtibial	11.4%	91
Anteromedial portal	74.8%	598
Out-in technique	13.9%	111
Total		800

Q12 What type of femoral fixation do you prefer to use?

Answer choices	Responses	
Compression	22.3%	169
Expansion	4.1%	31
Cortical suspension	66.1%	500
Cortico-cancellous suspension	7.5%	57
Total		757

Q13 What type of tibial fixation do you prefer to use?

Answer choices	Responses	
Compression	70.9%	537
Expansion	8.5%	64
Cortical suspension	15.1%	114
Cortico-cancellous suspension	5.6%	42
Total		757

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