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When is Anterolateral Complex Augmentation Indicated? Perspectives from the 2024 Freddie Fu Panther Sports Medicine Symposium

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Title

When is Anterolateral Complex Augmentation Indicated? Perspectives from the 2024 Freddie Fu Panther Sports Medicine Symposium

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TITLE

When is Anterolateral Complex Augmentation Indicated? Perspectives from the 2024 Freddie Fu Panther Sports Medicine Symposium

ABSTRACT

PURPOSE: To determine the trends and indications for anterolateral complex augmentation during anterior cruciate ligament reconstruction (ACL-R) among international orthopaedic sports surgeons.

METHODS: An electronically distributed survey was sent out to international surgeons with high-volume experience in complex ligament reconstructions and revision surgery attending the 2024 Freddie Fu Panther Sports Medicine Symposium. The survey was sent prior to the meeting with questions related to the use of lateral extra-articular tenodesis (LET) or anterolateral ligament reconstruction (ALL-R) during ACL-R. Sessions pertaining to anterolateral complex augmentation were held during the symposium to inform about current clinical practices among attendees.

RESULTS: A total of 49 surgeons were identified from 5 different geographic regions prior to the meeting date and sent an electronic survey, of which 48 responded (98% response rate). Among surgeons who reported performing anterolateral complex augmentation procedures (n=45), a total of 39 (87%) respondents reported using only the LET technique, 2 (4%) using only the ALL-R technique, and 4 (9%) using both techniques during ACL-R. The most common indication for anterolateral complex augmentation was a high-grade pivot shift, which 39/43 (91%) of respondents ranked in their top 3 indications. In the setting of primary ACL-R, respondents added a LET when using hamstring tendon autograft in 38% of cases on average compared with 34% of cases when using either bone-patellar tendon-bone autograft or quadriceps tendon autograft. In the setting of revision ACL-R, a LET was added in an average of 68% of cases for a first-time revision ACL-R and 84% of cases for a multiple revision ACL-R.

CONCLUSION: The most common indication for ACL-R with anterolateral complex augmentation was a high-grade pivot shift and most respondents preferred LET over ALL-R. Respondents performed LET in a comparable percentage of cases of primary ACL-R using hamstring tendon, bone-patellar tendon-bone and quadriceps tendon autografts and this number increased with the number of revision ACL-Rs. Based on the results of this survey, surgeons may consider adding a LET in cases of revision ACL-R or in patients with a high-grade pivot shift.

LEVEL OF EVIDENCE: Level V

KEY TERMS: ACL, lateral extra-articular tenodesis, anterolateral ligament reconstruction, revision surgery, rotatory instability

What are the new findings?

- The most commonly ranked indication for anterior cruciate ligament reconstruction with lateral extra-articular tenodesis was a high-grade pivot shift.
- Most orthopaedic sports surgeons preferred lateral extra-articular tenodesis (87%) over anterolateral ligament reconstruction (4%) for anterolateral complex augmentation.
- Lateral extra-articular tenodesis was performed in a comparable percentage of cases of primary anterior cruciate ligament reconstruction with different autograft types, but more frequently as the number of revision surgeries increased.

INTRODUCTION

Anterior cruciate ligament (ACL) reconstruction (ACL-R) can in most cases successfully restore knee stability in ACL deficient patients; however, ACL graft failure after ACL-R may approach up to 20% in high-risk individuals (i.e. young age, female sex, competitive athlete participating in pivoting sports) [1,2]. ACL graft failure often leads to worsening chondral and meniscal injury which can have long-term consequences both with respect to return to play for the patient but also to the risk of developing post-traumatic osteoarthritis and overall long-term health of the knee joint [3,4]. As such, strategies to reduce the risk of ACL graft failure and associated complications are evolving. Anterolateral complex augmentation during ACL-R has been used in attempt to decrease ACL graft failure rates [5,6]. Historically, descriptions of an anterolateral complex date back to 1829 and anterolateral complex augmentation can first be traced back to Lemaire who described an iliotibial band tenodesis for ACL deficiency in 1967 [7,8]. Procedures involving the anterolateral complex gained renewed interest in 2013 following the description of an “anterolateral ligament” (ALL) [9].

Two common techniques for anterolateral complex augmentation include various forms of lateral extra-articular tenodesis (LET) and anterolateral ligament reconstruction (ALL-R). The modified Lemaire LET technique uses a strip of the iliotibial band and attaches the proximal end to segment on the lateral femoral condyle, leaving the native distal insertion at Gerdy’s tubercle intact [8,10]. Various ALL-R techniques have been described, but most involve reconstruction using a free autograft or allograft with fixation at both the lateral femoral condyle and anterolateral proximal tibial near the anterolateral complex insertion [11].

There have been several studies demonstrating that anterolateral complex augmentation leads to decreased ACL graft failure rates following ACL-R [5,6,12-14]. Notably, the

STABILITY trial demonstrated the addition of a LET procedure decreased the rate of ACL graft failure and persistent rotatory knee instability in high-risk patients (<25 years old, pivot shift grade ≥2, participation in high risk/pivoting sports, and having generalized ligamentous laxity) when using hamstring tendon (HS) autograft for ACL-R [5]. However, patients in the isolated ACL-R cohort had less pain post-operatively and less hardware irritation than those patients who underwent the LET procedure [5]. Results of the STABILITY trial have produced recommendations to add a LET for young athletes in pivoting sports undergoing primary ACL-R with HS autograft [15]. A similar follow-up study is currently being performed analyzing those patients who undergo ACL-R using bone-patellar tendon-bone (BPTB) or quadriceps tendon (QT) autografts [16]. In the revision setting, a recent meta-analysis of 10 studies found improved International Knee Documentation Committee Subjective Knee Forms (IKDC SKF) scores, better restoration of rotatory knee instability, and smaller side-to-side differences in those patients who had revision ACL-R with anterolateral complex augmentation compared with those patients who had isolated revision ACL-R [17].

Risk factors for persistent rotatory knee instability after ACL-R and ACL graft failure include younger patients with joint hyperlaxity, female sex, those who engage in high-risk pivoting activities (for example: soccer, basketball, and handball), and increased posterior tibial slope [18,19]. However, the appropriate indication for anterolateral complex augmentation is not yet clearly defined for both primary and revision ACL-R. The purpose of this study was to determine the trends and current indications for anterolateral complex augmentation during ACL-R among high-volume international sports orthopaedic surgeons.

METHODS

This study did not require institutional review board approval as it does not involve human subjects. A survey was administered to a group of high-volume orthopaedic sports surgeons trained in knee and/or sports medicine surgery attending an international sports medicine conference. Surgeons were invited to the 2024 Freddie Fu Panther Sports Medicine Symposium (Pittsburgh, PA) in June 2024 in which presentations, panel discussions, debates and live demonstrations took place to discuss the current practices in ACL surgery. Health care providers and educators who attended the conference without specific training in orthopaedic surgery (i.e. non-operative sports medicine physicians, physical therapists, and athletic trainers) were not included in the survey, but were invited to attend in-person discussion sessions.

The survey questions were drafted by members of the symposium organization committee specific to practice patterns in terms of the use of anterolateral complex augmentation procedures (LET and ALL-R). Questions included self-reported estimates of annual primary and revision ACL-R volume, ACL graft preferences in different clinical scenarios, indications for anterolateral complex augmentation, and preferences for anterolateral complex augmentation technique (LET or ALL-R). Surgeons were asked their ACL graft preferences in primary and revision settings for younger athletes <26 years old and older athletes ≥35 years old as patient age is the strongest predictor of graft choice [20] and the rate of revision ACL-R increases by over 3 fold in the <26 years group [21].

The survey was administered to invited surgeons prior to the symposium via e-mail. A link to the survey questionnaire was provided and responses were recorded anonymously and analyzed using a web-based software (Qualtrics, Provo, UT). Questions were asked with responses given in either a multiple choice, priority rank list, or Likert scale format. An anonymous link was initially distributed to surgeons on 10/27/2023 with a follow-up reminder sent via email two weeks later on 11/10/2023. A total of 49 surgeons met inclusion criteria and were invited to complete the survey, 48 of which responded (98% response rate) from 5 different geographic regions. A copy of survey questions used for the study can be found in the supplementary material (Supplementary Figure 1).

Sessions entitled “Anterolateral Instability and ACL” and “LET/ALL” were held during the symposium with presentations and case discussions about the use of LET/ALL-R in the setting of ACL-R. Discussion points from attendees in terms of the management of anterolateral and rotatory knee instability in the setting of an ACL injury were additionally reviewed in this study.

Statistical analyses

Descriptive statistics were used to characterize survey response data. Continuous data (i.e. surgeon estimates of number or percent of cases) are presented as means and standard deviations with 95% confidence intervals, whereas categorical data (i.e. number of responses) are presented as counts and percentages. A Mann-Whitney U test was performed to compare differences in the rate of self-reported LET use between cases of first and multiple revision ACLR. A Chi-Square analysis was performed to determine differences in surgical volume, ACL graft preferences, and the likelihood of adding anterolateral complex augmentation between surgeons who exclusively perform LET and surgeons who perform any ALL-R. Annual surgical volume was estimated by survey respondents and inputted into the analysis as a binary variable based on the mean annual volume for all respondents. A post-hoc power analysis of the Chi-Square analysis was performed to estimate the power of observed associations with a power >0.800 at an alpha of 0.050 indicating sufficient power to detect statistical significance.

Descriptive statistics were calculated using Microsoft Excel (Microsoft, Redmond, WA). Statistical analyses were performed using SPSS (version 29.0.1.0, IBM) and statistical significance was defined as $P \leq 0.050$.

RESULTS

Of the 48 respondents, 21 (44%) were from North America, 16 (33%) from Europe, 8 (17%) from Asia/Oceania, 2 (4%) from South America and 1 (2%) from Africa. The mean number of self-reported primary ACL-Rs was 127 cases annually and 30 (63%) respondents performed ≥100 primary ACL-Rs per year. Regarding primary ACL-R among younger athletes age <26 years of age, 24 (45%) surgeons preferred BPTB autograft, 16 (30%) HS autograft, and 12 (23%) QT autograft. There were no respondents who selected allograft for patients age <26 years old. Among older athletes (age ≥35 years old), 28 surgeons (56%) preferred HS autograft, while 12 (24%) and 6 (12%) preferred QT and BPTB autografts, respectively. Allograft was preferred in 3 (6%) respondents for older athletes (Figure 1A). For cases of revision ACL-R in younger athletes age <26 years old, 28 (52%) favored BPTB autograft, 18 (33%) QT autograft, 7 (13%) HS autograft, and no respondents (0%) selected allograft. Among older athletes age ≥35 years old undergoing revision ACL-R, 16 (31%) opted for BPTB autograft, 14 (27%) QT autograft, 10 (20%) HS autograft, and 10 (20%) allograft. One respondent (2%) preferred using an artificial ACL graft in all clinical scenarios, including both primary and revision ACL-R.

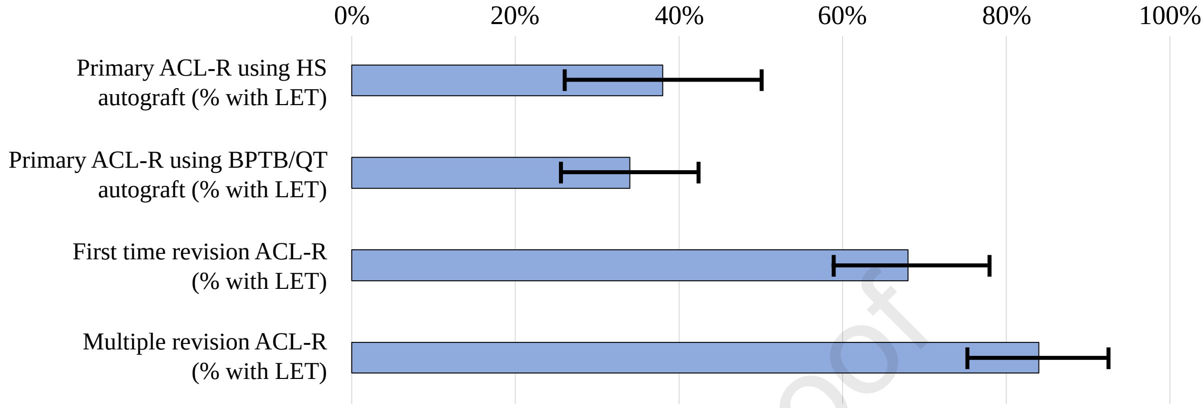
A total of 46 (94%) surgeons responded to the question asking if they perform anterolateral complex augmentation during ACL-R when indications are met, one of whom reported never performing the procedure. In terms of anterolateral complex augmentation technique preferences among surgeons who do perform the procedure, 39 (87%) of the surgeons exclusively performed LET, 2 (4%) exclusively ALL-R, and 4 (9%) both LET and ALL-R

(Figure 1B). When provided primary ACL-R case scenarios and asked about LET use, respondents estimated adding a LET when using HS autograft for ACL-R in an average of 38% of cases, whereas a LET would be added during primary BPTB or QT autograft ACL-R in an average of 34% of cases (Table 1). For revision ACL-R, respondents estimated adding a LET in the setting of a first-time revision ACL-R in an average of 68% of cases and in an average of 84% of cases involving a multiply revised ACL-R (P=0.003,Table 1). When asked about reasons for ACL graft failure, incorrect tunnel positioning was estimated to be present in 53% of cases on average. If a revision ACL-R case involved transitioning from a non-anatomic to an anatomic femoral tunnel placement for the ACL graft, 28/44 respondents (64% of those who both responded and perform anterolateral complex augmentation) reported adding a concomitant LET "always" or "most of the time." If a revision case involved changing the failed ACL graft from an allograft to an autograft, 28/42 respondents (67% of those who both responded and perform anterolateral complex augmentation) would add a LET "always" or "most of the time" (Table 1). Only 1 respondent reported "never" adding a LET in the above scenarios, whereas the remaining reported "occasionally" adding a LET.

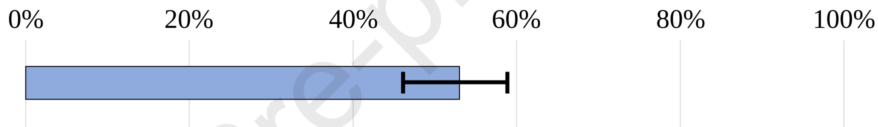
A question asking respondents to rank in order of priority their indications for ACL-R with a concomitant LET in order of priority revealed a high-grade pivot shift to be most commonly ranked as the top indication for 22 respondents (51%), followed by cases of multiple revision ACL-R for 15 respondents (35%), and younger age for 3 respondents (7%). High-grade pivot shift, revision ACL-R, and younger age were also most commonly ranked in the top 3 indications for adding a LET (Table 2).

Table 1: Survey responses for self-reported LET use

"For the below scenarios, please estimate the percent of cases that you perform a concomitant LET."



"In what percent of your revision ACL-Rs do you find wrong tunnel placement?"



"For revision ACLR, do you add a LET in the following scenarios?"

	Always	Most of the time	Occasionally	Never
Changing graft from allograft to autograft	29% (n=12)	38% (n=16)	31% (n=13)	2% (n=1)
Changing tunnel placement from non-anatomic to anatomic	25% (n=11)	39% (n=17)	34% (n=15)	2% (n=1)

ACL-R: anterior cruciate ligament reconstruction, LET: lateral extra-articular tenodesis, HS: hamstring tendon, BPTB: bone-patellar tendon-bone, QT: quadriceps tendon. Percent of cases presented as the mean of all responses with 95% confidence intervals. Responses from two surgeons who indicated they do not perform LET were omitted.

The Chi Square analysis did not reveal any statistically significant differences in practice patterns between surgeons who reported exclusively performing LET and surgeons who reported performing any ALL-R (Table 3). There were no differences in primary (P=0.686) or revision (P=1.000) ACL-R volume between the two groups compared to the mean number of annual cases. There were no differences in the rate of preference for HS autograft in different clinical scenarios including primary ACL-R in a younger athlete <26 years old (P=0.110), primary ACL-R in an older athlete ≥35 years old (P=0.371), revision ACL-R in a younger athlete <26 years old

(P=0.488), and revision ACL-R in an older athlete ≥35 years old (P=1.000). Surgeons from the LET and ALL-R groups also reported performing anterolateral complex augmentation at comparable rates during cases of revision ACL-R that involve alternative reasons for ACL graft failure, including revising an allograft to autograft or revising non-anatomic tunnels to anatomic (Table 3). The post-hoc power analysis demonstrated that all analyses comparing practice patterns between LET and ALL-R failed to reach a power >0.800, indicating that they were underpowered to detect statistically significant differences.

Table 2: Indications for LET

Survey question	Ranked #1 indication % (n)	Ranked in top 3 indications % (n)
Rank your top indications for performing a lateral augmentation procedure*		
High grade pivot shift	51% (n=22)	91% (n=39)
Multiple revision ACL-R	35% (n=15)	63% (n=27)
Revision ACL-R	2% (n=1)	63% (n=27)
Younger age	7% (n=3)	42% (n=18)
Competitive athlete	0% (n=0)	23% (n=10)
Any ACL injury	2% (n=1)	12% (n=5)
Older age	0% (n=0)	2% (n=1)
Recreationally active	0% (n=0)	0% (n=0)
Primary ACL-R	0% (n=0)	0% (n=0)

ACL: anterior cruciate ligament, ACL-R: anterior cruciate ligament reconstruction, LET: lateral extra-articular tenodesis.
**Question asked in a drag and drop format in which respondents select top indications (10 available choices) to the top of the screen. Surgeons who do not perform anterolateral complex augmentation procedures were asked to rank "I do no perform lateral augmentation procedures" as #1 (n=1). A total of 43 responses were recorded for this question.*

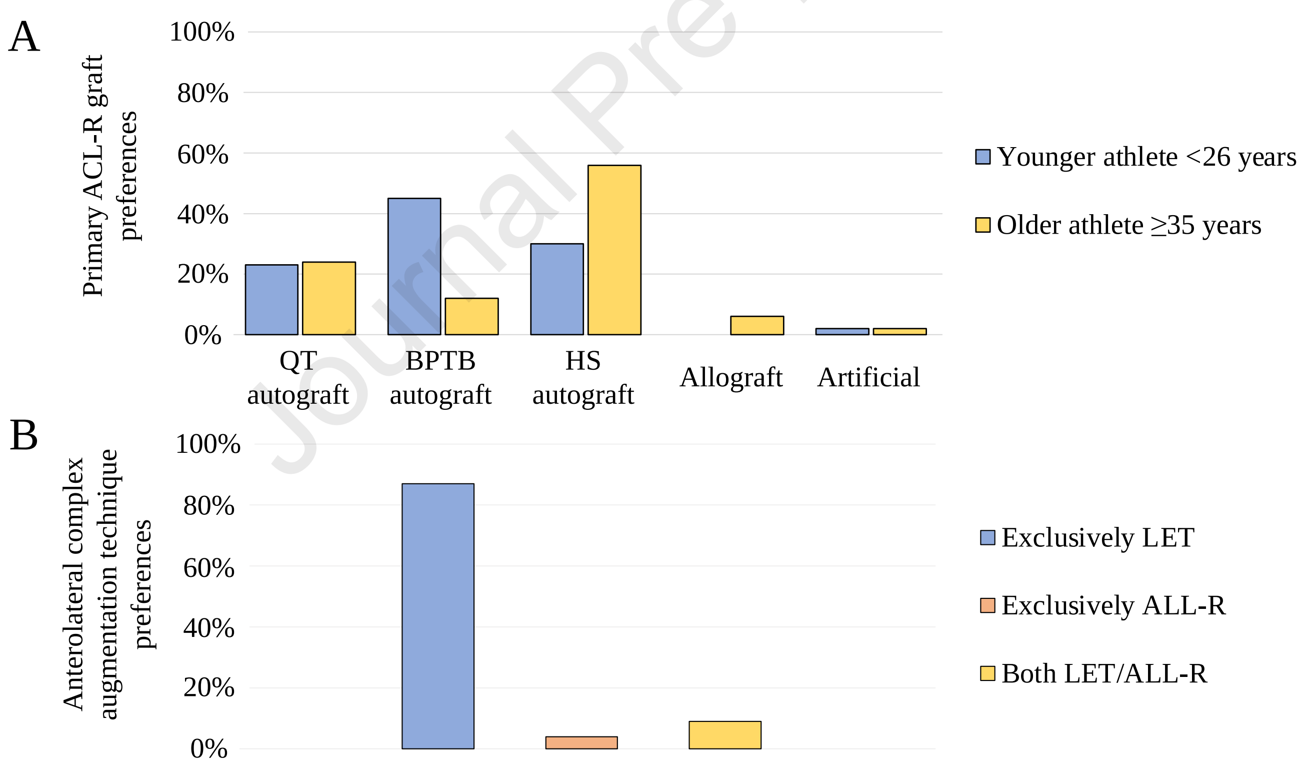
Table 3: Practice patterns based on anterolateral complex augmentation technique preferences

	Perform LET exclusively	Perform any ALL-R	P value	Estimated power (post-hoc analysis)
Surgeon volume				
Primary ACLR volume ≥127 cases annually	41% (n=16/39)	50% (n=3/6)	0.686	0.073
Revision ACLR volume ≥32 cases annually	33% (n=13/39)	40% (n=2/5)	1.000	0.067
Graft preference for HS autograft in below scenarios:				

Primary ACLR in a younger athlete <26 years old	22% (n=8/36)	60% (n=3/5)	0.110	0.437
Primary ACLR in an older athlete ≥35 years old	54% (n=20/37)	80% (n=4/5)	0.371	0.151
Revision ACLR in a younger athlete <26 years old	11% (n=4/37)	20% (n=1/5)	0.488	0.146
Revision ACLR in an older athlete ≥35 years old	21% (n=8/38)	17% (n=1/6)	1.000	0.043
Would add anterolateral complex augmentation for revision ACLR in below scenarios:				
Revising allograft to autograft	68% (n=25/37)	60% (n=3/5)	1.000	0.072
Revising non-anatomic tunnels to anatomic	64% (n=25/39)	60% (n=3/5)	1.000	0.057

ACL-R: anterior cruciate ligament reconstruction, LET: lateral extra-articular tenodesis, ALL-R: anterolateral ligament reconstruction, HS: hamstring tendon. Surgeon volume cutoff values determine by the mean of all responses. P value <0.050 indicates a statistically significant difference, estimated power >0.800 indicates sufficient power to detect statistical significance.

Figure 1: Surgeon reported preferences for ACL graft and anterolateral complex augmentation



ACL: anterior cruciate ligament, ACL-R: anterior cruciate ligament reconstruction, QT: quadriceps tendon, BPTB: bone-patellar tendon-bone, HS: hamstring, LET: lateral extra-articular tenodesis, ALL-R: anterolateral ligament reconstruction. One respondent reported using an artificial ACL graft for both scenarios and no respondents reported using hybrid ACL grafts.

DISCUSSION

The most important finding of this study was that a high-grade pivot shift was most commonly ranked as the top indication for adding a LET or ALL-R during ACL-R among included surgeons. Secondary findings included the much less frequent use of ALL-R compared to LET for anterolateral complex augmentation and similar rates of LET when using HS versus BPTB or QT autograft for ACL-R. The self-reported rate of LET use exceeded 60% in the setting of revision ACL-R even in cases where primary ACL-R failure could be attributed to other causes including graft choice (revising an allograft to an autograft) and tunnel malposition (revising non-anatomic tunnels to anatomic). This study explored ACL graft preferences during primary and revision ACL-R and found a higher percentage of BPTB autograft use in younger athletes (<26 years old) undergoing primary or revision ACL-R, HS autograft use in older athletes (≥35 years old) undergoing primary ACL-R, and mixed preferences for any autograft in older athletes undergoing revision ACL-R.

The results of this study identified the presence of a high-grade pivot shift test as the most common indication for utilization of LET or ALL-R, with 51% of included surgeons listing this finding as their primary indication. This reflects the current biomechanical and clinical data that suggest increased rotatory knee instability represents an element of anterolateral instability that may not be completely restored with ACL-R alone [22-24]. LET or ALL-R may address this rotatory knee instability and reduce ACL graft failure rates following revision ACL-R [25]. Moreover, multiple biomechanical studies have shown that anterolateral complex augmentation in the setting of ACL-R reduces rotatory knee instability and can restore intact knee kinematics [26-28]. These findings have been further supported by consensus groups, including the Anterolateral Ligament Expert Group as evidence continues to grow since the original description of the ALL [9,29]. However, it should be noted that residual rotatory knee instability may also be due to non-anatomic tunnel placement. A prior study evaluating tunnel placement on magnetic resonance imaging following ACL-R found more vertical femoral and tibial tunnel positioning among patients who had a residual pivot shift without definite anteroposterior laxity [30]. In cases of revision ACL-R that involve revising non-anatomic tunnels to anatomic tunnels, anterolateral complex augmentation may be unnecessary to restore rotatory knee stability.

The results of this study demonstrated that 39 (87%) of the included surgeons exclusively utilized the LET technique for anterolateral complex augmentation compared to only 2 (4%) who exclusively utilized the ALL-R technique, while 4 (9%) utilized both techniques. When comparing the LET, in which a strip of the iliotibial band is passed deep to the lateral collateral ligament, to ALL-R, in which a free graft is attached to the femur and tibia while passing deep to the ITB and superficial to the lateral collateral ligament, one must consider biomechanical and clinical differences. Clinically, ALL-R can be more technically demanding than LET and involve additional tunnels, which may increase the risk of complications. ALL-R has also been shown to have a longer operative time and be more costly than LET [31].

From a biomechanical perspective, both LET and ALL-R techniques can effectively restore intact knee kinematics following ACL-R [24-26], although LET may better restore kinematics compared to ALL-R [32]. However, there is conflicting data evaluating lateral compartment mobility and contact forces following these procedures. For example, one study compared LET and ALL-R in 6 cadaveric knees and found that both techniques were similar in restoring intact knee kinematics and neither resulted in excessive limitations to lateral compartment anterior tibial translation or internal rotation [33]. A separate study comparing LET to ALL-R in four cadaveric knees found that although both techniques re-established intact knee kinematics following ACL-R, LET caused increased lateral compartment contact pressures during internal knee rotation [34]. Another cadaveric study utilized 10 paired cadaveric knees to compare ACL-R with LET and ALL-R and found significant improvement in tibiofemoral motion throughout knee range of motion, but also evidence of limited tibial internal rotation compared to the intact state with both techniques [28]. Limited tibial internal rotation within the lateral compartment may have clinical implications postoperatively, including excessive forces that may lead to lateral compartment osteoarthritis. For example, one study has shown evidence of detrimental cartilage changes on magnetic resonance imaging (MRI) following LET [35], whereas another showed only small differences in cartilage signals which may not be correlated with clinical outcomes [36]. While reasons for technique preferences were not investigated in this study, the LET may also offer advantages of decreased surgical time, avoidance of the use of a free graft, and reduced cost when compared with ALL-R [31]. Furthermore, surgeons may prefer LET over ALL-R for anterolateral complex augmentation due to some biomechanical evidence showing improved restoration of rotatory knee stability and anterior tibial translation with LET compared to ALL-R [28,32].

One unanticipated finding in this study was that in the setting of primary ACL-R, the included surgeons utilized LET at similar rates regardless of ACL graft choice, with surgeons adding a LET in an average of 38% of cases of primary ACL-R with HS autograft and 34% of cases of primary ACL-R with either QT or BPTB autograft. While the STABILITY trial showed a significant reduction in ACL graft failure rates when LET was performed concomitantly with primary HS autograft ACL-R, the same level of evidence currently does not exist to support its use during primary BPTB or QT autograft ACL-R [5]. However, a recent retrospective cohort study directly compared 36 matched patients undergoing revision BPTB autograft ACL-R with

LET to revision HS autograft ACL-R with ALL-R, finding that adding LET to both autograft options resulted in similar reduction of failure rates [37]. It should be noted that the STABILITY 2 Trial is a multicenter randomized trial currently evaluating the effects of a LET during primary ACL-R with QT and BPTB autografts (ClinicalTrials.gov ID: NCT03935750) [16]. The similar rates of LET use for primary ACL-R with either HS, QT or BPTB autografts was unanticipated since there is a discrepancy in the strength of evidence for LET with HS autograft compared to QT and BPTB autografts. A high powered randomized controlled trial has shown the reduced failure rate of primary ACL-R with LET for cases with HS autograft, whereas cases with QT and BPTB autografts are limited to retrospective cohorts and underpowered randomized trials [5,14,37,38]. Results of STABILITY 2 and other high powered randomized controlled trials will allow for a better comparison of LET efficacy between grafts and may subsequently influence clinical practice trends.

The results of the present study also showed that included surgeons utilized LET in an average of 68% of cases of a first-time revision ACL-R, and in 84% of cases involving a multiple revision ACL-R. Moreover, when presented with certain clinical scenarios for revision ACL-R, 67% responded that they would perform LET “always or mostly” when changing the ACL graft from allograft to autograft in revision ACL-R, and 64% responded that they would perform LET “always or mostly” even if non-anatomic tunnels were encountered and corrected in revision ACL-R. These results further suggest that even if in the setting of a clear cause for primary ACL-R failure, such as tunnel malposition or poor graft selection (i.e. use of allograft in a young athlete), surgeons are performing LET during revision ACL-R at high rates. While reasons for these responses were not provided in this study, these results reflect surgeon caution when performing revision ACL-R and reliance on current biomechanical and clinical evidence that show a benefit to adding a LET [5,22-23,25-28]. However, further biomechanical and clinical studies investigating the impact of correcting a clear cause of ACL graft failure (i.e. correcting tunnel position to anatomic, reducing the posterior tibial slope via a slope-reducing osteotomy, changing ACL graft from allograft to autograft, etc...) versus adding a LET may provide clinical guidance for revision ACL-R.

This study has a few limitations. The use of survey data to obtain results allows for an expert panel of providers to provide independent assessments of clinical case scenarios but lacks statistical comparisons and relies strongly on clinical experience. Survey data may also be subject to various self-reporting biases, including an over- or underestimation of current surgical practices for ACL-R. A failure of survey responses to accurately capture true indications and practice patterns for anterolateral complex augmentation during ACL-R may be present, although it provides insight into general trends. Providers who participated in the symposium also practice in various geographical regions internationally and various types of athletes/sports that are primarily treated, which can influence practice patterns and be another source of bias. The survey failed to include questions about complications from anterolateral complex augmentation procedures, although these are well described in the literature and include hardware irritation, need for subsequent surgery to remove hardware, limited mobility and increased contract pressures within the lateral compartment, and a potentially increased risk of lateral compartment osteoarthritis [34-36,39]. Comparisons between practice trends among surgeons who perform LET or ALL-R were also underpowered due to the low number of ALL-R responses.

CONCLUSION

The most common indication for ACL-R with anterolateral complex augmentation was a high-grade pivot shift and most respondents preferred using the LET technique over ALL-R.

Respondents performed LET in a comparable percentage of cases of primary ACL-R using HS, BPTB and QT autografts, and this number increases with the number of revision ACL-Rs. Based on the results of this survey, surgeons may consider adding a LET in cases of revision ACL-R or in patients with a high-grade pivot shift.

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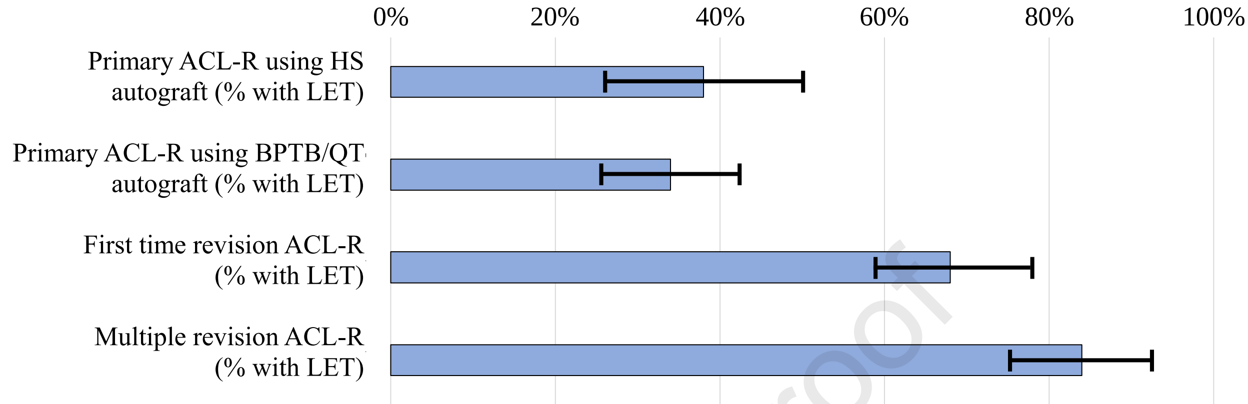
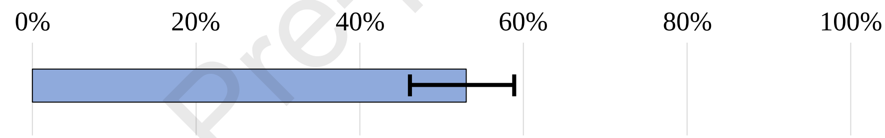
Table 1: Survey responses for self-reported LET use

"For the below scenarios, please estimate the percent of cases that you perform a concomitant LET."



"In what percent of your revision ACL-Rs do you find wrong tunnel placement?"



"For revision ACL-R, do you add a LET in the following scenarios?"

	Always	Most of the time	Occasionally	Never
Changing graft from allograft to autograft	29% (n=12)	38% (n=16)	31% (n=13)	2% (n=1)
Changing tunnel placement from non-anatomic to anatomic	25% (n=11)	39% (n=17)	34% (n=15)	2% (n=1)

ACL-R: anterior cruciate ligament reconstruction, LET: lateral extra-articular tenodesis, HS: hamstring tendon, BPTB: bone-patellar tendon-bone, QT: quadriceps tendon. Percent of cases presented as the mean of all responses with 95% confidence intervals. Responses from two surgeons who indicated they do not perform LET were omitted.

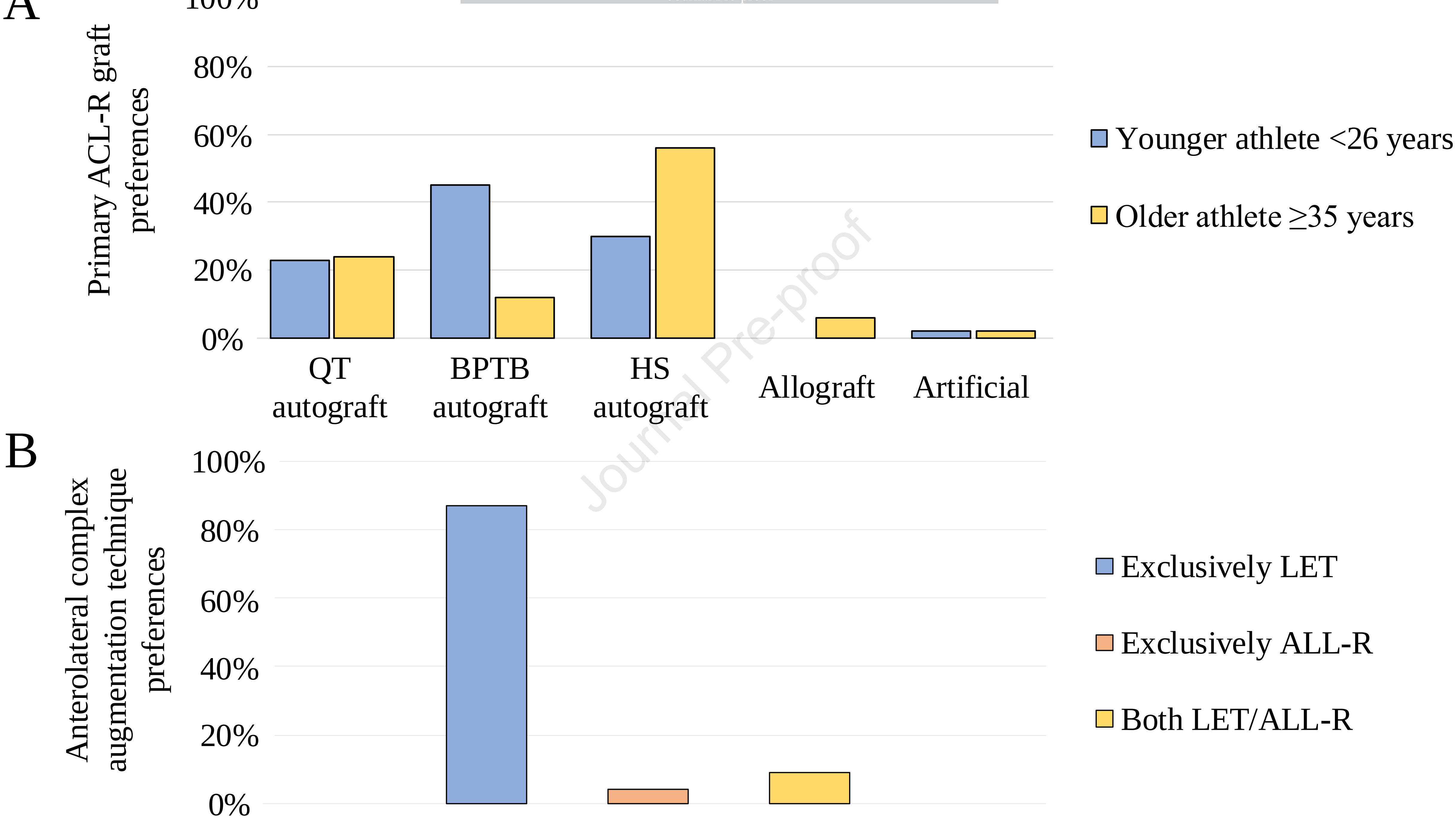

A
Primary ACL-R graft preferences
100%
80%
60%
40%
20%
0%
QT autograft
BPTB autograft
HS autograft
Allograft
Artificial
Younger athlete <26 years
Older athlete ≥35 years
B
Anterolateral complex augmentation technique preferences
100%
80%
60%
40%
20%
0%
Exclusively LET
Exclusively ALL-R
Both LET/ALL-R

Figure 1: Surgeon reported preferences for ACL graft and anterolateral complex augmentation

ACL: anterior cruciate ligament, ACL-R: anterior cruciate ligament reconstruction, QT: quadriceps tendon, BPTB: bone-patellar tendon-bone, HS: hamstring, LET: lateral extra-articular tenodesis, ALL-R: anterolateral ligament reconstruction. One respondent reported using an artificial ACL graft for both scenarios and no respondents reported using hybrid ACL grafts.

Declaration of interests

☐ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☒ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

BPL received payment from Mid-Atlantic Surgical Systems for education. JDH has received grant support from Arthrex, education payments from Mid-Atlantic Surgical Systems and Smith + Nephew, and hospitality payments from SI-BONE and Stryker and is on the editorial board of Knee Surgery, Sports Traumatology, Arthroscopy (KSSTA). JJI is President of the Board of Directors for the Journal of Orthopaedic and Sports Physical Therapy (JOSPT). VM received consulting fees from Smith & Nephew and Newclip, educational fees from Arthrex, DePuy Synthesis, and Conmed, and is a board member of the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS), and the Assistant editor-in-chief of Knee Surgery, Sports Traumatology, Arthroscopy (KSSTA). VM has a patent, U.S. Patent No. 9,949,684, issued on April 24, 2018, to the University of Pittsburgh. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.