Knee Surgery, Sports Traumatology, Arthroscopy (2021) 29:4286–4295
https://doi.org/10.1007/s00167-021-06550-7

KNEE

Same knee, different goals: patients and surgeons have different priorities related to ACL reconstruction

Hana Marmura[1,2,3,4] · Dianne M. Bryant[1,2,3,4,5,6] · Trevor B. Birmingham[1,3,7] · Anita Kothari[1] · Kurt P. Spindler[8] · Christopher C. Kaeding[9] · Tim Spalding[10] · Alan M. J. Getgood[1,2,3,4,5]

Received: 8 October 2020 / Accepted: 25 March 2021 / Published online: 19 April 2021

Abstract

Purpose The priorities of patients should be shared by those treating them. Patients and surgeons are likely to have different priorities surrounding anterior cruciate ligament reconstruction (ACLR), with implications for shared decision-making and patient education. The optimal surgical approach for ACLR is constantly evolving, and the magnitude of treatment effect necessary for evidence to change surgical practice is unknown. The aim of this study was to determine (1) the priorities of surgeons and patients when making decisions regarding ACLR and (2) the magnitude of reduction in ACLR graft failure risk that orthopaedic surgeons require before changing practice.

Methods This study followed a cross-sectional survey design. Three distinct electronic surveys were administered to pre-operative ACLR patients, post-operative ACLR patients, and orthopaedic surgeons. Patients and surgeons were asked about the importance of various outcomes and considerations pertaining to ACLR. Surgeons were asked scenario-based questions regarding changing practice for ACLR based on new research.

Results Surgeons were more likely to prioritize outcomes related to the surgical knee itself, whereas patients were more likely to prioritize outcomes related to their daily lifestyle and activities. Knee instability and risk of re-injury were unanimous top priorities among all three groups. A mean relative risk reduction in ACLR graft failure of about 50% was required by orthopaedic surgeons to change practice regardless of the type of change, or patient risk profile.

Conclusion There are discrepancies between the priorities of surgeons and patients, and orthopaedic surgeons appear resistant to changing practice for ACLR.

Level of evidence IV.

Keywords Anterior cruciate ligament · ACL reconstruction · Surgical practice · Failure · Outcome · Risk · Shared decision-making · Young patients

Abbreviations

ACL	Anterior cruciate ligament
ACLR	Anterior cruciate ligament reconstruction
ACLSG	ACL Study Group
RD	Risk difference
RRR	Relative risk reduction

✉ Alan M. J. Getgood
alan.getgood@uwo.ca

1 Faculty of Health Sciences, Western University, London, ON, Canada

2 Fowler Kennedy Sport Medicine Clinic, London, ON, Canada

3 Bone and Joint Institute, Western University, London, ON, Canada

4 Lawson Research, London Health Sciences Centre, London, ON, Canada

5 Department of Surgery, Schulich School of Medicine and Dentistry, London, ON, Canada

6 Department of Health Research Methods, Evidence and Impact, McMaster University, Hamilton, ON, Canada

7 Wolf Orthopaedic Biomechanics Lab, Fowler Kennedy Sport Medicine Clinic, London, ON, Canada

8 Orthopaedic Surgery, Cleveland Clinic, Cleveland, Ohio, USA

9 Department of Orthopaedics, The Ohio State University, Ohio, USA

10 Department of Orthopaedics, University Hospital Coventry and Warwickshire NHS Trust, Coventry, UK

CI	Confidence interval
RCTs	Randomized clinical trials
OA	Osteoarthritis

Introduction

The rate of graft rupture following anterior cruciate ligament (ACL) reconstruction (ACLR) varies from 2 to 11%, depending on surgical technique and patient characteristics [21]. The rate of clinical graft failure, encompassing rupture or symptomatic instability, can be as high as 40% [10]. Younger age and participation in sports are two main risk factors for ACL injuries [17]. Unfortunately, these individuals are also more likely to sustain a further injury and require revision surgery [21, 22]. The risk of suffering either a graft rupture or contralateral ACL injury requiring surgery following primary ACLR in patients under 20 can reach 29% [21] . Subsequent surgeries can worsen outcomes, reduce quality of life, and place economic strain on the healthcare system [12, 14, 23]. Thus, significant research efforts continue with the aim of preventing the failure of ACLR grafts and improving patient outcomes.

With this in mind it is important to acknowledge the perspectives and priorities of patients undergoing ACLR. In studies aiming to make treatment recommendations, a greater emphasis has been placed on primary outcomes that are important to patients [1]. While surgeons strive for optimal clinical outcomes, patients are the ones who must lead their lives following reconstructive surgery. This may lead patients to prioritize different outcomes than surgeons. Information regarding these discrepancies is needed to determine where emphasis should be placed in clinical research.

There is no clear consensus regarding one optimal surgical approach for ACL injury, as clinical practice guidelines support the use of multiple techniques [3]. This makes evidence-based practice somewhat ambiguous and emphasizes the need for individualized treatment decisions. Surgeons must develop a treatment plan that encompasses three elements: evidence, clinical expertise, and patient preferences [11].

Studies investigating surgical methods to improve outcomes following ACLR provide minimal benefits to patients when surgeons do not incorporate the findings into their practice. The point at which these evidence-based practice changes occur has not been well established. Significant time, effort, and resources are dedicated to answer questions believed to be both clinically relevant and beneficial to patients and the healthcare system. Therefore, it seems reasonable to ask how large the treatment effects of studies must be to warrant adoption into practice.

The purpose of our study was to determine (1) the outcomes surgeons and patients prioritize when making decisions regarding ACLR and (2) the magnitude of reduction in ACLR graft failure risk that orthopaedic surgeons require before changing practice, in patients with different risk profiles. It was hypothesized that surgeons would prioritize clinical adverse event outcomes while patients would prioritize return to sport/activity outcomes. Secondly, it was thought that a 40% relative risk reduction in graft failure may be sufficient in influencing surgeons to change practice for ACLR, based on a 10–40% absolute risk of graft failure (rupture or persistent instability) observed in the literature [10, 15, 21].

Materials and methods

This study was granted ethics approval by the Western University Health Science Research Ethics Board (IRB #: 114977).

A cross-sectional survey design was used for this study. Electronic surveys (Qualtrics XM Software) were developed for three distinct populations. The populations sampled were (1) pre-operative (pre-op) ACLR patients; (2) post-operative (post-op) ACLR patients; and (3) orthopaedic surgeons. Patients were recruited from the clinics of four orthopaedic surgeons at the Fowler Kennedy Sport Medicine Clinic in London, ON, from February to April 2020 via phone, email, and in person. Pre-operative patients were eligible to participate if they had an ACL deficient knee and were considering or were scheduled for an ACLR. Post-operative patients were eligible to participate if they had undergone ACLR surgery in the past six years (April 2014–January 2020). Patients were excluded from the study if they were younger than 14, older than 35, had or were scheduled for a revision ACLR, or had a multi-ligament injury. This age range was chosen to focus on a skeletally mature, highly active population with an increased risk of graft failure. The surgeon survey was distributed by email to the 170 members of the Anterior Cruciate Ligament Study Group (ACLSG) during the group's 2020 meeting. Orthopaedic surgeons with an active practice who perform ACLR were eligible to participate.

Surveys 1 and 2: pre- and post-operative patients

The patient surveys contained demographic questions and questions regarding outcome importance. The post-operative patient survey contained two additional questions about time since, and level of satisfaction with their ACLR. Patients were provided 19 multiple choice questions regarding outcomes and considerations related to ACLR and asked to indicate the importance of each on a five-point Likert scale from 'not at all important' to 'extremely important'. These questions included a layman's definition for each outcome/

consideration to ensure clarity and consistency. Patients were then asked to rank their five most important items from the same list (from one to five). The outcomes/considerations were divided into five categories (Table 1).

The patient surveys were pre-tested with 14 patients in accordance with methods outlined by Dillman et al. [7]. Pre-tested patients were observed filling out the survey on an electronic tablet to obtain verbal and non-verbal feedback, and a debriefing session was used to explore general attitudes, points of misunderstanding, applicability issues, or concerns of bias. This pre-test data were not used in analysis.

Survey 3: orthopaedic surgeons

The orthopaedic surgeon survey contained questions regarding demographics, attitudes towards changing practice based on new evidence, and outcome importance. A matrix table of the same 19 outcomes and considerations as provided to patients was given to the surgeons (Table 1). Surgeons were asked to similarly indicate the importance of each outcome and provide a ranked priority list of their five most important items.

Surgeons were presented with nine scenario-based questions regarding changing practice. Surgeons were asked to consider making three types of changes to their ACLR procedure: a new graft type (bone patellar tendon bone autograft, hamstring tendon autograft, quadriceps tendon autograft, allograft, etc.), a new surgical technique (tunnel drilling method, double or single bundle, repair, etc.), or an added extra-articular procedure (anterolateral ligament reconstruction, lateral extra-articular tenodesis, etc.). Within each of these scenarios three levels of patient risk for graft failure were presented: 20% (high-risk), 10% (moderate risk), and 5% (low risk). Surgeons were asked to indicate a new risk of graft failure, compared to this initial risk that would influence them to change practice. Graft failure was defined as graft rupture or symptomatic instability.

The face validity of this survey was reviewed using a focus group of five surgeons to determine if questions were directly applicable to the research question, clear and unbiased.

Statistical analysis

Outcome importance and agreement

The median was used as the measure of central tendency for the ordinal levels of outcome importance. The responses were coded as follows: 'not at all important' = 1, 'slightly important' = 2, 'moderately important' = 3, very important = 4, and 'extremely important' = 5. The level of agreement between groups was determined by calculating the percentage of 19 outcomes with the same median in each group.

Priorities

The outcomes ranked first to fifth most important by respondents were considered their "top priorities". A points system was introduced for data analysis [8]. An outcome ranked first (most important) was given five points, second was given four points, continuing to fifth (one point). The points allotted to each outcome were summed across all respondents and weighted based on the number of individuals that ranked the outcome as a top priority. Outcomes were

Table 1 Surgical outcomes and considerations related to ACL reconstructions for all surveys

Category	Surgical outcomes/considerations
Major Complications	Risk of graft rupture
	Knee instability (rotational laxity, asymmetric pivot shift)
	Risk of re-injury (either knee)
	Need for additional surgery
Minor complications	Complications at donor site (infection, numbness, etc.)
Functional status	Time to return to pre-injury level of daily activities
	Time to return to school or work
	Time to return to any sport
	Time to return to pre-injury level of sport
	Range of motion
	Quadriceps and hamstring strength
	Functional performance (hop tests, etc.)
Quality of life	Perioperative pain
	Longer term pain
	Emotional well-being
	Risking of developing osteoarthritis in 10 years (long term loss of function)
Health resource utilization	Cost of surgery
	Complexity of surgery
	Time in surgery

ordered by points (most to least) and ranked priority lists were generated for each group. All patients' responses were pooled and the same points system was used to generate ranked priority lists based on age and sex.

Changing practice

Risk difference (RD) and relative risk reduction (RRR) were calculated from surgeons' responses to the scenario-based questions. Risk differences were used to investigate the change required within each specific scenario, and RRR allowed for comparison of the change required across scenarios. Means and 95% confidence intervals (CI) were calculated for RD and RRR. To investigate associations between surgeon demographics and RRR, Pearson's r correlation analyses were run. Pearson's r correlation coefficients were interpreted as follows; negligible correlation ($r = 0.00–0.09$), weak correlation ($r = 0.10–0.39$), moderate correlation ($r = 0.40–0.69$), strong correlation ($r = 0.70–0.89$), and very strong correlation ($r = 0.90–1.00$) [18].

Sample size

Sample size calculations were based on the finite population of surgeons and patients meeting the inclusion criteria that we had access to during the data collection period. This constituted 170 surgeon members of the ACLSG, 99 pre-operative ACLR patients, and 283 post-operative ACLR patients. Sample sizes of 62, 49 and 72 were calculated for the surgeon, pre-op patient and post-op patient surveys, respectively, based on 95% confidence intervals, 10% margin of error, and the most conservative estimate of survey response parameters (50%).

Data were analysed as collected, as there was a low percentage of missing data. Statistical significance was set at $p < 0.05$, and all analyses were performed using SPSS (IBM SPSS Statistics, Version 26).

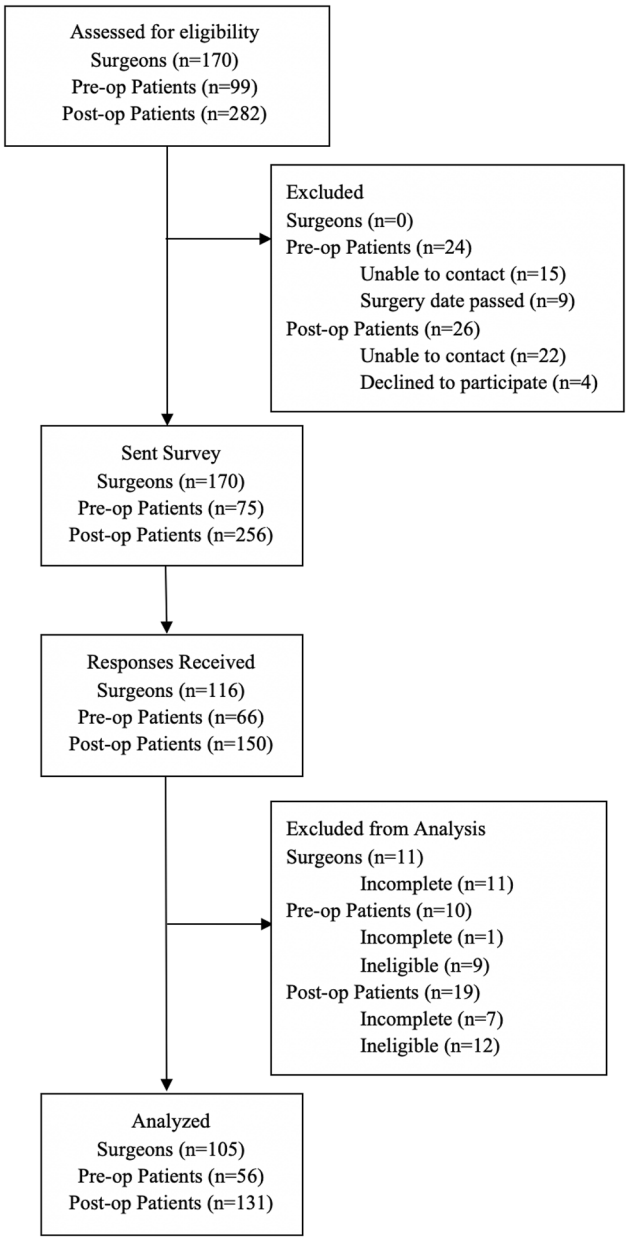

Fig. 1 Participant flow diagram

Results

The pre-testing of the patient surveys and focus group of surgeons indicated adequate face validity of all three surveys, and recommended changes were made to increase clarity and reduce bias.

A response rate of 67% (66/99) and 53% (150/283) was achieved from the pre-op and post-op patients, respectively. A total of 56 pre-op and 131 post-op patients' responses were suitable for analysis, with 0% and 0.4% missing data, respectively. Figure 1 depicts participant flow. Patient demographics are presented in Table 2.

A response rate of 68% (116/170) was achieved from the ACLSG. A total of 105 responses were suitable for analysis, with 5.7% missing data (Fig. 1). Surgeon demographics are presented in Table 3.

Outcome importance and agreement

Nearly all outcomes (96%) were categorized as 'moderately', 'very', or 'extremely' important. Pre-op and post-op patients rated a larger proportion of outcomes as 'extremely important' than did surgeons (47% and 53% versus 16%, respectively). No outcomes were labelled 'not at all important'.

Surgeons and pre-op patients agreed on the level of importance for 47% of the outcomes (9/19), whereas

Table 2 Patient demographics (pre- and post-operative)

	Pre-op patients (mean ± SD) or *N* (%)	Post-op patients (mean ± SD) or *N* (%)
Sex		
Male	23 (41.1)	47 (37.6)
Female	33 (58.9)	78 (62.4)
Age (years)	24.8 ± 5.9	23.1 ± 4.7
Time since surgery (years)	N/A	2.5 ± 2.0
Satisfaction with surgery		
Extremely satisfied		88 (67.2)
Somewhat satisfied	N/A	30 (22.9)
Neither satisfied nor dissatisfied		8 (6.1)
Somewhat dissatisfied		5 (3.8)
Extremely dissatisfied		0 (0.0)

Table 3 Surgeon demographics

	Mean ± SD or *N* (%)
Sex	
Male	95 (95.9)
Female	4 (4.0)
Age (years)	52.6 ± 10.7
Years of experience	
As an orthopaedic surgeon	22.4 ± 10.3
Completing ACLR	20.7 ± 10.5
Fellowship trained in ACLR	
Yes	92 (88.5)
No	12 (11.5)
Region	
Europe	51 (49.0)
North America	28 (29.9)
Australia/New Zealand	13 (12.5)
Asia	6 (5.8)
Middle East	2 (1.9)
South America	3 (2.9)
Africa	1 (1.0)
Type of practice	
Academic/teaching	58 (55.2)
Private	41 (39.0)
Community/public	6 (5.7)

surgeons and post-op patients agreed on 53% (10/19). The two groups of patients agreed more frequently, with 68% of the same median responses (13/19). Altogether, the three groups agreed on 37% of the outcomes' importance (7/19).

Priorities

Ranked priority lists of the three groups are shown in Table 4. Knee instability and risk of re-injury to either knee were shared as top five priorities among all three groups. Looking across the top three priorities of each group, preoperative patients uniquely prioritized returning to school or work; post-operative patients uniquely prioritized returning to any level or pre-injury level of sport; and surgeons uniquely prioritized the risk of graft rupture and of developing osteoarthritis (Table 4). Pooling patient responses revealed differences in top priorities based on age and sex (Fig. 2a, b, respectively).

Changing practice

Surgeons required a mean RRR in ACLR graft failure of 51.4% to influence practice change across the nine survey scenarios (Table 5). Surgeons required a mean RRR of 52.8%, 50.5%, and 50.9% to change graft type, surgical technique, and use of an extra-articular procedure, respectively. Surgeons required a mean absolute RD of 10.2%, 5.1%, and 2.6% to change practice for the high, moderate, and low risk groups, respectively. The mean RRR showed weak but statistically significant positive correlations with increasing age ($r = 0.33$, 95% CI 0.15–0.50, $p = 0.01$), years of experience as an orthopaedic surgeon ($r = 0.39$, 95% CI 0.22–0.55, $p < 0.01$) and years of experience performing ACLR ($r = 0.37$, 95% CI 0.19–0.52, $p < 0.01$).

Discussion

The most important finding of our study was that surgeons and patients have different priorities when making decisions regarding ACLR. Overall, surgeons were more likely to prioritize outcomes specifically related to the patients' surgical knee (graft rupture, instability, and osteoarthritis), whereas patients were more likely to prioritize outcomes related to their daily life (returning to daily activities, sport, school, and work). This is intuitive based on each groups' setting and exposure to the outcomes. Surgeons see patients experiencing complications and adverse events, and their reputation as a clinician is based on preventing such occurrences. Patients spend most of their lives outside the clinical setting and will be most concerned with how their daily lifestyle and activities are affected.

All three groups acknowledged the high importance of nearly all listed outcomes, emphasizing need for prioritization to determine optimal surgical approaches. Knee stability and preventing re-injury were unanimous top priorities. These may be ideal primary outcomes for studies investigating ACLR, as they appear to be both surgeon and patient

Table 4 Ranked priority lists of outcomes or considerations related to ACL reconstruction

Orthopaedic surgeons	Pre-op patients	Post-op patients
1. Knee instability[a]	1. Time to return to school/work	1. Risk of re-injury (either knee)[a]
2. Risk of graft rupture	2. Time to return to pre-injury level of daily activities[b]	2. Time to return to any level of sport
3. Risk of re-injury (either knee)[a]	3. Risk of re-injury (either knee)[a]	3. Time to return to pre-injury level of daily activities[b]
4. Range of motion[b]	4. Knee instability[a]	4. Time to return to pre-injury level of sport
5. Risk of developing OA in 10 years	5. Range of motion[b]	5. Knee instability[a]

[a]Outcome/consideration is shared as a top priority by both other groups

[b]Outcome/consideration is shared as a top priority by one other group

Fig. 2 Top five priorities of ACL reconstruction patients, by age (**a**) and sex (b)

Table 5 Change in ACL graft failure risk required by surgeons to consider changing practice (mean ± 95% CI)

Type of change	20% initial risk (high)	10% initial risk (moderate)	5% initial risk (low)	Mean
Graft type				
RD	10.6 ± 0.8	5.3 ± 0.4	2.6 ± 0.2	–
RRR	52.9 ± 4.2	53.0 ± 3.6	52.7 ± 4.4	52.8 ± 2.3
Surgical technique				
RD	10.0 ± 0.9	5.0 ± 0.4	2.6 ± 0.2	–
RRR	49.9 ± 4.4	50.4 ± 3.8	51.2 ± 4.6	50.5 ± 2.4
Extra-articular procedure				
RD	10.1 ± 0.9	4.9 ± 0.4	2.6 ± 0.2	–
RRR	50.5 ± 4.7	49.3 ± 4.1	52.9 ± 4.5	50.9 ± 2.5
Mean				
RD	10.2 ± 0.5	5.1 ± 0.2	2.6 ± 0.1	–
RRR	51.1 ± 2.5	50.9 ± 2.2	52.3 ± 2.6	51.4 ± 1.4

RD (%) = risk difference (initial risk − new acceptable risk)

RRR (%) = relative risk reduction (RD/initial risk × 100)

important. Pooled across all three groups, risk of re-injury was the most important outcome. Patients cite fear of re-injury as the most common psychological reason for not returning to sport or activity after ACLR [16].

The risk of developing osteoarthritis (OA) in 10 years was considered a top priority by surgeons, but not by patients. The concept of OA appears to be a common point of misunderstanding among ACLR patients. Patients erroneously expect little to no risk of developing OA following ACLR, or believe that reconstructive surgery will decrease their risk for the condition [9], which may explain its relatively low importance rating by patients. Evidence suggests that about 50% of ACLR patients will develop radiographic OA within 10–20 years of an ACL tear, regardless of surgical treatment [13]. Patients are rarely cognisant of this risk and education from health care professionals related to OA must be improved.

Patients rated about half of the ACLR outcomes as extremely important, in contrast to surgeons who classified less than one-fifth as such. Patients may have unrealistically high expectations regarding ACLR compared to the post-operative reality of outcomes [9]. The overwhelming majority of patients expect a normal or near-normal knee condition, return to pre-injury level of sport or activity, and little to no risk of osteoarthritis [9]. The diversity in surgeons' answers may reflect more realistic expectations regarding patient recovery and post-operative condition.

Survey studies of ACLR patients have shown that the most influential factor in patients' choice of ACLR graft type is surgeon recommendation [4, 5]. Similarly, operating surgeon was the strongest predictor of graft type for ACLR in a recent cohort study by the Multicenter Orthopedic Outcomes Network [19]. Surgeons generally have more knowledge regarding ACLR treatment options and outcomes than their patients. However, healthcare delivery has shifted from a paternalistic approach in which surgeons instruct patients on what is best for them, to a patient-centred model in which patients are active participants in their treatment plan [6]. Surgical treatment decisions must be made on an individual basis, but informative patient education is needed to clarify risks, benefits and expectations. We suggest a simple ranked priority list approach similar to that used in this study to aid in the shared decision-making process.

Overall, a 51% relative risk reduction was necessary for surgeons to consider changing practice for ACLR. To our knowledge, this is the first study investigating the magnitude of results necessary for orthopaedic surgeons to consider changing practice for ACLR. We question whether the requirement to cut failure rates in half before adopting a new intervention for ACLR is appropriately cautious, or unrealistically high for clinical research. It is interesting to note that while the participating surgeons ranked knee instability and graft rupture (two components of what can be defined as clinical graft failure [10]) as their top two priorities for ACLR, the same surgeons appear resistant to changing practice to improve these metrics.

Orthopaedic surgeons have been shown to be most influenced by randomized clinical trials (RCTs), systematic reviews and meta-analyses with large sample sizes, published in reputable journals [20]. However, ACLR literature is often troubled by underpowered studies that do not investigate patient important outcomes, with samples not generalizable to the average surgeons' treatment population. If large, methodologically sound RCTs or cohort studies show a consistent and precise treatment effect for a well-defined, clinically and patient important outcome, a change in practice should follow. This is true for risk reductions smaller in magnitude than 51%. Conversely, practice change should

not occur in response to one or two small studies. This holds even when small studies show large treatment effects such as the 51% RRR highlighted in the survey responses. It is possible that other external factors such as the influence from industry are even more significant drivers of surgical practice and subsequent evolution of practice change, than clinical research. A thorough discussion of these influences is beyond the scope of this paper.

Somewhat surprisingly, surgeons indicated that a larger RD would be needed for them to change practice in a high-risk patient (10.2%) compared to a low-risk patient (2.6%), with the RRR staying fairly constant. A 50% RRR may be realistic for a low-risk scenario such that risk of failure drops from 5 to 2.5% (RD = 2.5%). In comparison, a 50% RRR from 20 to 10% (RD = 10%) is much less likely to occur in a clinical setting. It is interesting to note that in both of these scenarios, the number of patients needed to treat in order to prevent one graft failure is the same, 40 patients. Further research is needed to support this finding and explore why surgeons may be more hesitant to change practice for the population of patients in greater need of improved failure rates.

Based on the correlations observed in our data, older and more experienced surgeons required larger risk reductions to change practice. Bhandari et al. reported that surgical residents "identified a surgeon's "ego", "older age", "rigidity", and "insecurity" as characteristics that impaired the practice of evidence-based medicine" [2]. Older, more experienced surgeons have likely developed practice habits with low adverse event rates and feel little motivation to change. A comment from one participating surgeon regarding changing practice to add an extra-articular procedure illustrates this point: "I feel a double bundle hamstring graft in my hands has low failure rates and negates the need for extra-articular procedures". The issue with this perspective is that it does not acknowledge the hierarchy of evidence on which the practice of evidence-based medicine is built, whereby systematic research is placed above anecdotal clinical experiences.

The response rate of our surveys (67, 53, and 68%) introduces the possibility of bias. Less than three-quarters of potential participants responded to the survey and we cannot be certain if those who did respond are different, in some meaningful way, from those who did not. The patients surveyed were recruited from one clinic and were within a younger age group. Therefore, the results of this study cannot be generalized to all patients undergoing ACLR. Although including patients at various timepoints may provide a unique view of patient perspectives, this study was not longitudinal, and we cannot conclude how individual patients' responses change over time.

The ACLSG sample of surgeons provided diversity in region and type of practice. However, this is a specialized sample and cannot be generalized to all surgeons. This group is dedicated to advancing research of ACL injuries and treatment and may be more likely to change practice than the general population of orthopaedic surgeons. It is possible that the scenario-based questions presented to surgeons were unclear or that the concept of moving from an initial risk level to an acceptable risk which would influence change was convoluted due to the questions' phrasing. Lastly, it is likely our survey did not adequately capture the multifactorial nature of a surgeon's practice decisions. A comment left by one surgeon respondent emphasizes this point: "too complex questions…too many ifs and show me the first isolated ACL [injury] to come to happen…so many variables are at issue here". Factors such as concomitant injuries, cost, surgeon experience, and numerous patient characteristics were not addressed and would influence practice change decisions.

Conclusion

There are discrepancies between the priorities of surgeons and patients for ACLR. Surgeons were more likely to prioritize outcomes related to the patients' surgical knee (graft rupture, instability, and osteoarthritis), whereas patients were more likely to prioritize outcomes related to their daily lifestyle and activities (returning to daily activities, sport, school, and work). Orthopaedic surgeons appear similarly resistant to changing practice for ACLR, independent of the type of change or patient risk profile. Effective shared decision-making aligned with rigorous clinical research is necessary to further progress in reducing ACL graft failure for high-risk patients.

Acknowledgements The authors would like to thank the ACL Study Group for participating in this study. The authors would also like to acknowledge Dr. Robert Litchfield, Dr. Kevin Willits and Dr. Ryan Degen for allowing their patients to be recruited for this study.

Author contributions HM helped with study conception and design, completed data collection, completed statistical analysis, helped with interpretation of the data and drafted the manuscript. DMB helped with study conception and design, statistical analysis, interpretation of the data and drafting the manuscript. TBB helped with study conception and design, interpretation of the data and drafting the manuscript. AK helped with study conception and design, interpretation of the data and drafting the manuscript. KPS helped with interpretation of the data and critically revised the manuscript. CCK helped with data collection, interpretation of the data and critically revised the manuscript. TS helped with data collection, interpretation of the data and critically revised the manuscript. AMJG helped with study conception and design, data collection, interpretation of the data and drafting the manuscript.

Funding No funding was provided for this study.

Declarations

Conflict of interest H.M., D.M.B, T.B.B. and K.T. declare that they have no competing interests. K.P.S. has received consulting fees from the National Football League, Service Excellence, Mitek, Flexion, Samumed and Novopeds; research funding from Smith & Nephew Endoscopy, DonJoy Orthopedics and NIH/NIAMS; and hospitality payments from DePuy and Biosense Webster. C.C.K. was the past president of the ACL Study Group and has received research funding from DJO and Zimmer Biomet, consulting fees from Zimmer Biomet, education payments from CDC Medical, and compensation for services other than consulting from Arthrex. T.S. is the President of the ACL Study Group and has received speaking fees from Conmed, Smith & Nephew, and JRF Ortho, and royalties from Conmed. A.M.J.G. is the Program Chair of the ACL Study Group and has received royalties from Smith & Nephew and Graymont Inc, research funding from Smith & Nephew and Ossur, and consulting fees from Smith & Nephew, Ossur, and Olympus.

Ethical approval This study was grant ethics approval by the Western University Health Science Research Ethics Board (Ref #: 114977).

Informed consent Informed consent was obtained from all participants.

References

1. Adie S, Harris IA, Naylor JM, Mittal R (2017) Are outcomes reported in surgical randomized trials patient-important? A systematic review and meta-analysis. Can J Surg 60:86–93
2. Bhandari M, Montori V, Devereaux PJ, Dosanjh S, Sprague S, Guyatt GH (2003) Challenges to the practice of evidence-based medicine during residents' surgical training: a qualitative study using grounded theory. Acad Med 78:1183–1190
3. Carey JL, Shea KG (2015) AAOS clinical practice guideline: management of anterior cruciate ligament injuries: evidence-based guideline. J Am Acad Orthop Surg 23:e6–e8
4. Cheung SC, Allen CR, Gallo RA, Ma CB, Feeley BT (2012) Patients' attitudes and factors in their selection of grafts for anterior cruciate ligament reconstruction. Knee 19:49–54
5. Cohen SB, Yucha DT, Ciccotti MC, Goldstein DT, Ciccotti MA, Ciccotti MG (2009) Factors affecting patient selection of graft type in anterior cruciate ligament reconstruction. Arthroscopy 25:1006–1010
6. Cole BJ, Cotter EJ, Wang KC, Davey A (2017) Patient understanding, expectations, outcomes, and satisfaction regarding anterior cruciate ligament injuries and surgical management. Arthroscopy 33:1092–1096
7. Dillman DA, Smyth JD, Christian LM (2014) Ordering questions and testing for question order effects. In: Internet, phone, mail, and mixed-mode surveys: the tailored design method. Wiley, pp 228–257
8. Dyson MP, Shave K, Gates A, Fernandes RM, Scott SD, Hartling L (2017) Which outcomes are important to patients and families who have experienced paediatric acute respiratory illness? Findings from a mixed methods sequential exploratory study. BMJ Open 7:1–10
9. Feucht MJ, Cotic M, Saier T, Minzlaff P, Plath JE, Imhoff AB, Hinterwimmer S (2016) Patient expectations of primary and revision anterior cruciate ligament reconstruction. Knee Surg Sport Traumatol Arthrosc 24:201–207
10. Getgood AMJ, Bryant DM, Litchfield R, Heard M, McCormack RG, Rezansoff A, Peterson D, Bardana D, MacDonald PB, Verdonk PCM, Spalding T, Willits K, Birmingham T, Hewison C, Wanlin S, Firth A, Pinto R, Martindale A, O'Neill L, Jennings M, Daniluk M, Boyer D, Zomar M, Moon K, Pritchett R, Payne K, Fan B, Mohan B, Buchko GM, Hiemstra LA, Kerslake S, Tynedal J, Stranges G, Mcrae S, Gullett LA, Brown H, Legary A, Longo A, Christian M, Ferguson C, Mohtadi N, Barber R, Chan D, Campbell C, Garven A, Pulsifer K, Mayer M, Simunovic N, Duong A, Robinson D, Levy D, Skelly M, Shanmugaraj A, Howells F, Tough M, Spalding T, Thompson P, Metcalfe A, Asplin L, Dube A, Clarkson L, Brown J, Bolsover A, Bradshaw C, Belgrove L, Millan F, Turner S, Verdugo S, Lowe J, Dunne D, McGowan K, Suddens CM, Declercq G, Vuylsteke K, Van Haver M (2020) Lateral extra-articular tenodesis reduces failure of hamstring tendon autograft anterior cruciate ligament reconstruction: 2-year outcomes from the STABILITY study randomized clinical trial. Am J Sports Med 48:285–297
11. Guyatt G, Haynes B, Jaeschke R, Meade MO, Wilson M, Montori V, Richardson S (2008) The philosophy of evidence based medicine. In: Users' guide to the medical literature. McGraw-Hill Medical, pp 1–14
12. Kamath GV, Redfern JC, Greis PE, Burks RT (2011) Revision anterior cruciate ligament reconstruction. Am J Sports Med 39:199–217
13. Lohmander SL, Englund MP, Dahl LL, Roos EM (2007) The long-term consequence of anterior cruciate ligament and meniscus injuries: osteoarthritis. Am J Sports Med 35:1756–1769
14. Mather RC, Koenig L, Kocher MS, Dall TM, Gallo P, Scott DJ, Bach BR, Spindler KP (2013) Societal and economic impact of anterior cruciate ligament tears. J Bone Jt Surg 95:1751–1759
15. Mohtadi NG, Chan DS (2019) A randomized clinical trial comparing patellar tendon, hamstring tendon, and double-bundle ACL reconstructions: patient-reported and clinical outcomes at 5-year follow-up. J Bone Jt Surg 101:949–960
16. Nwachukwu BU, Adjei J, Rauck RC, Chahla J, Okoroha KR, Verma NN, Allen AA, Williams RJ (2019) How much do psychological factors affect lack of return to play after anterior cruciate ligament reconstruction? A systematic review. Orthop J Sport Med 7:1–7
17. Sanders TL, Maradit Kremers H, Bryan AJ, Larson DR, Dahm DL, Levy BA, Stuart MJ, Krych AJ (2016) Incidence of anterior cruciate ligament tears and reconstruction: a 21-year population-based study. Am J Sports Med 44:1502–1507
18. Schober P, Schwarte LA (2018) Correlation coefficients: appropriate use and interpretation. Anesth Analg 126:1763–1768
19. Spindler KP, Huston LJ, Zajichek A, Reinke EK, Amendola A, Andrish JT, Brophy RH, Dunn WR, Flanigan DC, Jones MH, Kaeding CC, Marx RG, Matava MJ, McCarty EC, Parker RD, Vidal AF, Wolcott ML, Wolf BR, Wright RW (2020) Anterior cruciate ligament reconstruction in high school and college-aged athletes: does autograft choice influence anterior cruciate ligament revision rates? Am J Sports Med 48:298–309
20. Thornley P, De Sa D, Evaniew N, Farrokhyar F, Bhandari M, Ghert M (2016) An international survey to identify the intrinsic and extrinsic factors of research studies most likely to change orthopaedic practice. Bone Jt Res 5:130–136
21. Webster KE, Feller JA, Leigh WB, Richmond AK (2014) Younger patients are at increased risk for graft rupture and contralateral injury after anterior cruciate ligament reconstruction. Am J Sports Med 42:641–647
22. Wiggins AJ, Grandhi RK, Schneider DK, Stanfield D, Webster KE, Myer GD (2016) Risk of secondary injury in younger athletes after anterior cruciate ligament reconstruction. Am J Sports Med 44:1861–1876
23. Wright RW, Huston LJ, Haas AK, Allen CR, Anderson AF, Cooper DE, DeBerardino TM, Dunn WR, Lantz BA, Mann B, Spindler KP, Stuart MJ, Nwosu SK, Pennings JS, Albright JP, Amendola A, Andrish JT, Annunziata CC, Arciero RA, Bach BR,

Baker CL, Bartolozzi AR, Baumgarten KM, Bechler JR, Berg JH, Bernas GA, Brockmeier SF, Brophy RH, Bush-Joseph CA, Butler JB, Campbell JD, Carey JL, Carpenter JE, Cole BJ, Cooper JM, Cox CL, Creighton RA, Dahm DL, David TS, Flanigan DC, Frederick RW, Ganley TJ, Garofoli EA, Gatt CJ, Gecha SR, Giffin JR, Hame SL, Hannafin JA, Harner CD, Harris NL, Hechtman KS, Hershman EB, Hoellrich RG, Hosea TM, Johnson DC, Johnson TS, Jones MH, Kaeding CC, Kamath GV, Klootwyk TE, Levy BA, Ma CB, Maiers GP, Marx RG, Matava MJ, Mathien GM, McAllister DR, McCarty EC, McCormack RG, Miller BS, Nissen CW, O'Neill DF, Owens BD, Parker RD, Purnell ML, Ramappa AJ, Rauh MA, Rettig AC, Sekiya JK, Shea KG, Sherman OH, Slauterbeck JR, Smith MV, Spang JT, Svoboda LSJ, Taft TN, Tenuta JJ, Tingstad EM, Vidal AF, Viskontas DG, White RA, Williams JS, Wolcott ML, Wolf BR, York JJ (2020) Predictors of clinical outcome following revision anterior cruciate ligament reconstruction. J Orthop Res 38:1191–1203