VIDEO Abstract

Osteochondral Allograft Transplant for Focal Cartilage Defects of the Femoral Condyles

Clinically Significant Outcomes, Failures, and Survival at a Minimum 5-Year Follow-up

Ron Gilat,*† MD, Eric D. Haunschild,* BS, Hailey P. Huddleston,* BS, Tracy M. Tauro,* BS, BA, Sumit Patel,‡ MS, Theodore S. Wolfson,* MD, Kevin C. Parvaresh,* MD, Adam B. Yanke,* MD, PhD, and Brian J. Cole,*§ MD, MBA
Investigation performed at Rush University Medical Center, Chicago, Illinois, USA

Background: Osteochondral allograft (OCA) transplant for symptomatic focal cartilage defects in the knee has demonstrated favorable short- to midterm outcomes. However, the reoperation rate is high, and literature on mid- to long-term outcomes is limited.

Purpose: To analyze clinically significant outcomes (CSOs), failures, and graft survival rates after OCA transplant of the femoral condyles at a minimum 5-year follow-up.

Study Design: Case series; Level of evidence, 4.

Methods: Review of a prospectively maintained database of 205 consecutive patients who had primary OCA transplant was performed to identify patients with a minimum of 5 years of follow-up. Outcomes including patient-reported outcomes (PROs), CSOs, complications, reoperation rate, and failures were evaluated. Failure was defined as revision cartilage procedure, conversion to knee arthroplasty, or macroscopic graft failure confirmed using second-look arthroscopy. Patient preoperative and surgical factors were assessed for their association with outcomes.

Results: A total of 160 patients (78.0% follow-up) underwent OCA transplant with a mean follow-up of 7.7 ± 2.7 years (range, 5.0-16.3 years). Mean age at the time of surgery was 31.9 ± 10.7 years, with a mean symptom duration of 5.8 ± 6.3 years. All mean PRO scores significantly improved, with 75.0% of patients achieving minimal clinically important difference (MCID), and 58.9% of patients achieving significant clinical benefit for the International Knee Documentation Committee score at final follow-up. The reoperation rate was 39.4% and was associated with a lower probability of achieving MCID. However, most patients undergoing reoperation did not proceed to failure at final follow-up (63.4% of total reoperations). A total of 34 (21.3%) patients had failures overall, and the 5- and 10-year survival rates were 86.2% and 81.8%, respectively. Failure was independently associated with greater body mass index, longer symptom duration, number of previous procedures, and previous failed cartilage debridement. Athletes were protected against failure. Survival rates over time were not affected by OCA site (P = .154), previous cartilage or meniscal procedure (P = .287 and P = .284, respectively), or concomitant procedures at the time of OCA transplant (P = .140).

Conclusion: OCA transplant was associated with significant clinical improvement and durability at mid- to long-term follow-up, with 5- and 10-year survival rates of 86.2% and 81.8%, respectively. Maintenance of CSOs can be expected in the majority of patients at a mean of 7.7 years after OCA transplant. Although the reoperation rate was high (39.4%) and could have adversely affected chances of maintaining MCID, most patients did not have failure at long-term follow-up.

Keywords: osteochondral allograft transplant; OCA; OAG; cartilage restoration; focal cartilage defect

Focal chondral and osteochondral defects are a significant source of knee pain and can predispose patients to osteoarthritis.[26-28] Although some patients may do well with nonoperative management for a significant period of time, others commonly experience failure of nonoperative treatment and seek surgical intervention. Surgical options for the treatment of focal cartilage defects can be broadly categorized into palliative approaches (eg, chondroplasty, debridement) or reparative or restorative approaches (eg, osteochondral allograft or autograft transplant, autologous chondrocyte implantation [ACI], autologous minced cartilage, microfracture).[1,5,14,20,25,29,35]

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Osteochondral allograft (OCA) transplant is a commonly used procedure that has multiple advantages. Unlike ACI, which restores only cartilage, OCA restores both cartilage and subchondral bone. OCA can also be used in large, multifocal, multicompartmental defects, unlike osteochondral autograft transplant, which is typically confined to smaller, isolated defects.[45] Previous studies have illustrated the versatility of OCA, demonstrating significant clinical improvement and low failure rates of OCA transplant with concomitant procedures (meniscal allograft transplant [MAT], anterior cruciate ligament reconstruction, and corrective alignment osteotomy), as well as after previous microfracture or ACI.[17,19,34,40,48]

OCA transplant has demonstrated consistent, significant improvement in postoperative patient-reported outcomes (PROs) and satisfaction compared with those at baseline in multiple short-term studies.[2,13,24,32,46] However, the focus in outcomes research has recently shifted toward defining clinically significant outcome (CSO) measures, such as the minimal clinically important difference (MCID) and substantial clinical benefit (SCB). Previous studies have defined and investigated these values at a 1- or 2-year minimum follow-up. However, whether these CSOs are maintained at a minimum 5-year follow-up remains unknown.[38,47]

In addition to showing significant improvements in clinical outcomes, previous studies have analyzed mid- to long-term survivorship of OCA transplant in various settings, demonstrating a mean survivorship of 86.7% and 78.7% at 5 and 10 years, respectively.[3,4,7,12,13,21,22,39] However, most studies have been limited by small cohorts of specific diagnoses (eg, traumatic origin, osteochondritis dissecans), absence of CSO assessment, and short- to mid-term follow-up intervals.

Given the lack of literature investigating CSOs and OCA transplant survivorship at a minimum 5-year follow-up, the purposes of this study were to (1) quantify mid- and long-term survival rates, failure and reoperation rates, and risk factors associated with outcomes, at a minimum of 5 years after OCA transplant of the distal femoral condyles and (2) evaluate PROs and CSOs at final follow-up. We hypothesized that the 5-year and 10-year survival rates would be similar to those in previous studies and that the majority of patients would have significant clinical improvement at a minimum of 5 years of follow-up. We also expected to identify specific factors associated with reoperation, failure, and probability of maintaining CSOs at final follow-up.

METHODS

Patient Population

Approval from the institutional review board was obtained before commencement of this study. A prospectively collected database was queried to identify consecutive patients who underwent OCA transplant between 2000 and 2014. Patients who underwent primary OCA transplant of the distal femoral condyles with a minimum of 5 years of follow-up were included. Notably, patients who had a previous ipsilateral cartilage or adjunct procedure at the time of OCA transplant were also included. Exclusion criteria were (1) revision OCA, (2) primary OCA transplant of the patellofemoral joint (trochlea and/or patella only), (3) <5 years of follow-up, (4) inflammatory arthropathy, and (5) patients younger than 15 years. All patients included in the study participated in our institutional prospective OCA outcomes database. Patients were separately contacted to complete PRO questionnaires and provide relevant information regarding subsequent procedures and complications. Of relevance for future meta-analyses, although the present study represents a unique analysis, partial data on some patients included in this study have likely been reported in other studies.[9,10,16,18]

Data Collection

Table 1 presents the characteristic, preoperative, intraoperative, and postoperative data collected for patients included in the cohort. Validated preoperative and minimum 5-year postoperative PROs including the International Knee Documentation Committee (IKDC) score, Knee injury and Osteoarthritis Outcome Score (KOOS), Lysholm score, and 12-Item Short Form Health Survey (SF-12) mental and physical subscales were obtained and evaluated. Other postoperative data analyzed included the rate of reoperation, time to reoperation, procedure performed, and intraoperative findings during reoperation. Any surgical procedure on the ipsilateral knee after OCA was classified as a reoperation. Indications for reoperation included (1) chronic or recurrent knee pain, (2) impaired mechanics, or (3) disabling swelling that did not resolve after nonsurgical care. Failure was defined as gross appearance of graft failure at second-look arthroscopy,

[§]Address correspondence to Brian J. Cole, MD, MBA, Midwest Orthopaedics at Rush University Medical Center, 1611 W Harrison St, Chicago, IL 60612, USA (email: brian.cole@rushortho.com).

*Midwest Orthopaedics at Rush University Medical Center, Chicago, Illinois, USA.

[†]Department of Orthopaedic Surgery, Shamir Medical Center and Tel Aviv University, Tel Aviv, Israel.

[‡]Chicago Medical School at Rosalind Franklin University, Chicago, Illinois, USA.

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TABLE 1
Patient Factors Collected[a]

Characteristic	Sex, age, body mass index, smoking status, comorbidities (type 2 diabetes mellitus, hypertension, thyroid disease), and workers' compensation status
Preoperative	Laterality, mechanism of injury, diagnosis (eg, osteochondritis dissecans), type and level of athlete, type and number of ipsilateral knee surgeries, symptoms (pain and/or effusion), duration of symptoms, range of motion, and alignment
Intraoperative	Location of lesion, number of plugs transplanted, presence or absence of tibial disease, size of defect, use of orthobiologics, and concomitant procedures performed: • OCA with ligament reconstruction (anterior cruciate ligament or medial patellofemoral ligament) • OCA with lateral or medial meniscal allograft transplant • OCA with realignment procedure (high tibial osteotomy, distal femoral osteotomy, or tibial tuberosity osteotomy)
Postoperative	Complications, reoperation, failures, graft survival, patient-reported outcome scores, and clinically significant outcomes at a minimum of 5 years after surgery

[a]OCA, osteochondral allograft transplant.

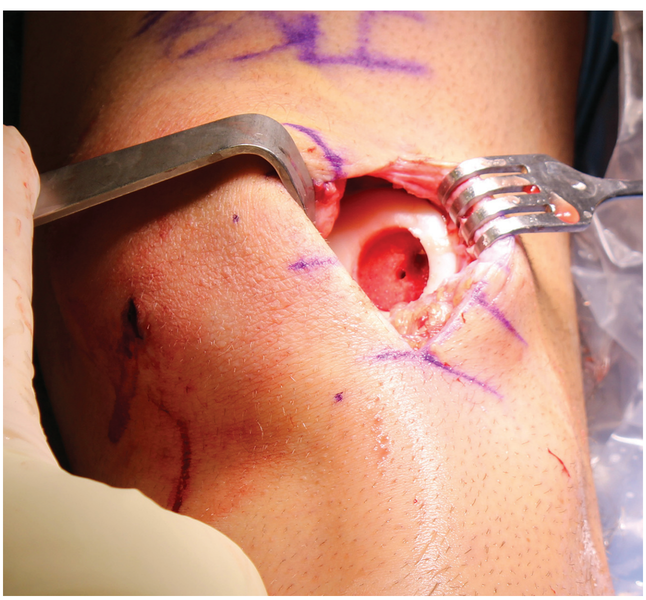

Figure 1. Lateral retinacular arthrotomy of the left knee showing a lateral femoral condyle defect ready for osteochondral allograft transplant.

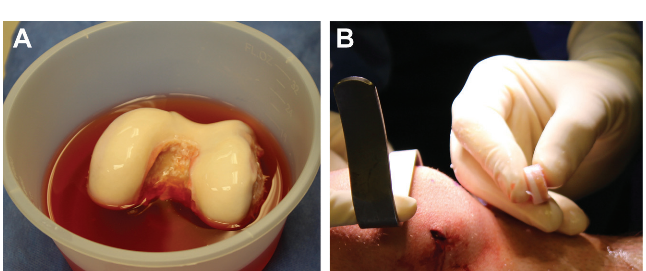

Figure 2. Preparation of the osteochondral graft. (A) A distal femur allograft ready to allow harvest of a cylindrical plug. (B) The cylindrical osteochondral allograft before being introduced into the knee.

Figure 3. A completed osteochondral allograft transplant to a lateral femoral condyle of a left knee.

revision OCA, or conversion to unilateral or total knee arthroplasty (TKA).

Surgical Technique

The preferred surgical technique used by the senior author (B.J.C.) for OCA has been described previously by Stone et al[44] (Figures 1-3).

Clinically Significant Outcomes

Achievement of MCID was defined as a >9.8-point increase in IKDC score between preoperative and final postoperative assessments. Achievement of SCB was defined as a >26.9-point increase between preoperative and final postoperative IKDC assessments.[38]

Statistical Analysis

Descriptive statistics were applied to the variables presented in Table 1. Binomial variables are presented in frequencies (proportions), and continuous variables are presented as means with SDs. Independent 2-tailed Student *t* tests were used to analyze change between preoperative and postoperative PROs. Patient factors were analyzed using a univariate logistic regression model to assess association with achievement of CSOs, requirement of reoperations, and treatment failures. Factors that were significant in the univariate model were then included in a multivariate model along with age and sex. Cross-tabulation was used to generate odds ratios (ORs), and a 2-tailed Fisher exact probability test was conducted to determine statistical significance. Kaplan-Meier survival analysis was used to determine survival probabilities, with failure defined as conversion to knee arthroplasty, revision OCA transplant, or macroscopic graft failure as viewed during second-look arthroscopy. The analysis assumed similar behavior between procedures that were performed at different time periods, a nonparametric distribution of time-dependent survival, and similar survival behavior between patients not meeting failure criteria and those who did meet failure criteria. Log-rank testing was used to compare survival between patients based on the location of OCA (medial, lateral, or patellofemoral) and whether patients had undergone a previous cartilage procedure, a previous meniscal procedure, and concomitant procedures. Statistical significance was determined as $P < .05$. Statistical analyses were performed using Stata Version 13.0 (StataCorp).

RESULTS

Patient Characteristics

Of the 205 available patients, 160 (78.0%) patients met the inclusion criteria. Patient characteristics are detailed in Table 2. Mean follow-up was 7.7 ± 2.7 years (range, 5-16.3 years).

Previous Surgical Procedures

Overall, 155 (96.9%) patients had at least 1 previous procedure, with an average of 2.7 ± 1.7 previous procedures per patient. Previous surgical procedures are presented in detail in Table 3.

Surgical Details and Concomitant Procedures

The most common location for OCA transplant was the medial femoral condyle (MFC) (n = 90), followed by the lateral femoral condyle (LFC) (n = 76). Multiple plugs in separate locations were placed in 6 (3.8%) patients, whereas the use of 2 plugs in the same location ("snowman" technique) was performed in 13 (8.1%) patients. Tibial plateau disease was present in 28 (17.5%) patients, with the lateral

TABLE 2
Patient Characteristics (N = 160)[a]

	Finding
Age at time of surgery, y	31.9 ± 10.7
Sex	
Male	84 (52.5)
Female	76 (47.5)
Body mass index	26.7 ± 4.6
Laterality	
Right	75 (46.9)
Left	85 (53.1)
Smoking	
Never	150 (93.8)
Yes	6 (3.8)
Former	4 (2.5)
Diabetes mellitus	2 (1.3)
Hypertension	6 (3.8)
Thyroid disease	5 (3.1)
Athlete	64 (40.0)
Traumatic event	78 (48.8)
Symptom duration, y	5.8 ± 6.3
Osteochondritis dissecans	33 (20.6)
Preoperative alignment	
Neutral	116 (72.5)
Varus	20 (12.5)
Valgus	24 (15)
Follow-up, y	7.7 ± 2.7

[a]Continuous variables are presented as mean ± SD. Binomial variables are presented as frequency (proportion).

TABLE 3
Previous Surgical Procedures[a]

	Finding
No. of patients with ≥1 previous procedure of the index knee	155 (96.9)
No. of previous surgeries	2.7 ± 1.7
0	5 (3.1)
1	29 (18.1)
2	52 (32.5)
3	44 (27.5)
>3	30 (18.8)
Previous cartilage surgery	135 (84.4)
Chondroplasty	115 (71.9)
Microfracture	56 (35.0)
Osteochondral autograft transplant	7 (4.4)
Fixation of osteochondritis dissecans	13 (8.1)
DeNovo (particulated juvenile allograft)	3 (1.9)
Autologous chondrocyte implantation	8 (5.0)
Previous meniscal surgery	87 (54.4)
Meniscal repair	1 (0.6)
Lateral meniscectomy	48 (30.0)
Medial meniscectomy	42 (26.3)
Meniscal transplant	5 (3.1)

[a]Continuous variables are presented as mean ± SD. Binomial variables are presented as frequency (proportion).

TABLE 4
Surgical Details and Concomitant Procedures of Osteochondral Allograft Transplant[a]

	Finding
Osteochondral allograft location	
Medial femoral condyle	90 (55.1)
Lateral femoral condyle	76 (46.7)
Multiple (2) plugs in different locations	6 (3.8)
Use of 2 plugs (same location—"snowman" technique)	13 (8.1)
Tibial disease	28 (17.5)
Medial tibial plateau	7 (4.4)
Lateral tibial plateau	21 (13.1)
Defect size, mm^2	
Medial femoral condyle	443.0 ± 194.5
Lateral femoral condyle	439.9 ± 165.5
Major concomitant procedure	
Lateral meniscal allograft transplant	39 (24.4)
Medial meniscal allograft transplant	31 (19.4)
High tibial osteotomy	16 (10.0)
Distal femoral osteotomy	15 (9.4)
Tibial tuberosity osteotomy	3 (1.9)
Anterior cruciate ligament reconstruction	5 (3.1)
Medial patellofemoral ligament reconstruction	1 (0.6)
Platelet-rich plasma injection	2 (1.3)

[a]Continuous variables are presented as mean ± SD. Binomial variables are presented as frequency (proportion).

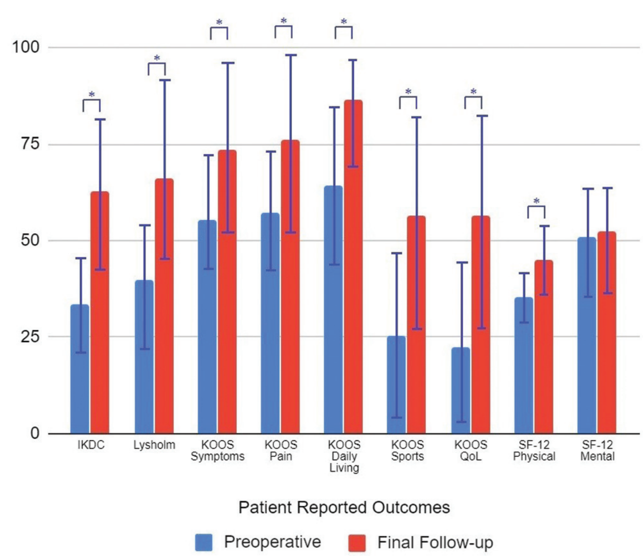

Figure 4. Preoperative and postoperative (final follow-up) patient-reported outcomes, including the International Knee Documentation Committee (IKDC) score, Knee injury and Osteoarthritis Outcome Score (KOOS), Lysholm score, and 12-Item Short Form Health Survey (SF-12) mental and physical subscales. QoL, Quality of Life. *$P < .05$.

tibial plateau involved in 21 patients (13.1%) and the medial tibial plateau involved in 7 (4.4%) patients. A total of 95 (59.4%) patients had at least 1 concomitant procedure, including 39 lateral MATs (24.4%), 31 medial MATs (19.4%), 16 (10.0%) high tibial osteotomies, 15 (9.4%) distal femoral osteotomies, 3 (1.9%) tibial tuberosity osteotomies, 5 (3.1%) anterior cruciate ligament reconstructions, and 1 (0.6%) medial patellofemoral ligament reconstruction (Table 4).

Clinical Outcomes

All joint-specific and physically focused PROs showed a statistically significant improvement in mean scores between preoperative baseline and final follow-up. IKDC score improved from 33.9 ± 13.7 to 64.3 ± 22.1 ($P < .001$), Lysholm score improved from 40.5 ± 18.3 to 68.2 ± 22.9 ($P < .001$), KOOS Symptoms improved from 55.0 ± 17.1 to 73.1 ± 19.4 ($P < .001$), KOOS Pain improved from 57.4 ± 17.0 to 75.8 ± 20.1 ($P < .001$), KOOS Activities of Daily Living improved from 64.8 ± 22.0 to 86.2 ± 19.4 ($P < .001$), KOOS Sport improved from 25.8 ± 19.9 to 55.6 ± 28.0 ($P < .001$), and KOOS Quality of Life improved from 23.1 ± 18.0 to 56.2 ± 26.4 ($P < .001$). SF-12 physical scale improved from 35.4 ± 5.5 preoperatively to 46.0 ± 8.7 at final follow-up ($P < .001$). SF-12 mental scale was the only PRO that did not improve significantly by final follow-up (from 50.7 ± 12.4 preoperatively to 52.8 ± 10.3 at final follow-up; $P = .232$) (Figure 4).

MCID and SCB

A total of 56 patients who had preoperative and postoperative IKDC scores and had not experienced treatment failure were available for MCID and SCB assessment. Of these, 42 (75.0%) patients achieved MCID at final follow-up, and 33 (58.9%) patients achieved SCB at final follow-up. Not achieving MCID was associated with preoperative knee effusion (OR, 9; 95% CI, 1.49-54.3; $P = .017$) and number of reoperations (OR, 2.7; 95% CI, 1.01-7.18; $P = .048$). Not achieving SCB was associated with preoperative knee effusion (OR, 5.83; 95% CI, 1.29-26.22; $P = .021$) and previous meniscal procedure (OR, 3.25; 95% CI, 1.02-10.34; $P = .046$,).

Reoperations (Including Nonfailures)

There were 93 reoperations in 63 (39.4%) patients, with a mean time to initial reoperation of 3.0 ± 2.9 years. Simple knee arthroscopies with or without debridement constituted 54 (85.7%) of the initial 63 reoperations. Of these second-look arthroscopies, 44 (81.5%) demonstrated arthroscopic evidence of an intact graft (Figure 5). A total of 31 (70.5%) patients with an intact graft on second-look arthroscopy did not experience failure by final follow-up. Reoperations were associated with workers' compensation claim (OR, 2.6; 95% CI, 1.13-6.13; $P = .025$) and number of previous procedures (OR, 1.7; 95% CI, 1.26-2.18; $P < .001$). Reoperations were less likely in athletic patients (OR, 0.4; 95% CI, 0.22-0.85; $P = .016$) and in those with lateral tibial plateau disease (OR, 0.23; 95% CI, 0.07-0.83; $P = .025$).

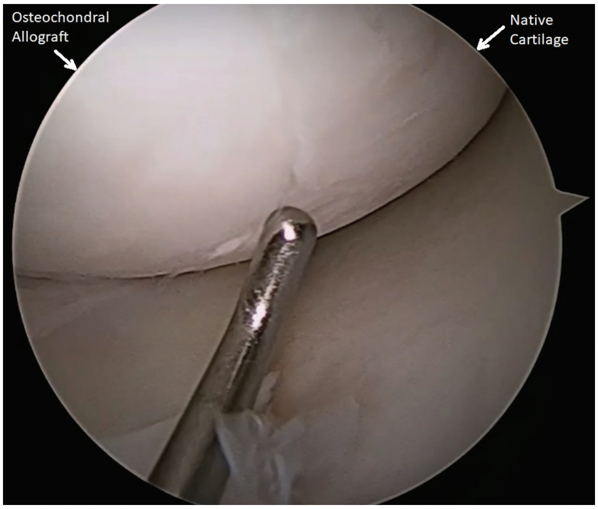

Figure 5. Second-look arthroscopy showing an intact osteochondral allograft of the lateral femoral condyle of a right knee. A probe indicates the subtle interface between native cartilage and osteochondral allograft.

Failures

A total of 34 (21.3%) patients had treatment failures. Of these, 15 (9.4%) patients underwent TKA, 9 (5.6%) patients underwent revision OCA, and 10 (6.3%) patients underwent second-look arthroscopy that documented gross appearance of graft failure. These 10 patients who exhibited graft failure during second-look arthroscopy were treated using debridement of unstable fragments of the OCA. Failure was weakly associated with higher BMI (OR, 1.02; 95% CI, 1.01-1.03; $P = .006$) and longer symptom duration (OR, 1.1; 95% CI, 1.04-1.18; $P = .001$) and was strongly associated with the number of previous procedures (OR, 1.9; 95% CI, 1.40-2.57; $P > .001$) and previous failed chondroplasty (OR, 4.4; 95% CI, 1.27-15.4; $P = .019$). Failure was negatively associated with athletes (OR, 0.2; 95% CI, 0.08-0.65; $P = .005$).

Complications

A total of 7 (4.4%) patients had complications. Of these, 3 patients had superficial infections treated using antibiotics, and 1 patient had a postoperative hematoma that required evacuation. One patient had stiffness in flexion and required manipulation under anesthesia. One patient who had undergone OCA transplant without an associated concomitant procedure had a peroneal palsy, which resolved spontaneously by 7.5 months postoperatively. One patient developed pneumonia, which resolved with antibiotic treatment without further complication.

Survival Analysis

Overall survival probabilities of osteochondral transplant were 98.7%, 95.6%, 91.2%, 86.2%, and 81.8%, at 1, 2, 3, 5, and 10 years, respectively. There were no differences in survival probabilities associated with transplant site (MFC or LFC), previous cartilage or meniscal procedures, or concomitant procedures ($P = .154$, .287, .284, and .140, respectively) (Figure 6).

DISCUSSION

This study presents the largest series to date of patients undergoing OCA transplant with a minimum 5-year follow-up. The main finding of the current study is that OCA transplant was associated with a significant improvement in PROs at mid- to long-term follow-up and a 10-year survival rate of 81.8%. The majority of patients reached important thresholds of clinical improvement after OCA transplant at mid- to long-term follow-up. Although the reoperation rate was high and was associated with a lower probability of achieving MCID, most patients undergoing reoperation did not have failure at final follow-up. Failure after OCA transplant was independently associated with a higher BMI, longer symptom duration, greater number of previous procedures, and previous failed cartilage debridement. Although previous failed cartilage debridement was associated with failure, it was not shown to have a significant effect on time-dependent survival. Also, we found athletes to be at a lower risk for failure.

Several studies have demonstrated that OCA transplant results in improved function, decreased pain, and high patient satisfaction.[‖] Familiari et al[13] performed a systematic review of 19 studies (1036 patients) with a minimum 18 month follow-up, reporting a reoperation rate of 30.2%, a failure rate of 18.2%, and a mean 10-year survival rate of 78.7%. Assenmacher et al[2] identified 5 studies with long-term outcomes showing improved clinical outcomes with a 36% reoperation rate and a 25% failure rate at 12.3 years after surgery. However, included studies were heterogeneous, and only 2 studies,[24,41] which used fresh grafts, reported outcomes at a near minimum of 5 years of follow-up. Salai et al[41] reported good functional outcomes in 6 patients who underwent fresh OCA transplant of the knee with a minimum follow-up of 15 years. Gross et al[24] reported on the use of fresh OCAs in 60 patients with posttraumatic cartilage defects at a minimum 4.8-year follow-up, finding a survival rate of 85% at 10 years and an overall rate of conversion to TKA of 20%. A later follow-up study on the same cohort of patients reported survival rates of 84%, 69%, and 59% at 15, 20, and 25 years of follow-up, respectively.[39] Altogether, these reports are similar to our findings, with comparable rates of reoperation (39.4%), overall failure (21.3%), and 10-year survival (81.8%). However, it is crucial to identify several significant differences between the present study and other studies with minimum 5-year follow-up; among these differences are a focus on femoral condyle defects only, inclusion of nontraumatic lesions, and mainly the large size of the cohort of the current study. Moreover, to our

[‖]References 3, 6, 8, 11, 16, 18, 23, 24, 31, 33, 36, 42.

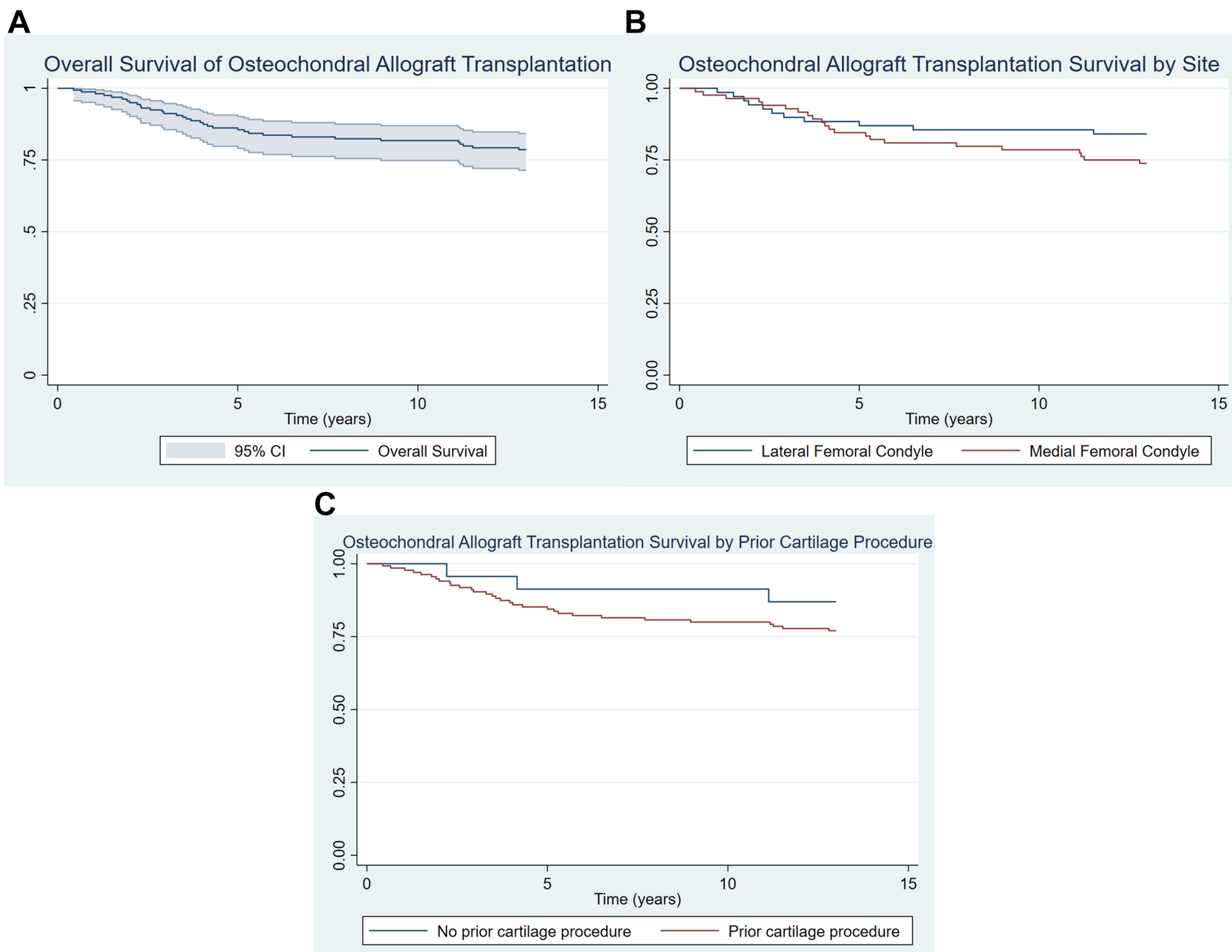

Figure 6. Results of Kaplan-Meier survival analyses. (A) Overall Kaplan-Meier survival analysis. Survival probabilities at 1, 2, 3, 5, and 10 years were 98.7%, 95.6%, 91.2%, 86.2%, and 81.8%, respectively. (B) Kaplan-Meier survival analysis stratified by osteochondral allograft transplant site. Respective survival probabilities at 1, 2, 3, 5, and 10 years were 97.6%, 96.4%, 92.9%, 84.5%, and 78.6% for medial femoral condyle grafts and 100.0%, 94.2%, 89.9%, 88.4%, and 85.5% for lateral femoral condyle grafts. The log-rank test did not demonstrate a significant difference in survival distributions between these groups (P = .154). (C) Kaplan-Meier survival analysis stratified by whether a previous cartilage procedure was performed. Respective survival probabilities at 1, 2, 3, 5, and 10 years were 100%, 100%, 95.7%, 91.3%, and 91.3% for patients who did not have a previous cartilage procedure and 98.5%, 94.8%, 90.4%, 85.2%, and 80.0% for patients who had a previous cartilage procedure. The log-rank test did not demonstrate a significant difference in survival distributions between these groups (P = .287).

knowledge, this is the first study to present data regarding CSOs (MCID and SCB) at mid- to long-term follow-up.

A subanalysis on time-based survival did not detect significant differences in survival rates when stratified by transplant site, previous cartilage or meniscal procedures, and concomitant procedures. Although the Kaplan-Meier curves showed further decline in survival rates at 12 years postoperatively, only 17 (10.6%) patients had >12 years of follow-up. These values, therefore, likely represent a sampling bias, as patients without significant clinical issues are less likely to follow up long-term.

We found failure to be weakly associated with a higher BMI and longer symptom duration and strongly associated with a larger number of previous procedures and previous failed cartilage debridement. Being an athlete was a protective factor in terms of failure. The effect of these factors on the risk for failure is understandable and is aligned with that reported in previous studies.[13,18] Interestingly, having a workers' compensation claim was independently associated with undergoing a reoperation but not with failure. We can speculate that this finding may be attributed to the effect of (conscious or unconscious) secondary gain associated with workers' compensation. Knowledge of these prognostic indicators may assist in patient selection, counseling, and discussion of prognosis.

The vast majority of the patients in the present study underwent previous knee surgery before OCA transplant. This likely reflects the modern role of OCA transplant in the surgical treatment algorithm for symptomatic chondral defects of the knee. OCA remains a second-line "salvage" procedure, typically reserved for patients with persistent symptoms despite less invasive and technically challenging procedures, such as chondral debridement or marrow stimulation. The present study demonstrated high survivorship independent of previous procedures at long-term follow-up, confirming the role of OCA as a reliable salvage procedure. However, although OCA transplant does not hinder further surgical options and allows for subsequent knee arthroplasty in the event of failure, outcomes of knee arthroplasty after OCA transplant are inferior in these challenging cases.[15,43]

The significant improvements in PROs that have been demonstrated in this study are in line with results of previous studies reporting on outcomes of OCA transplant.[2,13] Assessment and understanding of clinically relevant results are important in determining long-term outcomes. MCID and SCB are common measures used to define CSOs. MCID is defined as the smallest change or difference in an outcome measure perceived as beneficial by the patient and is generally measured using distribution, anchor, and consensus-based methods.[30] SCB is also commonly measured using anchor-based methods and is defined as the threshold outcome improvement that the patient perceives as considerable.[37] Ogura et al[38] defined the MCID and SCB for patients undergoing OCA transplant. Those investigators reported that 78% of patients achieved MCID and 50% achieved SCB at a minimum 1-year follow-up. IKDC had the highest area under the curve for both MCID and SCB and therefore was used in the present study. Our study confirmed that MCID and SCB rates were maintained in patients undergoing OCA transplant for a mean period of 7.7 years, as we found MCID and SCB rates to be 75.0% and 58.9%, respectively, at final follow-up. We also found that not achieving MCID was associated with preoperative knee effusion and the number of reoperations. Additionally, preoperative knee effusion and previous meniscal procedure were associated with not achieving SCB. The finding that preoperative knee effusion affected patient outcomes in this setting is particularly interesting and may suggest an inflammatory cause for pain and disease in this subset of patients. This may have a clinical implication, as the finding of preoperative knee effusion should perhaps prompt the surgeon to consider using anti-inflammatory measures (eg, NSAIDs, orthobiologic agents) to replace or augment the surgical procedure, although future studies are needed to evaluate this concept.

Limitations

There are several limitations to this study. A total of 38 (18.5%) patients could not be reached to provide a minimum 5-year follow-up, and therefore a detection bias may have been present. These patients may have performed very well and therefore did not seek further medical care; alternatively, they may have decided to seek further medical and/or surgical care elsewhere. There is also a potential for performance bias, as these patients were treated by a single high-volume surgeon (B.J.C.), using a validated surgical technique. Additionally, patients included in this study were heterogeneous in terms of surgical site affected (LFC or MFC), previous procedures, and concomitant procedures. However, there were no differences in survival analyses stratified by these factors. Moreover, the granularity of the data allowed us to use regression analysis to evaluate the relationship between these factors and outcomes. Given our sample size and the number of independent variables evaluated in the regression analysis, there was also a higher likelihood of a type 2 error, and our results should be interpreted as such. Last, CSOs for IKDC (MCID and SCB) could be calculated only for a subset of the cohort (35.0%) due to absent preoperative IKDC scores. Despite these limitations, to our knowledge, this preliminary analysis is the first to report on CSOs after OCA transplant at a minimum of 5 years of follow-up.

CONCLUSION

OCA transplant of the femoral condyles was associated with a significant improvement in PROs and a 10-year survival rate of 81.8%. Maintenance of MCID and SCB can be expected in most patients at 7.7 years after OCA transplant. Although the reoperation rate was significant and could have adversely affected chances of maintaining MCID, most patients did not have failure. Factors associated with failure and decreased probability for achieving CSO should be considered in the clinical decision process for patients with focal chondral and osteochondral defects.

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