Patient Decision Making in Anterior Cruciate Ligament Reconstruction

A Discrete Choice Experiment Examining Graft Preference

John Hayden Sonnier,* MS, Ryan W. Paul,* BS, Hayden E. Sando,† BS, Anya T. Hall,* BS, Fotios P. Tjoumakaris,‡ MD, Steven B. Cohen,* MD, and Kevin B. Freedman,*§ MD

Investigation performed at Rothman Orthopaedic Institute, Philadelphia, Pennsylvania, USA

Background: Bone–patellar tendon–bone (BTB) and hamstring autografts are the most common grafts used for anterior cruciate ligament (ACL) reconstruction. Patient preferences should be accounted for as a part of shared decision making.

Purpose/Hypothesis: The purpose of this study was to perform a discrete choice experiment that evaluated patient preferences toward ACL autografts. We hypothesized that there would be no difference in patient preferences between groups.

Study Design: Cross-sectional study.

Methods: Patients aged 18 to 25 years who underwent shoulder arthroscopy at a single institution between 2013 and 2019 were included in the study as a proxy for healthy controls. Patients with a history of ACL tear were excluded. A discrete choice experiment was developed from a literature search and used the following data points as they pertain to BTB or hamstring autograft: risk of developing a significant complication, return-to-play rate, risk of anterior knee pain with kneeling, and risk of additional surgery due to graft failure. Included patients completed a custom survey in which they were asked to choose between "surgery A" (hamstring) and "surgery B" (BTB).

Results: A total of 107 participants were included in the analysis. Of these participants, 39 (36.5%) chose surgery A (hamstring) and 68 (63.6%) chose surgery B (BTB). When comparing the hamstring group with the BTB group, there was no significant difference in age, sex, body mass index, race, level of education, or employment status. However, 80.5% of self-reported athletes preferred BTB ($P = .008$). When controlling for age, sex, and body mass index, patients in the BTB group were more likely to rate return to sport (risk ratio [RR] = 1.49 [95% CI, 1.18-1.98]; $P = .001$) and the risk of requiring additional surgery due to graft failure (RR = 1.26 [95% CI, 1.02-1.58]; $P = .037$) as highly important. Conversely, they were less likely than patients in the hamstring group to rate pain while kneeling (RR = 0.65 [95% CI, 0.98-1.05]; $P < .001$) and complication risk (RR = 0.75 [95% CI, 0.59-0.94]; $P = .013$) as important.

Conclusion: The study hypothesis was rejected, as patient values did affect ACL graft choice preference. Utilizing patient-selected values in a quantifiable way can benefit the shared decision-making process before ACL reconstruction.

Keywords: anterior cruciate ligament; reconstruction; shared decision making

More than 200,000 anterior cruciate ligament (ACL) reconstructions are performed every year.[24] When planning for ACL reconstruction, graft choice is a critical decision that should be discussed with the patient before surgery. Although many factors affect outcomes after ACL reconstruction, graft choice is one factor that has been studied in depth, as it is an easily modifiable surgical factor that may directly affect outcomes such as re-rupture rate, return to sports, donor-site morbidity, and risk of future osteoarthritis. The 2 most commonly used autografts are the bone–patellar tendon–bone (BTB) graft, which is harvested from the middle third of the ipsilateral patellar tendon, and the hamstring graft, which is harvested from the semitendinosus and gracilis tendons.[2,5] When comparing BTB grafts with hamstring grafts, there is no clearly superior choice. Each graft carries with it a unique performance profile of which the pros and cons should be weighed with the patient through shared decision making. For example, BTB autografts are the historical gold standard and offer a higher rate of return to sport, with some studies demonstrating a lower failure rate compared with hamstring autografts.[5,19] However, BTB grafts carry significant donor-site morbidity, such as anterior knee pain or pain while kneeling.[26] Although the risks and benefits of each graft type extend beyond these few listed parameters, the process of synthesizing complex, evidence-based literature

The Orthopaedic Journal of Sports Medicine, 11(2), 23259671221144983
DOI: 10.1177/23259671221144983

to evaluate outcome probabilities in a way that is easy to understand is a crucial element of shared decision making.[6] During this process, taking the time to understand patient values and preferences can help ensure that the goals of the surgeon properly align with the goals of the patient.

Although each patient presents a unique set of circumstances, understanding how the outcome preferences of patients correlate with specific treatment regimens may help bridge the gap between evidence-based medicine and patient-centered care. The discrete choice experiment is a commonly used method of eliciting patient preferences.[20] In this type of experiment, participants are given a set of data points and asked to state their preferences.[20] For example, Hutyra et al[10] surveyed a cohort of patients with osteoarthritis of the knee and presented them with a discrete choice experiment designed to evaluate their preferences for unicompartmental knee arthroplasty versus total knee arthroplasty. To do this, they provided patients with outcome data on factors such as complication risk, functional ability, awareness of knee implant, and revision rate. Patients were then asked to state their preferences based on the data points provided.[10]

Discrete choice experiments are advantageous because, by taking a realistic situation and asking participants to perform a risk-benefit analysis, they enable researchers to effectively quantify the decision-making process.[20] Although there are many factors that play a role in determining success after ACL reconstruction, graft choice is a significant part of the decision-making process. Furthermore, asking patients to assign a quantifiable value to potential surgical outcomes is profoundly important; as new data come to light and better fixation techniques or grafts become available, studies such as these, which shine a light on patient preferences, may allow surgeons to optimize patient care by aligning high-quality data with the goals of individual patients.

The purpose of this study was to perform a discrete choice experiment to evaluate patient preferences with regard to ACL graft choice. We hypothesized that there would be no difference in patient preferences between groups.

METHODS

Study Population

Institutional review board approval was obtained prior to initiation of the study. Patients undergoing ACL reconstruction were not included as the primary study population because physician counseling during the perioperative period would likely have influenced the responses to the discrete choice experiment. As such, to survey a population that broadly approximated the age range at which the peak incidence of ACL tears occurred, patients aged 18 to 25 years who underwent shoulder arthroscopy (Current Procedural Terminology codes 29806, 29807, and 29822) at our institution between 2013 and 2019 were included in the study as a proxy for healthy controls. All patients were surveyed $\geq$2 years after they underwent shoulder surgery.

Literature Review

The first step in creating the discrete choice experiment was to perform a comprehensive literature review. This was done by searching "anterior cruciate ligament reconstruction" in combination with terms such as "return to sport," "revision," and "infection." Inclusion criteria included (1) prospective randomized controlled trials or meta-analyses of randomized controlled trials, (2) published in 2015 or later, and (3) directly comparing BTB to hamstring autograft. Thirteen studies met the inclusion criteria.[‖] Data regarding sample size, follow-up duration, and postoperative outcomes were compiled from these 13 studies. Notably, only autograft data were included, as this type of graft is most commonly used in the young, athletic population broadly approximated by our survey population.[12,23]

After this initial phase, 3 experts (fellowship-trained academic sports medicine orthopaedic surgeons, F.P.T., S.B.C., K.B.F.) reviewed the studies and selected data points to include in the survey based on clinical expertise, study quality, and sample size. The experts agreed on the following 4 key decision-making variables to include in the survey: (1) risk of developing a significant complication (defined by Rousseau et al[17] as infection or thromboembolism) within 3 months, (2) return-to-play (RTP) rate, (3) risk of developing pain while kneeling, and (4) risk of additional surgery because of graft failure. Table 1 lists the studies that were selected based on their representation of these outcome parameters. We used in the survey those studies with the highest level of evidence included in our literature search for each reported outcome of interest. If

[‖]References 1, 3, 5, 9, 11, 13-15, 17, 19, 21, 25, 26.

[§]Address correspondence to Kevin B. Freedman, MD, Rothman Orthopaedics at Thomas Jefferson University, 825 Old Lancaster Road, Suite 200, Bryn Mawr, PA 19010, USA (email: kevin.freedman@rothmanortho.com) (Twitter: @RothmanOrtho).

*Rothman Orthopaedic Institute, Philadelphia, Pennsylvania, USA.

[†]Drexel University College of Medicine, Philadelphia, Pennsylvania, USA.

[‡]Rothman Orthopaedic Institute, Egg Harbor Township, New Jersey, USA.

Final revision submitted September 6, 2022; accepted September 26, 2022.

One or more of the authors has declared the following potential conflict of interest or source of funding: F.P.T. has received consulting fees from DePuy/Medical Device Business Services and has stock/stock options in Trice Medical. S.B.C. has received research support from Arthrex and Major League Baseball, education payments from Liberty Surgical, consulting fees from Conmed Linvatec and Zimmer, speaking fees from Zimmer, and royalties from Slack Inc. K.B.F. has received education payments from Liberty Surgical; consulting fees from DePuy/Medical Device Business Services, Innocoll, and Vericel; and speaking fees and honoraria from Vericel. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Ethical approval for this study was waived by Thomas Jefferson University.

TABLE 1
Characteristics and Key Findings of the Included Studies[a]

Lead Author (Year)	Study Design	Sample Size	Follow-up	Key Finding
Rousseau (2019)[17]	Prospective cohort study	811 patients	2 y	General complications: 4.8% (hamstring), 7% (BTB)
DeFazio (2020)[5]	Meta-analysis	20 studies (2348 athletes)	Minimum 1 y	Return-to-sport rate: 70.6% (hamstring), 81% (BTB)
Zhao (2020)[26]	Meta-analysis of randomized controlled trials	15 RCTs (1298 patients)	5-18 y	Postoperative kneeling pain: 21% (hamstring), 27.7% (BTB)
Kaeding (2015)[11]	Prospective cohort study	2683 patients	2 y	Graft failure rate: 4.6% (hamstring), 3.2% (BTB)

[a]BTB, bone–patellar tendon–bone; RCT, randomized controlled trial.

≥2 included studies with a similar level of evidence provided data on the same variable, the data from the study with the largest sample size was used in the survey.

Data Collection

Patients meeting the inclusion criteria were contacted via REDCap (Vanderbilt University)[7,8] to complete a custom survey. Demographic variables such as age, sex, race, and body mass index (BMI) were collected from patient medical records. In the survey, patients were asked about their involvement in sport, level of education, employment status, and history of ACL tear. Patients were then given the discrete choice experiment, in which they were presented with a table comparing "surgery A" with "surgery B" with respect to the 4 decision-making variables gathered from our initial literature review (Figure 1). Patients were asked, "Based on the following information, if you were to tear your ACL and required surgery to fix it, would you prefer to get surgery A or surgery B?" Surgery A corresponded to outcomes after ACL reconstruction using a hamstring graft, and surgery B corresponded to the outcomes after ACL reconstruction with a BTB graft.

Patients were instructed to rate each of the 4 variables as *not important at all*, *somewhat important*, *important*, *very important*, or *extremely important*. Finally, they were asked whether they would choose to undergo their selected procedure if they were given the option. The full survey can be found in the Appendix.

Statistical Analysis

All continuous data were analyzed using Mann-Whitney *U* tests, and categorical data were analyzed using chi-square tests. The possible responses to the decision-making questions were consolidated into binomial variables, in which the responses *not important at all*, *somewhat important*, and *important* were grouped and labeled as "less important" and the responses *very important* and *extremely important* were grouped and labeled as "highly important." When analyzing these decision-making variables, we performed Poisson regression analysis to control for age, sex, and BMI. The statistical analyses were conducted utilizing R Studio (Version 3.6.3, Vienna, Austria).

A post hoc power analysis generated a sample size of 182.

Surgery A	Surgery B
5% chance of developing a significant complication within 3 months	**7%** chance of developing a significant complication within 3 months
71% chance of returning to sport	**80%** chance of returning to sport
21% chance of pain while kneeling	**28%** chance of pain while kneeling
5% chance that the ACL repair surgery will fail and an additional surgery will be required to fix it	**3%** chance that the ACL repair surgery will fail and an additional surgery will be required to fix it

Figure 1. Discrete choice experiment provided to patients in the survey. Patients were asked, "Based on the following information, if you were to tear your ACL and required surgery to fix it, would you prefer to get surgery A or surgery B?" ACL, anterior cruciate ligament.

RESULTS

Overall, 118 patients agreed to participate in the study. Eleven patients reported a history of ACL tear and were excluded from the analysis, leaving 107 patients who met the inclusion criteria. Of those, 39 (36.45%) chose surgery A (hamstring) and 68 (63.55%) chose surgery B (BTB). There was no significant difference between the groups in age, race, sex, BMI, level of education, or employment status. Among the patients who reported that they were currently employed, there was no significant difference in the number who self-reported working a physically demanding job. However, the number of individuals who reported that they currently play or participate in a sport differed significantly between groups. Of the 41 self-reported athletes, 8 (19.5%) chose surgery A (hamstring) and 33 (80.5%) chose surgery B (BTB) ($P = .008$). Among this subgroup of athletes, there was no difference in the number of individuals reporting participation in a contact sport ($P \geq .999$). Table 2 presents complete patient descriptive characteristics.

When comparing the importance of each variable from the discrete choice experiment, we found significant differences between groups. Patients from the BTB group were more likely to rate the risk of graft failure requiring revision ($P = .002$) and the rate of RTP ($P < .001$) as highly important. Individuals from the hamstring group were

TABLE 2
Comparison of Patient Characteristics Between the Study Groups[a]

	Surgery A (Hamstring; n = 39)	Surgery B (BTB; n = 68)	*P*
Age, y	27.2 ± 2.80	26.3 ± 3.58	.171
Race			.943
White	35 (89.7)	58 (85.3)	
Asian	1 (2.56)	2 (2.94)	
Black	1 (2.56)	1 (1.47)	
Not reported/unknown	2 (5.13)	5 (7.35)	
Multiple	0 (0.00)	2 (2.94)	
Sex			.872
Male	25 (64.1)	46 (67.6)	
Female	14 (35.9)	22 (32.4)	
Body mass index	25.0 ± 5.10	26.3 ± 4.42	.195
Currently play a sport			**.008**
No	31 (79.5)	35 (51.5)	
Yes	8 (20.5)	33 (48.5)	
Currently play a contact sport			>.999
No	5 (62.5)	18 (54.5)	
Yes	3 (37.5)	15 (45.5)	
Highest level of education			.325
High school	5 (12.8)	15 (22.1)	
College	25 (64.1)	34 (50.0)	
Graduate school	9 (23.1)	19 (27.9)	
Employment status			.409
Full-time	35 (89.7)	52 (76.5)	
Part-time	2 (5.13)	6 (8.82)	
Unemployed	2 (5.13)	9 (13.2)	
Retired	0 (0.00)	1 (1.47)	
Physically demanding employment			.465
No	20 (54.1)	37 (63.8)	
Yes	17 (45.9)	21 (36.2)	

[a]Data are reported as n (%). Boldface *P* value indicates a statistically significant difference between groups ($P < .05$). BTB, bone–patellar tendon–bone.

TABLE 3
Importance of Outcome Factors in Patient Decision Making[a]

	Surgery A (Hamstring; n = 39)	Surgery B (BTB; n = 68)	*P*
Return-to-play rate			**<.001**
Less important	32 (82.1)	26 (38.2)	
Highly important	7 (17.9)	42 (61.8)	
Risk of revision surgery			**.002**
Less important	27 (69.2)	25 (36.8)	
Highly important	12 (30.8)	43 (63.2)	
Kneeling pain			**<.001**
Less important	11 (28.2)	59 (86.8)	
Highly important	28 (71.8)	9 (13.2)	
Risk of complication			**.001**
Less important	20 (51.3)	57 (83.8)	
Highly important	19 (48.7)	11 (16.2)	

[a]Data are reported as n (%). Boldface *P* values indicate a statistically significant difference between groups ($P < .05$). BTB, bone–patellar tendon–bone.

TABLE 4
Results of Poisson Regression Analysis Using "Surgery B" as the Reference Value

	Risk Ratio (95% CI)	*P*
Return-to-play rate	1.49 (1.18-1.98)	.001
Risk of revision surgery	1.26 (1.02-1.58)	.037
Kneeling pain	0.65 (0.98-1.05)	<.001
Risk of complication	0.75 (0.59-0.94)	.013

more likely to rate the risk of developing a significant complication within 3 months ($P = .001$) and the risk of developing pain while kneeling ($P < .001$) as highly important (Table 3).

Results from the Poisson regression analysis indicated that patients from the BTB group were more likely to rate RTP (risk ratio [RR] = 1.49 [95% CI, 1.18-1.98]; $P = .001$) and revision (RR = 1.26 [95% CI, 1.02-1.58]; $P = .037$) as more important. Conversely, they were less likely to rate pain while kneeling (RR = 0.65 [95% CI, 0.98-1.05]; $P < .001$) and complication risk (RR = 0.75 [95% CI, 0.59-0.94]; $P = .013$) as important (Table 4).

Finally, the percentage of patients who answered "yes" to the question, "If given the option, would you choose to undergo this procedure?" did not significantly differ between groups. Among patients in the BTB group, 95.6% said that they would be willing to undergo their selected procedure, compared with 87.2% of the patients in the hamstring group ($P = .138$).

DISCUSSION

The primary finding of this study was that patients who preferred BTB autograft were more likely to rate the risk of additional operation because of graft failure and the RTP rate as highly important, whereas individuals who preferred hamstring autograft were more likely to rate the risk of developing pain while kneeling and the risk of developing a significant complication within 3 months as highly important when controlling for age, sex, and BMI. The risk ratio from the return-to-sport variable was particularly striking, as patients from the BTB group were 49% more likely to rate RTP as highly important. Because significant differences between groups in patient preferences were found, the hypothesis was rejected.

Discrete choice experiments examining patient preferences in the setting of orthopaedic procedures have been studied previously in the orthopaedic literature. A discrete choice experiment by Hutyra et al[10] sought to evaluate patient decision making in the setting of knee arthroplasty. However, the methodology of the study differed from that of the present study in several key ways. First, they surveyed patients with osteoarthritis of the knee who were considered potential future candidates for knee arthroplasty. Second, they divided patients into 2 cohorts (based on Oxford

Knee Scores) before survey administration: a "good function" cohort and a "poor function" cohort. This was done to assess the effect of current knee function on the decision-making process. Overall, the purpose was to determine what factors were important for patients when deciding between total knee arthroplasty and unicompartmental knee arthroplasty, and the authors concluded that complication and revision rates were the most important factors to patients in both cohorts. However, patients in the good function cohort tended to prefer unicompartmental knee arthroplasty, and patients in the poor function cohort tended to prefer total knee arthroplasty.[10]

Although our study surveyed a population that served as a proxy for healthy controls and did not divide participants based on functional status, the results strongly suggest that patient preferences may play a larger role in ACL graft choice selection than in knee arthroplasty selection. Although the decision-making process for ACL graft choice is multifactorial, this study shows that participation in sport may play a large part in graft decision making and that patient preferences differ based on the treatment option of choice. Surgeon preferences are heavily predictive of the graft used,[15] but patient preferences may not align.

A recent meta-analysis by DeFazio et al[5] pooled data from 20 articles studying a total of 2348 athletes and found that RTP rates were higher in patients who received a BTB graft than in those who had received a hamstring graft. Furthermore, a study by the Multicenter Orthopaedic Outcomes Network Knee Group analyzed revision rates in athletes specifically and found that within a cohort of 839 high school and college-aged athletes, patients who received a BTB graft were less likely to require a revision than patients who received a hamstring graft (7.1% vs 13.0%).[15] Interestingly, this study also evaluated the variables predictive of graft choice during primary reconstruction. Surgeon preference had, by a large margin, the strongest influence on graft choice (a finding that was also demonstrated by Salminen et al[18]). Other variables that were studied included competition level, age, high-grade knee laxity, BMI, baseline Marx, sex, and sport.[15] Interestingly, patient goals or values were not analyzed. The importance of these findings is highlighted by the findings from the present study, as 81% of all self-reported athletes expressed a preference for the BTB graft; this can likely be attributed to the fact that these patients highly valued RTP as an outcome parameter.

Patients who expressed a preference for the hamstring graft tended to value the fact that this option offered a lower risk of developing pain while kneeling.[26] Given the relatively small number of athletes in this group, this outcome suggests that nonathletes may tend to value pain-free, quality-of-life metrics instead of return-to-sport or revision rates. Given these differences, athletes (including recreational athletes) and nonathletes should be thoroughly counseled on the outcome variables that they are most likely to value. In athletes, these factors may include return-to-sport rate, and in nonathletes, this may include quality-of-life factors such as the risk of developing pain while kneeling.

Despite the differences that existed between the hamstring group and the BTB group, it is worth noting that many descriptive variables, such as age, sex, BMI, race, level of education, and employment status, did not significantly differ between groups. These findings suggest that the previously discussed variables are applicable to a broad population. In addition, excluding individuals with a history of ACL tear was crucial because it is possible that patient counseling during the perioperative period may have biased patient preferences. After sustaining an actual ACL tear, these patients likely had a different perspective on the discrete choice experiment than patients with no history of ACL injury.

The current paucity of literature on patient graft choice preferences highlights a need for further research. Previous studies have demonstrated that surgeon preference is the strongest factor when deciding what type of graft to use for ACL reconstruction,[15,18] but little work has been done to highlight how patient goals and values may be associated with specific treatment options. To our knowledge, there has not been a study that weighs patient preferences to determine which outcome parameters specific patient groups are most interested in. This study demonstrates that summarizing the current body of literature into several key data points might provide an opportunity to more decisively elucidate patients' preference of graft choice, thus strengthening the connection between evidence-based medicine and patient-centered care. Although there is no clear-cut algorithm for this, understanding patient values and goals for surgery can assist surgeons in making decisions that are most beneficial to patients. The larger question is determining whether graft preference is a fixed value or whether it changes over time or when patients are confronted with an actual ACL injury. Further research will help to define these trends.

Strengths and Limitations

One strength of this study is its relatively large sample size. However, the study also has several limitations. First, previous studies have documented a significantly higher incidence of ACL tears in women than in men.[16,22] However, 66.4% of the participants in our study were male. This was likely reflective of the demographics of the patient population that was surveyed (Current Procedural Terminology codes 29806, 29807, and 29822). Within the age range of interest, shoulder arthroscopy tends to be performed more frequently in male patients.[4] Second, choosing a graft for ACL reconstruction is a complex decision, during which multiple patient-specific factors should be weighed. Consolidating this information into a table for use in the discrete choice experiment may represent an oversimplification. However, we did this deliberately to ensure that as many patients as possible found the table easy to understand, regardless of the level of health literacy. To this point, although we included studies with a high level of evidence as the basis of our discrete choice experiment, there are certain topics for which the data are still poorly defined in the literature. In addition, patients might have had a difficult time interpreting the implications of minor differences

in probability toward an adverse outcome. Another limitation is that this study assumes that all surgeons are equally comfortable with multiple techniques, whereas this may not always be the case. Finally, we chose to survey patients aged 18 to 25 years undergoing shoulder arthroscopy who were $\geq$2 years removed from surgery as a proxy for healthy controls, but unidentified variables within this population might have biased the results. For example, there is the potential for bias depending on the patients' operative experience.

CONCLUSION

The study hypothesis was rejected, as patient values did affect the preference for ACL graft choice. Using patient-selected values in a quantifiable way can benefit the shared decision-making process before ACL reconstruction.

REFERENCES

1. Bansal A, Lamplot JD, VandenBerg J, Brophy RH. Meta-analysis of the risk of infections after anterior cruciate ligament reconstruction by graft type. *Am J Sports Med*. 2018;46(6):1500-1508. doi:10.1177/0363546517714450
2. Brown MJ, Carter T. ACL allograft: advantages and when to use. *Sports Med Arthrosc Rev*. 2018;26(2):75-78. doi:10.1097/JSA.0000000000000194
3. Chen W, Li H, Chen Y, Jiang F, Wu Y, Chen S. Bone–patellar tendon–bone autografts versus hamstring autografts using the same suspensory fixations in ACL reconstruction: a systematic review and meta-analysis. *Orthop J Sports Med*. 2019;7(11):2325967119885314. doi:10.1177/2325967119885314
4. Cvetanovich GL, Gowd AK, Agarwalla A, Forsythe B, Romeo AA, Verma NN. Trends in the management of isolated SLAP tears in the United States. *Orthop J Sports Med*. 2019;7(3):2325967119833997. doi:10.1177/2325967119833997
5. DeFazio MW, Curry EJ, Gustin MJ, et al. Return to sport after ACL reconstruction with a BTB versus hamstring tendon autograft: a systematic review and meta-analysis. *Orthop J Sports Med*. 2020;8(12):2325967120964919. doi:10.1177/2325967120964919
6. Frosch DL, Kaplan RM. Shared decision making in clinical medicine: past research and future directions. *Am J Prev Med*. 1999;17(4):285-294. doi:10.1016/S0749-3797(99)00097-5
7. Harris PA, Taylor R, Minor BL, et al. The REDCap consortium: building an international community of software platform partners. *J Biomed Inform*. 2019;95:103208. doi:10.1016/j.jbi.2019.103208
8. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42(2):377-381. doi:10.1016/j.jbi.2008.08.010
9. He X, Yang XG, Feng JT, et al. Clinical outcomes of the central third patellar tendon versus four-strand hamstring tendon autograft used for anterior cruciate ligament reconstruction: a systematic review and subgroup meta-analysis of randomized controlled trials. *Injury*. 2020;51(8):1714-1725. doi:10.1016/j.injury.2020.05.025
10. Hutyra CA, Gonzalez JM, Yang JC, et al. Patient preferences for surgical treatment of knee osteoarthritis: a discrete-choice experiment evaluating total and unicompartmental knee arthroplasty. *J Bone Joint Surg Am*. 2020;102(23):2022-2031. doi:10.2106/JBJS.20.00132
11. Kaeding CC, Pedroza AD, Reinke EK, Huston LJ; MOON Consortium, Spindler KP. Risk factors and predictors of subsequent ACL injury in either knee after ACL reconstruction: prospective analysis of 2488 primary ACL reconstructions from the MOON cohort. *Am J Sports Med*. 2015;43(7):1583-1590. doi:10.1177/0363546515578836
12. Kraeutler MJ, Bravman JT, McCarty EC. Bone–patellar tendon–bone autograft versus allograft in outcomes of anterior cruciate ligament reconstruction: a meta-analysis of 5182 patients. *Am J Sports Med*. 2013;41(10):2439-2448. doi:10.1177/0363546513484127
13. Leys T, Salmon L, Waller A, Linklater J, Pinczewski L. Clinical results and risk factors for reinjury 15 years after anterior cruciate ligament reconstruction: a prospective study of hamstring and patellar tendon grafts. *Am J Sports Med*. 2012;40(3):595-605. doi:10.1177/0363546511430375
14. Mo Z, Li D, Yang B, Tang S. Comparative efficacy of graft options in anterior cruciate ligament reconstruction: a systematic review and network meta-analysis. *Arthrosc Sports Med Rehabil*. 2020;2(5):e645-e654. doi:10.1016/j.asmr.2020.05.007
15. MOON Knee Group; Spindler KP, Huston LJ, Zajichek A, et al. Anterior cruciate ligament reconstruction in high school and college-aged athletes: does autograft choice influence anterior cruciate ligament revision rates? *Am J Sports Med*. 2020;48(2):298-309. doi:10.1177/0363546519892991
16. Prodromos CC, Joyce BT, Shi K, Keller BL. A meta-analysis of stability after anterior cruciate ligament reconstruction as a function of hamstring versus patellar tendon graft and fixation type. *Arthroscopy*. 2005;21(10):1202. doi:10.1016/j.arthro.2005.08.036
17. Rousseau R, Labruyere C, Kajetanek C, Deschamps O, Makridis KG, Djian P. Complications after anterior cruciate ligament reconstruction and their relation to the type of graft: a prospective study of 958 cases. *Am J Sports Med*. 2019;47(11):2543-2549. doi:10.1177/0363546519867913
18. Salminen M, Kraeutler MJ, Freedman KB, et al. Choosing a graft for anterior cruciate ligament reconstruction: surgeon influence reigns supreme. *Am J Orthop (Belle Mead NJ)*. 2016;45(4):e192-e197.
19. Samuelsen BT, Webster KE, Johnson NR, Hewett TE, Krych AJ. Hamstring autograft versus patellar tendon autograft for ACL reconstruction: is there a difference in graft failure rate? A meta-analysis of 47,613 patients. *Clin Orthop Relat Res*. 2017;475(10):2459-2468. doi:10.1007/s11999-017-5278-9
20. Speckemeier C, Krabbe L, Schwenke S, Wasem J, Buchberger B, Neusser S. Discrete choice experiment to determine preferences of decision-makers in healthcare for different formats of rapid reviews. *Syst Rev*. 2021;10(1):121. doi:10.1186/s13643-021-01647-z
21. Thompson SM, Salmon LJ, Waller A, Linklater J, Roe JP, Pinczewski LA. Twenty-year outcome of a longitudinal prospective evaluation of isolated endoscopic anterior cruciate ligament reconstruction with patellar tendon or hamstring autograft. *Am J Sports Med*. 2016;44(12):3083-3094. doi:10.1177/0363546516658041
22. Toth AP, Cordasco FA. Anterior cruciate ligament injuries in the female athlete. *J Gend Specif Med*. 2001;4(4):25-34.
23. Wasserstein D, Sheth U, Cabrera A, Spindler KP. A systematic review of failed anterior cruciate ligament reconstruction with autograft compared with allograft in young patients. *Sports Health*. 2015;7(3):207-216. doi:10.1177/1941738115579030
24. Widner M, Dunleavy M, Lynch S. Outcomes following ACL reconstruction based on graft type: are all grafts equivalent? *Curr Rev Musculoskelet Med*. 2019;12(4):460-465. doi:10.1007/s12178-019-09588-w
25. Xie X, Liu X, Chen Z, Yu Y, Peng S, Li Q. A meta-analysis of bone-patellar tendon-bone autograft versus four-strand hamstring tendon autograft for anterior cruciate ligament reconstruction. *Knee*. 2015;22(2):100-110. doi:10.1016/j.knee.2014.11.014
26. Zhao L, Lu M, Deng M, Xing J, He L, Wang C. Outcome of bone–patellar tendon–bone vs hamstring tendon autograft for anterior cruciate ligament reconstruction: a meta-analysis of randomized controlled trials with a 5-year minimum follow-up. *Medicine (Baltimore)*. 2020;99(48):e23476. doi:10.1097/MD.0000000000023476

APPENDIX
Study Survey[a]

1. Do you currently play or regularly participate in a sport?
   (a) Yes
   (b) No
2. What sport do you play?
   (a) Baseball
   (b) Basketball
   (c) Cross-country
   (d) Field hockey
   (e) Football
   (f) Golf
   (g) Gymnastics
   (h) Hockey
   (i) Lacrosse
   (j) Rowing
   (k) Soccer
   (l) Swimming
   (m) Track and field
   (n) Volleyball
   (o) Wrestling
   (p) Other
3. Is this a contact sport?
   (a) Yes
   (b) No
4. What level of sport do you currently participate in?
   (a) Recreational
   (b) High school
   (c) College
   (d) Semiprofessional
   (3) Professional
5. What is the highest level of sport that you can realistically see yourself participating in?
   (a) Recreational
   (b) High school
   (c) College
   (d) Semiprofessional
   (e) Professional
6. What is the highest level of education that you have completed?
   (a) Elementary school
   (b) High school
   (c) College
   (d) Graduate school
7. Which of the following most accurately represents your employment status?
   (a) Full-time ($\geq$40 hours per week)
   (b) Part-time ($<$40 hours per week)
   (c) Not employed
   (d) Retired
8. Do you consider your job to be physically demanding?
   (a) Yes
   (b) No
9. Have you ever torn your ACL?
   (a) Yes
   (b) No
   (c) Unsure

(continued)

APPENDIX (continued)

Please answer the following questions even if you have never had a knee injury

10. Based on the following information, if you were to tear your ACL and required surgery to fix it, would you prefer to get surgery A or surgery B?
    (a) Surgery A
    (b) Surgery B

Surgery A	Surgery B
5% chance of developing a significant complication within 3 months	**7%** chance of developing a significant complication within 3 months
71% chance of returning to sport	**80%** chance of returning to sport
21% chance of pain while kneeling	**28%** chance of pain while kneeling
5% chance that the ACL repair surgery will fail and an additional surgery will be required to fix it	**3%** chance that the ACL repair surgery will fail and an additional surgery will be required to fix it

11. How important was the risk of developing a significant complication at 3 months in your decision-making process?
    (a) Not important at all
    (b) Somewhat important
    (c) Important
    (d) Very important
    (e) Extremely important
12. How would you rate the importance of being able to return to sport in your decision-making process?
    (a) Not important at all
    (b) Somewhat important
    (c) Important
    (d) Very important
    (e) Extremely important
13. How important was the risk of developing pain while kneeling in your decision-making process?
    (a) Not important at all
    (b) Somewhat important
    (c) Important
    (d) Very important
    (e) Extremely important
14. How important was the risk of requiring an additional surgery due to failure of the initial ACL repair in your decision-making process?
    (a) Not important at all
    (b) Somewhat important
    (c) Important
    (d) Very important
    (e) Extremely important
15. If given the option, would you choose to undergo this procedure?
    (a) Yes
    (b) No

[a]ACL, anterior cruciate ligament.