Effects of Patient Assessment and Education by an Integrated Care Team on Postoperative Adherence and Failure Rates After Osteochondral Allograft and Meniscal Allograft Transplantation in the Knee

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Background: Patient nonadherence with prescribed rehabilitation protocols is associated with up to 16 times higher likelihood of treatment failure after osteochondral allograft transplantation (OCA) and meniscal allograft transplantation.

Hypothesis: Patients who completed counseling with an orthopaedic health behavior psychologist as part of an evidence-based shift in practice at our institution would have significantly lower rates of nonadherence and surgical treatment failure versus patients who did not participate in counseling.

Study Design: Cohort study; Level of evidence, 2.

Methods: Patients in a prospective registry who underwent OCA and/or meniscal allograft transplantation between January 2016 and April 2021 were included for analysis when 1-year follow-up data were available. Of 292 potential patients, 213 were eligible for inclusion. Patients were categorized based on whether they participated in the preoperative counseling and postoperative patient management program: no health psych group (n = 172) versus health psych group (n = 41). Nonadherence was defined as documented evidence of a deviation from the prescribed postoperative rehabilitation protocol.

Results: In this cohort of patients, 50 (23.5%) were documented to be nonadherent. Patients in the no health psych cohort were significantly more likely to be nonadherent ($P = .023$; odds ratio [OR], 3.4). Tobacco use (OR, 7.9), higher preoperative Patient-Reported Outcomes Measurement Information System (PROMIS) Pain Interference score, lower preoperative PROMIS Mental Health score, older age, and higher body mass index were also significantly associated with nonadherence ($P < .001$ for all). Patients who were nonadherent with the prescribed postoperative rehabilitation protocol during the first year after transplantation were 3 times more likely ($P = .004$) to experience surgical treatment failure than those who were adherent. Overall, 26.2% of patients in the no health psych group experienced surgical treatment failure versus 12.2% in the health psych cohort.

Conclusion: Data from the present study suggest that preoperative counseling with a health behavior psychologist is associated with an improved rate of patient adherence and a lower proportion of surgical treatment failure after OCA and meniscal allograft transplantation. Patients who remained adherent to the postoperative protocol were 3 times more likely to have a successful short-term (≥1 year) outcome.

Keywords: adherence; health psychologist; knee osteoarthritis; osteochondral allograft; treatment outcomes

Osteochondral allograft transplantation (OCA) is a safe and effective surgical option for young, active patients with full-thickness articular cartilage loss in the knee.[15,22] For patients who are not indicated for unicompartmental knee arthroplasty (UKA) or total knee arthroplasty (TKA) based on age, activity level, and/or extent of pathology,[14,25] OCA transplantation can serve as an effective "bridging" procedure.[16,22] Reported outcomes after OCA transplantation in the knee vary widely depending on patient factors, cause of articular pathology, type and number of allografts transplanted, and method and timing of outcome assessments.[2,8,22] The highest functional survival and return to sport rates reported are consistently associated with isolated femoral condylar cylindrical "plug" OCAs, with the

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lowest rates reported for multisurface and bipolar OCAs.[8,22] In addition to large, multifocal transplants, other variables associated with inferior outcomes include older patient age, higher body mass index (BMI), tobacco use, lower OCA chondrocyte viability at the time of transplant, and nonadherence with prescribed postoperative rehabilitation protocols.[2,8,14,17,18] Successful outcomes after OCA transplantation require a relatively lengthy and restrictive postoperative rehabilitation, and nonadherence to the prescribed rehabilitation protocol during the first year after surgery has been reported to be associated with up to 15.5 times increased risk for OCA treatment failure.[5,17] As such, this modifiable risk factor deserves targeted research for application to clinical optimization, yet no such studies have been reported to date.

Based on our institution's programmatic evidence-based strategy for OCA transplantation, we implemented an integrated multidisciplinary team approach to mitigating modifiable risk factors to optimize associated outcomes.[6,17,18] The initial effort to address the nonadherence risk factor involved the integrated team's work to develop and implement evidence-based postoperative rehabilitation protocols and educate and support patients to adhere.[7,17] However, postoperative adherence remained the largest barrier to success after OCA transplantation surgery in our patient population.[17] As such, additional health care team- and system-based barriers to patient adherence were targeted. Health behavior psychologists have proven effective in screening patients to identify and moderate risk factors for postoperative adherence before complex surgeries, such as spinal cord stimulator implantation[4] and bariatric surgery.[9,21] Yet, health behavior psychologists have not routinely been included in pre- and postoperative patient care for complex orthopaedic surgeries.

In 2019, our institution committed to an evidence-based shift in practice by adding a health behavior psychologist (R.S.) to our team for preoperative counseling and postoperative patient management. The objective of the present study was to assess the effects of the inclusion of a health behavior psychologist as part of an integrated care team on postoperative adherence and associated outcomes for patients undergoing osteochondral and/or meniscal allograft transplantation in the knee. The study was designed to test the hypothesis that patients who completed counseling with the orthopaedic health behavior psychologist would have significantly lower rates of nonadherence and treatment failure.

METHODS

Study Patients

With institutional review board approval and documented informed consent, patients were prospectively enrolled into a registry dedicated to following outcomes after OCA and meniscal allograft transplantation[17,22,23] surgery between January 2016 and April 2021. All patients were eligible for inclusion in the registry if they were undergoing primary or revision osteochondral and/or meniscal allograft transplantation at a single institution to address symptomatic full-thickness cartilage loss and/or meniscal deficiency. All osteochondral and meniscal allografts used for this study were obtained from an American Association of Tissue Banks–accredited source (MTF Biologics) and used in conformance to the US Food and Drug Administration classification of a human cell and tissue product under section 361 of the Public Health Services Act. Tissues were preserved for up to 56 days after recovery using the Missouri Osteochondral Preservation System (MOPS).[22,23] Each patient spent considerable time (45-60 minutes) in preoperative consultation with the attending orthopaedic surgeon (J.P.S.) and the joint restoration health care team to discuss risks, benefits, expectations, and limitations associated with the planned procedure and recovery before consenting to transplantation surgery and consenting to enrollment in the registry.

Of the 292 patients with 1-year follow-up and documented registry consent, 213 (72.9%) were included for analysis. The use of non-MOPS allografts (n = 40) or revision allograft surgery (n = 39) resulted in the exclusion of 79 patients from analyses (Figure 1). Patients were not excluded from the analysis based on age, BMI, outcome, or tobacco use history.

Comparison Cohorts

The study patients were categorized into 2 groups based on their participation in the 2019 evidence-based shift in practice at our institution: no health psych group versus health psych group (Figure 1).

No Health Psych Cohort. Education on postoperative rehabilitation protocols was provided by an integrated care team specializing in joint preservation surgery. Preoperatively, the attending physician (J.P.S.) met with patients to discuss postoperative expectations for ambulation, range of motion, physical therapy, and return to activities. A physical therapist (PT) (C.R.C.) working alongside the

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Ethical approval for this study was obtained from the University of Missouri–Columbia (ref No. 2003053).

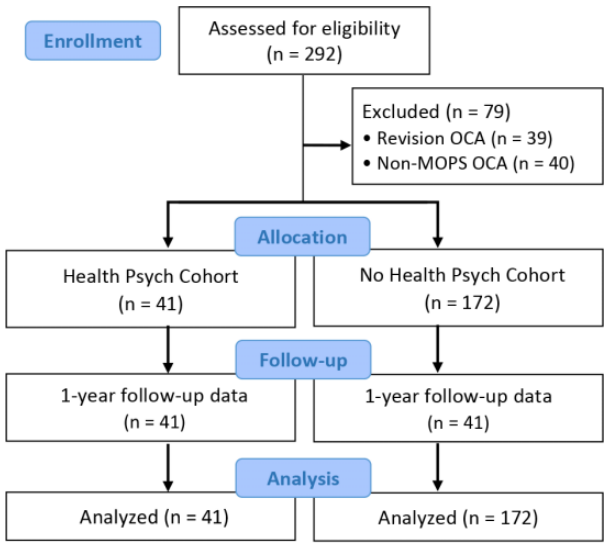

Figure 1. CONSORT (Consolidated Standards of Reporting Trials) flow diagram of patient inclusion. MOPS, Missouri Osteochondral Preservation System; OCA, osteochondral allograft transplantation.

physician provided a detailed handout describing the rehabilitation progression and was available to answer questions. Patients were counseled by the attending physician and/or the PT on return to work expectations and instructed to work with their employer on work accommodations as needed. Postoperatively, patients met with the PT for inpatient physical therapy. The PT demonstrated home exercises for the patient and discussed motion and weightbearing limits for the first stage (0-6 weeks) of recovery. At each postoperative appointment, the PT and/or the attending physician discussed the status of the patient's progress and provided instructions for the next stage of recovery, including updated weightbearing, range of motion, and activities. In addition, the integrated team's PT communicated with the patient's outpatient PT throughout the first year after surgery to ensure understanding and implementation of the prescribed physical therapy protocol, address related concerns and questions, and document any episodes of nonadherence.

Health Psych Cohort. In addition to all described above, the integrated team's health behavior psychologist met with patients preoperatively to assess and assist patients with identifying potential barriers to adherence, set expectations for postoperative protocols, and identify a plan to moderate risk factors to nonadherence. Most patients met with the health behavior psychologist once, but for patients with greater barriers to adherence or those who desired additional support, multiple visits were offered. After the health behavior psychologist met with the patient and before the final recommendation and clearance for transplantation surgery, the integrated team met to discuss patient-specific risks and barriers to adherence. Together, the team identified whether the patient was an appropriate candidate for transplantation surgery and communicated concerns, barriers, resources, and relative risks to the patient and his or her caregivers in a shared decision-making process regarding the ultimate treatment choice. For patients who proceeded with OCA and/or meniscal transplantation surgery, the integrated care team provided postoperative care as described above, and the health behavior psychologist was available for continued support as needed.

Surgical Procedure

All study patients underwent the same surgical procedure. The sizing of OCA and meniscal allograft was based on measurements obtained from calibrated radiographs or magnetic resonance imaging, which were matched by direct measurements obtained using calipers at the tissue bank. As previously described, single-surface OCA transplantations included unipolar cylindrical or shell grafts for the treatment of a single focal defect on the patella, trochlea, femoral condyle, or tibial plateau.[21] Multisurface OCA transplantations included unipolar cylindrical or shell grafts for the treatment of $\geq$2 focal defects on the patella, trochlea, femoral condyle, and/or tibial plateau.[21] Bipolar OCA transplantations included cylindrical or shell grafts for the treatment of apposing focal defects on the patella and trochlea or the femoral condyle and tibial plateau with or without the associated meniscus.[21] All OCA transplants were used to resurface large (>2.5 cm^2), grade 3 or 4 focal articular cartilage defects. Subchondral drill holes were created and the donor bone was thoroughly irrigated with 1 to 1.5 L of isotonic saline to remove marrow elements. The allograft bone was saturated with autogenous bone marrow aspirate concentrate (Angel System; Arthrex) immediately before implantation. OCAs were stabilized with either 2.0- or 2.4–mm cortical screws (DePuy Synthes), bioabsorbable pins (Arthrex), or bioabsorbable nails (ConMed) based on the discretion of the operating orthopaedic surgeon.[21] Meniscal allograft transplants were performed using a bone plug technique with suspensory fixation, meniscotibial ligament reconstruction, and capsular sutures or included as part of the tibial OCA transplant, as previously described.[20,22] Surgeries were performed by 1 of 3 orthopaedic surgeons (J.P.S.), with the majority (>98%) performed by 1 of the senior authors (J.P.S.).

Postoperative Management

Postoperative management protocols were standardized among the 3 surgeons. Surgical wounds were covered with occlusive petroleum gauze dressing, sterile abdominal pads, cast padding, and elastic bandage material until the patient was discharged from the hospital. Dressing changes using impermeable island dressings and elastic bandage material were performed by the attending physician, resident physician, or nursing staff as needed while the patient was an inpatient, on the day of discharge, and 5 to 7 days after surgery. Health care team members provided education on wound management, including written instructions regarding bandage and wound care, showering/bathing before suture removal, and a comprehensive postoperative rehabilitation protocol, as previously described.[7] Patients were instructed to immediately communicate any wound

concerns to the health care team and to return 2 weeks after surgery for a wound check and suture removal by the attending physician, resident physician, or nursing staff.

Outcome Measures

Data were collected preoperatively and at all postoperative visits, which were scheduled at 3 months, 6 months, and 1 year. Scores on the visual analog scale for pain,[3] International Knee Documentation Committee,[12] Patient-Reported Outcomes Measurement Information System (PROMIS) Mental Health,[11] and PROMIS Pain Interference[1] were self-reported by enrolled patients and entered into the database at each time point. Surgery date and type, surgeon, and patient variables—including age, sex, BMI, tobacco-use history, and patient-reported history of mental health issues (depression, anxiety)—were also entered into the registry database. All reported complications, reoperations, revisions, and failures were recorded. Treatment failure was defined as any reoperation to revise any of the osteochondral and/or meniscal allografts (revision) or for conversion to UKA or TKA in the affected knee. The decision to pursue revision surgery, TKA, or UKA was based on the attending orthopaedic surgeon's discussion of joint pathology, treatment options, and related prognosis in conjunction with patient preference. Functional survival (success) was defined as patient-reported pain and function scores improved from preoperative levels without the need for revision or arthroplasty at the final follow-up.

Patient Adherence

Patient adherence to the prescribed postoperative rehabilitation protocol was measured throughout the postoperative period through communication with the patient and the PT. Patient management by the PT was consistent for all included patients, with the PT calling or meeting with each patient preoperatively, performing therapy while the patient was still in the hospital, and calling or meeting with each patient at regular postoperative time points (2 weeks, 6 weeks, 3 months, 6 months, and 1 year). Patients were categorized as nonadherent when documented evidence of a break from the physical therapy protocol was recounted to a member of the health care team by the patient or the PT. Examples of nonadherence included returning to full weightbearing before being cleared by the health care team, participating in impact activities like running or jumping before the prescribed postoperative time point, or failing to participate in scheduled therapy and/or assessment follow-up appointments during the first year after transplantation.

Statistical Analysis

Data were included for analyses when applicable registry data were available for $\geq$1 year after surgery. The sample size was chosen via convenience sampling that included all registry patients meeting the inclusion criteria during the study period that was set a priori. Descriptive statistics were calculated to report means, ranges, and percentages. Patient adherence rates and outcomes were compared between the study cohorts. The chi-square or Fisher exact tests were used to analyze differences in proportions, while unpaired *t* tests or rank-sum tests were used to assess continuous or categorical data variables for differences between the cohorts. When significant differences in proportions were noted, odds ratios (ORs) and confidence intervals were calculated. Significance was set a priori at $P < .05$.

RESULTS

The mean age of the patients (N = 213) meeting the inclusion criteria was 36.7 years (range, 13-69 years), and the mean BMI was 28.7 kg/m$_2$ (range, 17-52 kg/m^2). Of the 213 patients, 128 (60.1%) were men and 41 patients (19.2%) were included in the health psych cohort. Based on preoperative and operative variables analyzed, patients in the health psych cohort were not significantly different from those in the no health psych cohort (Table 1). For the no health psych cohort, the mean follow-up was 52.7 months (range, 12-75 months), and the health psych cohort had a mean follow-up of 21.4 months (range, 12-36 months).

Patient Adherence

Of all study patients, 50 (23.5%) were documented to be nonadherent with their prescribed postoperative rehabilitation protocol. Of those who were nonadherent, 4 (8%) were in the health psych cohort versus 46 (92%) who were not. Patients in the no health psych cohort were significantly more likely to be nonadherent to postoperative rehabilitation protocols ($P = .023$; OR, 3.4). The addition of the health behavior psychologist's preoperative counseling and postoperative patient management was associated with a significant ($P = .02$) decrease in the rate of nonadherence from 26.7% to 9.8%. Tobacco use ($P < .001$; OR, 7.9), higher preoperative PROMIS Pain Interference score ($P < .001$), lower preoperative PROMIS Mental Health score ($P < .001$), older age ($P < .001$), and higher BMI ($P < .001$) were also significantly associated with nonadherence (Table 2).

Treatment Success/Failure

For patients in this study, 81.6% of adherent patients had successful outcomes (mean final follow-up, 46.7 months [range, 12-75 months]), while 40% of nonadherent patients required revision or TKA during the study period, suggesting that patients who were nonadherent with the prescribed postoperative rehabilitation protocol during the first year after transplantation were 3 times more likely ($P = .004$) to experience treatment failure than those who were adherent. In this cohort of patients, male sex ($P < .001$; OR, 3.4) and bipolar OCA transplantation surgeries ($P < .001$; OR, 5 [comparator = unipolar single and multisurface patients]) were also significantly associated with increased risk for treatment failure. Also, 26.2% of patients in the no health psych group experienced treatment failure versus 12.2% in the health psych cohort. Causes for treatment failures were similar between cohorts and included

TABLE 1
Preoperative and Perioperative Characteristics Between the No Health Psych and Health Psych Cohorts[a]

	No Health Psych (n = 172)	Health Psych (n = 41)	*P*
Age, y	37.24 ± 12.9 (13-69)	34.22 ± 12.2 (15-60)	.16
BMI, kg/m^2	28.74 ± 5.4 (17-48)	28.42 ± 6.3 (17-52)	.76
Sex			.63
Female	70 (40.7)	15 (36.6)	
Male	102 (59.3)	26 (63.4)	
Mental health history			.43
Yes	25 (14.5)	8 (19.5)	
No	147 (85.5)	32 (80.5)	
Tobacco use			.08
Yes	15 (8.7)	0 (0)	
No	157 (91.3)	41 (100)	
Number of surfaces			.26
Unipolar single	44 (25.6)	17 (41.5)	
Unipolar multisurface	23 (13.4)	1 (2.4)	
Bipolar	105 (61)	23 (56.1)	

[a]Data are presented as mean ± SD (range) or n (%). Bipolar, osteochondral allograft transplantations (OCAs) with or without meniscal allograft on opposing articular tibiofemoral or patellofemoral surfaces; BMI, body mass index; unipolar multisurface, focal OCAs on ≥2 nonapposing articular surfaces; unipolar single, focal OCA on 1 articular surface.

TABLE 2
Comparison of Patient and Surgical Variables Between Patients Who Were Adherent Versus Nonadherent to the Postoperative Rehabilitation Protocol[a]

	Adherence to Protocol (n = 163)	Nonadherence to Protocol (n = 50)	*P*	OR (95% CI)
Age, y	36.29 ± 13.3 (13-69)	37.86 ± 11 (16-64)	**<.001**	—
BMI, kg/m^2	27.94 ± 5.2 (17-48)	31.09 ± 6.3 (20-52)	**<.001**	—
Sex			.63	—
Female	70 (42.9)	15 (30)		
Male	93 (57.1)	35 (70)		
Mental health history			.47	—
Yes	26 (16)	7 (14)		
No	137 (84)	43 (86)		
Tobacco use			**<.001**	7.90 (2.6-24.4)
Yes	5 (3.1)	10 (20)		
No	158 (96.9)	40 (80)		
Preop VAS pain	5.62 ± 2.1 (0-10)	5.34 ± 1.8 (2.0-8.7)	.38	—
Preop IKDC	41.38 ± 12.6 (10.3-72.4)	39.57 ± 15.9 (8.1-78.2)	.49	—
Preop PROMIS-MH	52.09 ± 9.0 (25.1-67.6)	50.04 ± 8.8 (33.8-67.6)	**<.001**	—
Preop PROMIS-PI	60.15 ± 6.8 (38.7-76.4)	63.04 ± 6.2 (51.9-74.1)	**<.001**	—
Health behavior psychologist evaluation			**.023**	3.38 (1.1-10.0)
Yes	37 (22.7)	4 (8)		
No	126 (77.3)	46 (92)		
Number of surfaces			.47	—
Unipolar single	47 (28.8)	14 (28)		
Unipolar multisurface	21 (12.9)	3 (6)		
Bipolar	95 (58.3)	33 (66)		

[a]Data are presented as mean ± SD (range) or n (%). Bold *P* values indicate a statistically significant difference between groups ($P < .05$). Dashes indicate the odds ratio could not be calculated. Bipolar, osteochondral allograft transplantations (OCAs) with or without meniscal allograft transplantation on opposing articular tibiofemoral or patellofemoral surfaces; BMI, body mass index; IKDC, International Knee Documentation Committee; OR, odds ratio; Preop, preoperative; PROMIS-PI, Patient-Reported Outcomes Measurement Information System Pain Interference; PROMIS-MH, PROMIS Mental Health; unipolar multisurface, focal OCAs on ≥2 nonapposing articular surfaces; unipolar single, focal OCA on 1 articular surface; VAS, visual analog scale.

meniscal allograft transplantation tear and/or extrusion, allograft bone necrosis and/or collapse additional cartilage pathology, allograft cartilage erosion or delamination, or unknown etiology.

DISCUSSION

Inclusion of preoperative counseling and postoperative patient support by a health behavior psychologist as part

of integrated care team management for patients undergoing osteochondral and/or meniscal allograft transplantation in the knee was associated with significantly improved patient adherence to prescribed postoperative rehabilitation protocols and treatment success, allowing us to accept our hypothesis. Adherence with prescribed postoperative rehabilitation protocols was associated with a 3 times lower risk of treatment failure (revision surgery or TKA) for the patient population studied. Based on the inherent multifactorial complexity of clinical cohort comparisons, the significantly higher success rate for patients in the health psych cohort cannot be solely attributed to the completion of counseling with the health behavior psychologist. However, based on the lack of significant differences in patient characteristics and preoperative and operative variables in conjunction with the use of standardized surgical and postoperative management protocols for both cohorts, the data support the impact of this important addition to patient care in mitigating the crucial modifiable risk factor of nonadherence to optimize outcomes for patients undergoing this complex orthopaedic surgery.[17,18]

With the association of counseling with a health behavior psychologist and improved adherence established, single-factor binary analyses for initial delineation of other risk factors were performed. In addition to lack of counseling with the health behavior psychologist, tobacco use, higher preoperative PROMIS Pain Interference score, lower preoperative PROMIS Mental Health score, older age, and higher BMI were significantly associated with nonadherence in the present study. It is unlikely that tobacco use is causative for nonadherence in this patient population. However, tobacco use is frequently associated with increased risk for nonadherence[24,26] and can be considered an important marker to signify that a patient may need additional support during the postoperative period to maintain adherence. At the inception of our center, tobacco use was discouraged in patients considering OCA based on the risk for postoperative complications.[10,19] Once nonadherence was identified as the modifiable factor associated with the highest likelihood of treatment failure after OCA transplantation surgeries, measures were taken to further mitigate this risk factor. Currently, the health behavior psychologist assesses and counsels all patients preoperatively, identifying and providing resources to moderate risk factors for nonadherence. In addition, our center has instituted a policy for mandatory cessation of nicotine use as determined by urine testing before OCA transplantation surgery. Further, while studies have reported that BMI and older age are risk factors for treatment failure after OCA transplantation,[13,17] patients treated at our center are within indicated ranges established for these variables, except in rare cases of traumatic injuries for which patients are specifically counseled regarding increased risks and alternatives. Preoperative patient-reported outcome measures have not yet been used as the criteria for treatment decisions at our center. However, in conjunction with data from behavioral health testing batteries (Battery for Health Improvement–2), patient-reported outcome measures are considered when assessing patient outcomes to provide recovery expectations and further counseling.

In this cohort of patients, nonadherence with the prescribed postoperative rehabilitation protocol during the first postoperative year was associated with the highest risk for treatment failure. Nonadherent patients were 3 times more likely to require revision surgery or TKA, which corresponds well with previous studies.[17,22] Bipolar OCA transplantation was also significantly associated with an increased risk for treatment failure, which also mirrors previous studies.[14,22] In addition, male sex was associated with a higher risk for treatment failure, which in addition to age and BMI have been consistently identified as risk factors for failure after OCA transplantation.[8,13] In an attempt to mitigate these risk factors, our center has instituted standard eligibility requirements for OCA transplantation with respect to patient age ($\leq$55 years) and BMI ($\leq$35 kg/m^2), which are strictly upheld except for cases of overt trauma and/or contraindications for other surgical treatment options.[13] Importantly, these variables were similar between cohorts compared in the present study, and mitigation strategies were implemented in the same way for all patients.

It is important to note that while the health behavior psychologist identified potential barriers for postoperative adherence and factors that may lead to compromised outcomes after OCA, this individual did not make surgical treatment decisions. Rather, the health behavior psychologist met with the integrated team and shared patient expectations, barriers, enablers, and potential resources and tools for optimizing postoperative adherence and outcomes. In determining a subsequent recommended treatment plan, the physician-led team considered these variables in conjunction with the medical and surgical components to determine an optimized plan that included the patient's goals and current resources. The attending physician communicated this plan to the patient to identify barriers to adherence, outline resources and tools, and discuss potential advantages, disadvantages, and prognoses associated with potential treatment options in a shared decision-making process. In some cases, patients chose not to proceed with transplantation, and in other cases, patients were required to follow through on risk reduction prerequisites such as smoking cessation, weight reduction, and/or support system identification and implementation before proceeding with transplantation. In the latter scenario, patients were provided with resources to assist them in meeting these prerequisites or pursuing alternative treatment options. For patients who selected transplantation as a surgical treatment option, the integrated care team identified and helped to implement tools and resources for pre- and postoperative mitigation of barriers to adherence. The health behavior psychologist provided continued support as needed. This continued support included additional regularly scheduled visits or impromptu visits with the health behavior psychologist when the integrated team identified related patient needs.

Based on this emerging evidence regarding the impact of the role of health behavior psychologists in moderating the risk for nonadherence and associated treatment failure after OCA and meniscal transplantation surgeries in the knee, requests for their services will likely increase. All

services of the health behavior psychologist described in the present study were covered by health insurance payors with standard out-of-pocket costs, such that this intervention can be considered in line with current US-based health care practices. In light of the relatively small number of providers in this subspecialty, further research should determine the validity for nurse practitioners, nurse educators, and other members of the care team to appropriately implement similar preoperative and postoperative processes that effectively mitigate nonadherence. In addition, research in this area should target standardized definitions and metrics for adherence and tools (eg, behavioral health inventory testing battery) to identify potential barriers to adherence and validated methods to address or modify identified barriers for orthopaedic patient populations in a time- and cost-effective manner. Ultimately, a precision medicine approach to provide patient-centered education that partners with patients by identifying and planning for barriers to postoperative adherence and equipping patients for success in light of their expectations, resources, and tools is most likely to optimize adherence and associated outcomes after complex orthopaedic procedures such as OCA and meniscal transplantation surgeries.

Limitations

Limitations of the present study include the fact that it was completed at 1 facility specializing in joint preservation surgery and utilized 1 experienced health behavior psychologist and an integrated care team to carry out the aims of the research. The follow-up period for the cohort of patients who saw the health behavior psychologist was shorter (mean, 21.4 months) than for those who did not (mean, 52.7 months). While this did not influence 1-year adherence rates, it may have influenced failure rates as the reported mean time to failure after OCA transplantation has typically ranged from 14 to 18 months postoperatively.[8,22] Further, the effects of the number of postoperative visits with the health behavior psychologists were not analyzed. As such, future studies should include a larger cohort of patients with longer follow-ups. Adherence was self-reported by the patient or their treating outpatient PT, which could contribute to underreported nonadherence rates. In addition, treatment successes and failures cannot be directly attributed to a patient's adherence to prescribed postoperative rehabilitation protocols. Rather, adherence is a factor that, along with other factors, can increase or decrease the risk for treatment failure after OCA surgery.[8,13,17-19,22] In addition, research completed during this period led to evidence-based shifts in practice for surgical techniques, nonadherence risk education, and patient selection, such that the health behavior psychologist was likely not the only factor resulting in improved adherence. As such, single-factor binary analyses for the initial delineation of other risk factors were performed based on the interventional difference set a priori for this study. Subsequent studies can assess combinations of the defined risk factors when subcohorts reach sufficient size for valid multivariate analyses. Ongoing research at our center is focused on defining the full breadth of the patient, health care team, and health care system-related factors that contribute to a patient's ability to be adherent, as well as continuing to optimize modifiable risk factors that influence outcomes after these complex knee surgeries.

CONCLUSION

Data from the present study suggest that preoperative counseling with a health behavior psychologist is associated with an improved rate of patient adherence and a lower proportion of treatment failure after osteochondral and meniscal allograft transplantation surgery. Patients who completed counseling with an orthopaedic health behavior psychologist were 3.4 times more likely to remain adherent to their prescribed postoperative rehabilitation protocol. In this study, patients who remained adherent to the postoperative protocol were 3 times more likely to have a successful short-term ($\geq$1 year) outcome.

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REFERENCES

1. Askew RL, Cook KF, Revicki DA, Cella D, Amtmann D. Evidence from diverse clinical populations supported clinical validity of PROMIS pain interference and pain behavior. *J Clin Epidemiol*. 2016;73:103-111.
2. Assenmacher AT, Pareek A, Reardon PJ, Macalena JA, Stuart MJ, Krych AJ. Long-term outcomes after osteochondral allograft: a systematic review at long-term follow-up of 12.3 years. *Arthroscopy*. 2016;32(10):2160-2168. doi:10.1016/j.arthro.2016.04.020
3. Boonstra AM, Schiphorst Preuper HR, Reneman MF, Posthumus JB, Stewart RE. Reliability and validity of the visual analogue scale for disability in patients with chronic musculoskeletal pain. *Int J Rehabil Res*. 2008;31(2):165-169.
4. Campbell CM, Jamison RN, Edwards RR. Psychological screening/phenotyping as predictors for spinal cord stimulation. *Curr Pain Headache Rep*. 2013;17(1):307.
5. Cook JL, Rucinski K, Crecelius C, Fenkell B, Stannard JP. Assessment of outcomes after multisurface osteochondral allograft transplantations in the knee. *Orthop J Sports Med*. 2022;10(6):23259671221102452.
6. Cook JL, Rucinski K, Crecelius CR, Ma R, Stannard JP. Return to sport after large single-surface, multisurface, or bipolar osteochondral allograft transplantation in the knee using shell grafts. *Orthop J Sports Med*. 2021;9(1):2325967120967928.
7. Crecelius CR, Van Landuyt KJ, Schaal R. Postoperative management for articular cartilage surgery in the knee. *J Knee Surg*. 2021;34(1):20-29.
8. Familiari F, Cinque ME, Chahla J, et al. Clinical outcomes and failure rates of osteochondral allograft transplantation in the knee: a systematic review. *Am J Sports Med*. 2018;46(14):3541-3549.
9. Flores CA. Psychological assessment for bariatric surgery: current practices. *Arq Bras Cir Dig*. 2014;27(suppl 1):59-62.
10. Haber DB, Logan CA, Murphy CP, Sanchez A, LaPrade RF, Provencher MT. Osteochondral allograft transplantation for the knee: post-operative rehabilitation. *Int J Sports Phys Ther*. 2019;14(3):487-499.

11. Hays RD, Schalet BD, Spritzer KL, Cella D. Two-item PROMIS global physical and mental health scales. *J Patient Rep Outcomes*. 2017; 1(1):2.
12. Higgins LD, Taylor MK, Park D, et al. Reliability and validity of the International Knee Documentation Committee (IKDC) subjective knee form. *Joint Bone Spine*. 2007;74(6):594-599.
13. Kunze KN, Ramkumar PN, Manzi JE, Wright-Chisem J, Nwachukwu BU, Williams RJ. Risk factors for failure after osteochondral allograft transplantation of the knee: a systematic review and exploratory meta-analysis. *Am J Sports Med*. 2023;51(5):1356-1367.
14. Meric G, Gracitelli GC, Görtz S, De Young AJ, Bugbee WD. Fresh osteochondral allograft transplantation for bipolar reciprocal osteochondral lesions of the knee. *Am J Sports Med*. 2015;43(3): 709-714.
15. Nielsen ES, McCauley JC, Pulido PA, Bugbee WD. Return to sport and recreational activity after osteochondral allograft transplantation in the knee. *Am J Sports Med*. 2017;45(7):1608-1614.
16. Pisanu G, Cottino U, Rosso F, et al. Large osteochondral allografts of the knee: surgical technique and indications. *Joints*. 2018;6(1):42-53.
17. Rucinski K, Cook JL, Crecelius CR, Stucky R, Stannard JP. Effects of compliance with procedure-specific postoperative rehabilitation protocols on initial outcomes after osteochondral and meniscal allograft transplantation in the knee. *Orthop J Sports Med*. 2019;7(11): 2325967119884291.
18. Rucinski K, Stannard JP, Crecelius C, Cook JL. Changes in knee range of motion after large osteochondral allograft transplantations. *Knee*. 2021;28:207-213.
19. Rucinski K, Stannard JP, Leary EV, Cook JL. Incidence and cost of surgical site infections after osteochondral allograft transplantation and meniscal allograft transplantation in the knee. *Orthop J Sports Med*. 2022;10(3):23259671221084700.
20. Schreiner AJ, Stannard JP, Cook CR, et al. Initial clinical outcomes comparing frozen versus fresh meniscus allograft transplants. *Knee*. 2020;27(6):1811-1820.
21. Snyder AG. Psychological assessment of the patient undergoing bariatric surgery. *Ochsner J*. 2009;9(3):144-148.
22. Stannard JP, Cook JL. Prospective assessment of outcomes after primary unipolar, multisurface, and bipolar osteochondral allograft transplantations in the knee: a comparison of 2 preservation methods. *Am J Sports Med*. 2020;48(6):1356-1364.
23. Stoker AM, Stannard JP, Kuroki K, Bozynski CC, Pfeiffer FM, Cook JL. Validation of the Missouri Osteochondral Allograft Preservation System for the maintenance of osteochondral allograft quality during prolonged storage. *Am J Sports Med*. 2018;46(1): 58-65.
24. Tejwani NC, Takemoto RC, Nayak G, Pahk B, Egol KA. Who is lost to followup? A study of patients with distal radius fractures. *Clin Orthop Relat Res*. 2010;468(2):599-604.
25. Walker-Santiago R, Tegethoff JD, Ralston WM, Keeney JA. Revision total knee arthroplasty in young patients: higher early reoperation and rerevision. *J Arthroplasty*. 2021;36(2):653-656.
26. Whiting PS, Greenberg SE, Thakore RV, et al. What factors influence follow-up in orthopedic trauma surgery? *Arch Orthop Trauma Surg*. 2015;135(3):321-327.