

Choosing a Graft for Anterior Cruciate Ligament Reconstruction: Surgeon Influence Reigns Supreme

Matthew Salminen, BA, Matthew J. Kraeutler, MD, Kevin B. Freedman, MD, Brad S. Tucker, MD, John P. Salvo, MD, Michael G. Ciccotti, MD, and Steven B. Cohen, MD

Abstract

Selection of a graft type is an important decision for patients undergoing reconstructive surgery for a ligamentous injury. The purpose of this study was to determine the weight of key factors affecting patient selection of graft type for anterior cruciate ligament (ACL) reconstruction and to assess patients' knowledge of their particular graft type. We prospectively enrolled 304 patients who underwent primary ACL reconstruction. Patients filled out questionnaires at their first follow-up appointment after surgery and at least 1 year postoperatively. Questionnaires asked which type of graft was used and why

they chose that graft. At their first postoperative appointment, 88% of autograft patients and 71% of allograft patients were accurate in stating their graft type and harvest location. The most common factor influencing graft selection was physician recommendation (81.6%). At the time of follow-up, 96% of patients were satisfied with their graft choice. There is a high rate of accuracy with which patients remember the type of graft used for their ACL reconstruction. The majority of patients undergoing ACL reconstruction are primarily influenced by the physician's recommendation.

Anterior cruciate ligament (ACL) injuries affect >175,000 people each year,¹ with >100,000 Americans undergoing ACL reconstruction annually.² Due to the high impact this injury has on the general population, and especially on athletes, it is important to determine the factors that influence a patient's selection of a particular graft type. With increasing access to information and other outside influences, surgeons should attempt to provide as much objective information as possible in order to allow patients to make appropriate informed decisions regarding their graft choice for ACL surgery.

While autografts are used in >60% of primary ACL reconstructions, allografts are used in >80% of revision procedures.³ Both autografts and allografts offer advantages and disadvantages, and the advantages of each may depend on patient age, activity level, and occupation.⁴ For example, graft rupture rates have been shown to be higher

in patients with ACL allografts⁴, while kneeling pain has been shown to be worse in patients with bone-patellar tendon-bone (BPTB) autografts compared to hamstring autografts⁵ as well as BPTB allografts.⁴

Patient satisfaction rates are high for ACL autografts and allografts. Boonriong and Kietsiriroje⁶ have shown visual analog scale (VAS) patient satisfaction score averages to be 88 out of 100 for BPTB autografts and 93 out of 100 for hamstring tendon autografts. Fox and colleagues⁷ showed that 87% of patients were completely or mostly satisfied following revision ACL reconstruction with patellar tendon allograft. Cohen and colleagues⁸ evaluated 240 patients undergoing primary ACL reconstruction; 63.3% underwent ACL reconstruction with an allograft and 35.4% with an autograft. Of all patients enrolled in the study, 93% were satisfied with their graft choice, with 12.7% of patients opting to choose another graft if in the

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same situation again. Of those patients, 63.3% would have switched from an autograft to allograft. Although these numbers represent high patient satisfaction following a variety of ACL graft types, it is important to continue to identify graft selection factors in order to maximize patient outcomes.

The purposes of this prospective study were to assess patients' knowledge of their graft type used for ACL reconstruction, to determine the most influential factors involved in graft selection, and to determine the level of satisfaction with the graft of choice at a minimum of 1-year follow-up. Based on a previous retrospective study,⁸ we hypothesized that physician recommendation would be the most influential factor in ACL graft selection. We also hypothesized that patients receiving an autograft would be more accurate in stating their graft harvest location compared to allograft patients.

Materials and Methods

We prospectively enrolled 304 patients who underwent primary ACL reconstruction from January 2008 to September 2013. Surgery was performed by 9 different surgeons within the same practice. All patients undergoing primary ACL reconstruction were eligible for the study.

All surgeons explained to each patient the pros and cons of each graft choice based upon peer-reviewed literature. Each patient was allowed to choose autograft or allograft, although most of the surgeons strongly encourage patients under age 25 years to choose autograft. One of the surgeons specifically encourages a patellar tendon autograft in patients under age 30 to 35 years, except for those patients with a narrow patellar tendon on magnetic resonance imaging, in which case he recommends a hamstring autograft. Another surgeon also specifically encourages patellar tendon autograft in patients under 35 years, except in skeletally immature patients, for whom he encourages hamstring autograft. However, none of the surgeons prohibited patients from choosing autograft or allograft, regardless of age.

The Institutional Review Board at our institution provided approval for this study. At the first postoperative follow-up appointment, each patient completed a questionnaire asking to select from a list the type ("your own" or "a cadaver") and harvest site of the graft that was used for the surgery. Patients were also asked how they decided upon that graft type by ranking a list of 4 factors from 1 to 4. These included (1) physician recommendation, (2) family/friend's recommendation, (3) coach's

recommendation, and (4) the media. Patients had the option of ranking more than one factor as most important in their decision. In addition, patients were asked to list any other factors that influenced their decision regarding graft type.

At a minimum of 1 year following surgery, patients completed the same questionnaire described above. In addition, patients were asked if they were satisfied with their graft and whether they would choose the same graft type if undergoing ACL reconstruction again. Patients who would have chosen a different graft were asked which graft they would have chosen and why. Any patient who experienced graft rupture prior to follow-up was included in the analysis.

Statistical Analysis

Chi square tests were used to compare dichotomous outcomes. A type I error of less than 5% ($P < .05$) was considered statistically significant.

Results

At least 1 year following ACL reconstruction, 213 of 304 patients (70%) successfully completed the same questionnaire as they did at their first postoperative follow-up appointment. The mean age of these patients at the time of surgery was 31.9 ± 11.0 years (range, 13.9 to 58.0 years). The mean follow-up time was 1.4 ± 0.4 years (range, 1.0 to 2.6 years), and 59% of these patients were male.

Autografts were used for 139 patients (139/304, 46%), allografts for 156 patients (156/304, 51%), and hybrid grafts for 9 patients (9/304, 3%). Overall, 77% of patients were accurate in stating the type of graft used for their ACL reconstruction, including 88% of autograft patients, 71% of allograft patients, and 11% of hybrid graft patients (**Table 1**). Patients who underwent reconstruction with an autograft were significantly more accurate in stating their graft type compared to patients with an allograft ($P < .001$). Graft type by surgeon is shown in **Table 2**. A statistically significant difference was found in the proportion of patients choosing autograft versus allograft based on surgeon ($P < .0001$).

When asked which type of graft was used for their surgery, 12 of 304 patients (4%) did not know their graft type or harvest location. Twenty-nine patients stated that their graft was an allograft but did not know the harvest location. Five patients stated that their graft was an autograft but did not know the harvest location. The 34 patients who classified their choice of graft but did not know the harvest site (11%) stated their surgeon never told

Table 1. Accuracy of Graft Type Responses

Graft Type/Accuracy	Correct	Incorrect	Total
Autograft	122 (41.4%)	17 (5.8%)	139
Allograft	111 (37.6%)	45 (15.3%)	156
Total	233	62	295

A 2-by-2 contingency table is presented for patients who underwent anterior cruciate ligament reconstruction with an autograft or allograft (N = 295). Each patient was asked to state the graft type and harvest site used for their surgery at their first postoperative visit. Patients who correctly stated both the graft type and harvest site were listed as correct. Patients who incorrectly stated either the graft type or harvest site were listed as incorrect.

Table 2. Graft Selection by Surgeon

Surgeon	Autograft	Allograft
1	54 (31%)	118 (69%)
2	38 (81%)	9 (19%)
3	10 (37%)	17 (63%)
4	11 (79%)	3 (21%)
5	7 (70%)	3 (30%)
6	7 (100%)	0 (0%)
7	6 (86%)	1 (14%)
8	5 (83%)	1 (17%)
9	1 (20%)	4 (80%)
Total	139 (47%)	156 (53%)

A significant difference was found in the proportion of patients choosing autograft versus allograft based on surgeon. Note: Hybrid grafts are not included in this table.

them where their graft was from or they did not remember. A complete list of graft type responses is shown in **Table 3**.

Of the 29 patients who stated that their graft was an allograft but did not know the harvest location, 19 (66%) had a tibialis anterior allograft, 7 (24%) had a BPTB allograft, 2 (7%) had an Achilles tendon allograft, and 1 (3%) had a tibialis anterior autograft.

Physician recommendation was the most important decision-making factor listed for 82% of patients at their first postoperative appointment (**Table 4**). In addition to the 4 factors listed on our survey, patients were allowed to write in other factors involved in their decision. The most popular answers included recovery time, personal research on graft types, and prior personal experience with ACL reconstruction on the contralateral knee.

At the time of 1-year follow-up, 205 of 213 patients (96%) said they were satisfied with their graft choice (**Table 5**). All 4 unsatisfied autograft patients received a hamstring autograft, 3 of which were performed by the same surgeon. No significant difference was found in satisfaction rates between patients with autograft vs allograft ($P = .87$). There was a higher satisfaction rate among patients with a BPTB autograft compared to those with a hamstring autograft ($P = .043$). Of the unsatisfied patients, 3 patients stated that their graft had failed in the time prior to follow-up and 2 patients stated that they were having donor site pain following surgery with hamstring autograft and would consider an allograft if the reconstruction were repeated (**Table 6**). Two patients stated that they were unsatisfied with their graft but would need to do more research before deciding on a different graft type.

As shown in Tables 5 and 6, there is a discrepancy between the number of patients who were unsatisfied with their graft and the number of patients who stated that they would switch to a different graft type if they were to have ACL reconstruction again. A number of patients stated that they were satisfied with their graft, yet they would switch to a different graft. The main reasons for this related to issues from a hamstring autograft harvest site. One patient noted that although she was satisfied with her graft, she would switch after doing further research.

Discussion

Determining the decision-making factors for patients choosing between graft types for ACL reconstruction is important to ensure that patients can make a decision based on objective information. Several previous studies have evaluated patient selection of ACL grafts.⁹⁻¹⁰ All 3 of these studies showed that surgeon recommendation is the primary factor in a patient's decision. Similar to previous studies, we also found that physician recommendation is the most influential factor involved in this decision.

At an average follow-up of 41 months, Cohen and colleagues⁹ found that 1.3% of patients did not know whether they received an autograft or allograft for their ACL reconstruction. Furthermore, 50.7% of patients stating they received an allograft in Cohen's study⁹ were unsure of the harvest location. In our study, 4% of patients at their first postoperative visit did not know whether they had received an autograft or allograft and 10% of

patients stating they received an allograft selected an unknown harvest site. In contrast, only 2% of autograft patients in our study were unsure of the harvest location at their first postoperative appointment. It is likely that, over time, patients with an allograft forget the harvest location, whereas autograft patients are more likely to remember the location of harvest. This is especially true in patients with anterior knee pain or hamstring pain following ACL reconstruction with a BPTB or hamstring tendon autograft, respectively.

In terms of patients' knowledge of their graft type, we found an overall accuracy of 77%, with 88% of autograft patients, 71% of allograft patients, and 11% of hybrid graft patients remembering their graft type and harvest location. Although we do not believe it to be critical for patients to remember these details, we do believe that patients who do not know their graft type likely relied on the recommendation of their physician.

We found a significant difference in the proportion of patients choosing autograft vs allograft based on surgeon, despite these surgeons citing available data in the literature to each patient and ultimately allowing each patient to make his or her own decision. This is partly due to the low sample size of most of the surgeons involved. However, the main reason for this distortion is likely that different surgeons may highlight different aspects of the literature to "spin" patients towards one graft or another in certain cases.

Currently, there remains a lack of clarity in the literature on appropriate ACL graft choices for patients. With constant new findings being published on different aspects of various grafts, it is important for surgeons to remain up to date with the literature. Nevertheless, we believe that certain biases are inevitable among surgeons due to unique training experiences as well as experience with their own patients.

Cohen and colleagues⁸ found that only 7% of patients reported that their own personal research influenced their decision, and only 6.4% of patients reported the media as their primary decision-making factor. Cheung and colleagues⁹ conducted a retrospective study and found that more than half of patients did significant personal research prior to making a decision regarding their graft type. Most of this research was done using medical websites and literature. Koh and colleagues¹⁰ noted that >80% of patients consulted the internet for graft information before making a decision. Koh's study¹⁰ was performed in Korea and

Table 3. Graft Selection by Type

Graft Type	Number of Patients	% of Patients
<i>Autograft</i>	137	45.1
Patellar tendon	50	16.5
Hamstring tendon	87	28.6
<i>Allograft</i>	118	38.8
Patellar tendon	15	4.9
Achilles tendon	3	1
Tibialis anterior tendon	94	30.9
Tibialis posterior tendon	6	2
<i>Hybrid graft</i>	2	0.7
<i>Total Unknown</i>	47	15.4
Autograft, unknown location	5	1.6
Allograft, unknown location	29	9.5
Unknown graft, known location	1	0.3
Unknown graft, unknown location	12	4
Total	304	100

All patients were asked to state the type and harvest site of the graft used for their anterior cruciate ligament reconstruction at their first postoperative follow-up appointment.

Table 4. Factors for Graft Selection

Factors	Number of Patients
Primary factors	
Physician recommendation	248
Family/friend recommendation	46
Media	13
Coach's recommendation	11
Secondary factors	
Recovery time	18
Internet/personal research	13
Previous experience with ACL reconstruction	13
on contralateral knee	
Less pain	7
Potential for infection	3

All patients were asked to state the most influential factor in determining graft type for anterior cruciate ligament (ACL) reconstruction at their first postoperative visit. Patients were offered 4 factors ("primary factors") and asked to order them according to importance. Patients were also asked to write in any secondary factors that may have influenced their decision. Note: Some patients stated more than one primary factor as most important in their decision.

Table 5. Patient Satisfaction of Graft Selection

	Number of Patients	% of Patients
Satisfied with selection	205	96.2
Allograft	113	53.1
Autograft	85	39.9
Hybrid	7	3.3
Unsatisfied with selection	8	3.8
Allograft	4	1.9
Autograft	4	1.9
Hybrid	0	0.0
Total	213	100

All patients at 1-year follow-up were asked if they were satisfied with their surgery.

Table 6. Opinion on Future Graft Selection

	Number of Patients	% of Patients
Same graft	198	93.0
Different graft	15	7.0
Autograft to allograft	11	5.2
Allograft to autograft	4	1.9
Total	213	100

All patients at 1-year follow-up were asked if they would choose the same graft type or switch to a different graft if they were to undergo anterior cruciate ligament reconstruction again.

therefore the high prevalence of internet use may be culturally-related.

Overall, quality of information for patients undergoing ACL reconstruction is mixed across the internet, with only 22.5% of top websites being affiliated with an academic institution and 35.5% of websites authored by private physicians or physician groups.¹¹ Although a majority of internet websites offer discussion into the condition and surgical procedure of ACL reconstruction, less than half of these websites share the equally important information on the eligibility for surgery and concomitant complications following surgery.¹¹ In our study, only 39 patients (13%) listed the media as either the first (13, 4%) or second (26, 9%) most important factor in their graft decision. Clearly there is some discrepancy between studies regarding the influence of personal research and media. There are a few potential reasons for this. First, we did not explicitly ask patients if their own personal research had any influence on their graft decision. Rather, we asked patients to rank

their decision-making factors, and few patients ranked the media as their first or second greatest influence. Second, the word "media" was used in our questionnaire rather than "online research" or "internet." It may seem somewhat vague to patients what the word "media" really means in terms of their own research, whereas listing "online research" or "internet" as selection options may have influenced patient responses.

In our study, we asked patients for any additional factors that influenced their graft choice. Thirteen patients (4%) noted that "personal research" through internet, orthopaedic literature, and the media influenced their graft decision. This corroborates the idea that "media" may have seemed vague to some patients. Of these patients, 9 chose an autograft and 4 chose an allograft. The relative ease in accessing information regarding graft choice in ACL reconstruction should be noted. Numerous websites offer advice, graft options, and commentary from group practices and orthopaedic surgeons. Whether or not these sources provide reasonable support for one graft vs another graft remains to be answered. The physician should be responsible for providing the patient with this collected objective information.

In our study, 205 patients (96%) were satisfied with their graft choice at the time of follow-up, with 15 patients (7%) stating that they would have chosen a different graft type if they could redo the operation. Cheung and colleagues⁹ found a satisfaction rate of 87.4% at an average follow-up time of 19 months, with 4.6% stating they would have chosen a different graft type. Many factors can contribute to patient satisfaction after ACL reconstruction. Looking at patient variables such as age, demographics, occupation, activity level, surgical technique including tunnel placement and fixation, postoperative rehabilitation, and graft type may influence the success of the patient after ACL reconstruction.

The strengths of this study include the patient population size with 1-year follow-up as well as the prospective study design. In comparison to a previous retrospective study in 2009 by Cohen and colleagues⁸ with a sample size of 240 patients, our study collected 213 patients with 70% follow-up at minimum 1 year. Collecting data prospectively ensures accurate representation of the factors influencing each patient's graft selection, while follow-up data was useful for patient satisfaction.

The limitations of this study include the percentage of patients lost from follow-up as well as any

bias generated from the organization of the questionnaire. Unfortunately, with a younger, transient population of patients undergoing ACL reconstruction in a major metropolitan area, a percentage of patients are lost to follow-up. Many attempts were made to locate these patients. Another potential limitation was the order of decision factors listed on the questionnaire. These factors were not ordered randomly on each survey, but were listed in the following order: (1) physician recommendation (2) family/friend's recommendation (3) coach's recommendation and (4) the media. This may have influenced patient responses. The organization of these factors in the questionnaire started with physician recommendation, which may have influenced the patient's initial thought process of which factor had the greatest influence in their graft decision. In addition, for the surveys completed at least 1 year following surgery, some patients were contacted via e-mail and others via telephone. Thus, some patients may have changed their answers if they were able to see the questions rather than hearing the questions. We believe this is particularly true of the question regarding graft harvest site.

Our study indicates that the majority of patients undergoing ACL reconstruction are primarily influenced by the physician's recommendation.

Mr. Salminen is a Lab Logistics Specialist, Parexel International Corporation, Waltham, Massachusetts. Dr. Kraeutler is a Professional Research Assistant, University of Colorado School of Medicine, Boulder, Colorado. Dr. Freedman is an Associate Professor of Orthopaedic Surgery, Dr. Tucker is an Assistant Professor of Orthopaedic Surgery, Dr. Salvo is an Associate Professor of Orthopaedic Surgery, Dr. Ciccotti is an Endowed Professor of Orthopaedic Surgery, and Dr. Cohen is an Associate Professor of Orthopaedic Surgery, The Rothman Institute, Sidney Kimmel College of Medicine, Thomas Jefferson University, Philadelphia, Pennsylvania.

Address correspondence to: Steven Cohen, MD, The Rothman Institute, 1118 West Baltimore Pike, Health Center 4,

3rd Floor, Media, PA 19063 (tel, 1-800-321-9999; fax, 610-480-6045; email, steven.cohen@rothmaninstitute.com).

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