Clinical Sports Medicine Update

Osteochondral Allograft Transplantation in the Patellofemoral Joint

A Systematic Review

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Background: The initial focus of cartilage restoration algorithms has been on the femur; however, the patellofemoral compartment accounts for 20% to 30% of significant symptomatic chondral pathologies. While patellofemoral compartment treatment involves a completely unique subset of comorbidities, with a comprehensive and thoughtful approach many patients may benefit from osteochondral allograft treatment.

Purpose: To perform a systematic review of clinical outcomes and failure rates after osteochondral allograft transplantation (OCA) of the patellofemoral joint at a minimum 18-month follow-up.

Study Design: Systematic review; Level of evidence, 4.

Methods: A systematic review of the literature regarding the existing evidence for clinical outcomes and failure rates of OCA for patellofemoral joint chondral defects was performed with the Cochrane Database of Systematic Reviews, the Cochrane Central Register of Controlled Trials, PubMed, and MEDLINE from studies published between 1990 and 2017. Inclusion criteria were as follows: clinical outcomes and failure rates of OCA for the treatment of chondral defects in the patellofemoral joint, English language, minimum follow-up of 18 months, minimum study size of 5 patients, and human studies. The methodological quality of each study was assessed with a modified version of the Coleman methodology score.

Results: The systematic search identified 8 studies with a total of 129 patients. The methods of graft procurement and storage time included fresh (121 patients, 93.8%), and cryopreserved (8 patients, 6.2%) grafts. The mean survival rate was 87.9% at 5 years and 77.2% at 10 years. The following outcome scores showed significant improvement from pre- to postoperative status: modified d'Aubigné-Postel, International Knee Documentation Committee, Knee Society Score–Function, and Lysholm Knee Score.

Conclusion: OCA of the patellofemoral joint results in improved patient-reported outcome measures with high patient satisfaction rates. Five- and 10-year survival rates of 87.9% and 77.2%, respectively, can be expected after this procedure. These findings should be taken with caution, as a high percentage of patellofemoral osteochondral allografts were associated with concomitant procedures; therefore, further research is warranted to determine the effect of isolated osteochondral transplantations.

Keywords: osteochondral allograft transplantation; patellofemoral, knee; cartilage; repair

Chondral lesions of the patellofemoral compartment are noted in >33% of patients undergoing knee arthroscopy, making it the second-most common site for cartilage defects after the medial femoral condyle.[6,9,11,24] Chondral lesions of the patellofemoral joint are particularly challenging to manage, as treatment of the lesion itself must be performed in concert with any concomitant patellofemoral anatomic and biomechanical derangements. These abnormalities can include excessive lateral tilt, malalignment, maltracking, patella alta, limb coronal and axial malalignment, and trochlear dysplasia, all of which should be taken, cataloged, and addressed with a risk:reward ratio approach.[3,6,11,13,24]

Several treatment modalities have been described for the management of patellofemoral lesions, including osteochondral autograft transplantation, marrow stimulation (microfracture, abrasionplasty, or drilling), autologous chondrocyte implantation, osteochondral allograft transplantation (OCA), and particulated juvenile cartilage allograft.[6,17] However, inferior outcomes for patellofemoral cartilage procedures have been consistently reported in the literature when compared with other locations irrespective of the surgical technique used.[6,10]

OCA procedures offer numerous advantages, including the presence of metabolically active chondrocytes without

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concurrent donor site morbidity,[29] natural hyaline cartilage with structural osseous bed that can accept full loading as soon as the bone base has healed,[21] and immunoprivileged characteristics.[1] While extensive literature exists evaluating osteochondral allograft in the knee, the majority of outcomes are reported for OCAs of the femoral condyles.[2,8,10,20,27] There are fewer and less-powered studies that assess outcomes of OCA in the patellofemoral joint. Therefore, the purpose of this study was to perform a systematic review of clinical outcomes and failure rates after OCA transplantation of the patellofemoral joint at a minimum follow-up of 18 months. It was hypothesized that improved functional and objective outcomes would be obtained after a patellofemoral OCA with high mid- to long-term survival rates.

METHODS

Article Identification and Selection

This study was conducted in accordance with the 2009 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.[26] A systematic review of the literature regarding the existing evidence for clinical outcomes and failure rates of OCA transplantation of the patellofemoral joint was performed with the Cochrane Database of Systematic Reviews, the Cochrane Central Register of Controlled Trials, PubMed (1990-2017), and MEDLINE (1990-2017). The queries were performed in May 2018. The literature search strategy included the following:

Search 1: osteochondral[All Fields] AND ("allografts"[MeSH Terms] OR "allografts"[All Fields] OR "allograft"[All Fields]) AND patellofemoral[All Fields]

Search 2: osteochondral[All Fields] AND ("allografts"[MeSH Terms] OR "allografts"[All Fields] OR "allograft"[All Fields]) AND ("patella"[MeSH Terms] OR "patella"[All Fields])

Search 3: osteochondral[All Fields] AND ("allografts"[MeSH Terms] OR "allografts"[All Fields] OR "allograft"[All Fields]) AND trochlea[All Fields]

Systematic review registration was performed in May 2018 with the PROSPERO international prospective register of systematic reviews (registration CRD42018094608).

Inclusion criteria were as follows: original research reporting clinical outcomes and failure rates of OCA for the treatment of chondral defects in the patellofemoral joint, English language, minimum follow-up of 18 months, minimum of 5 patients, and human studies. We excluded cadaveric studies, animal studies, biomechanical reports, basic science articles, editorial articles, case reports, literature reviews, surgical technique descriptions, instructional courses, OCA for tumor, and studies in which OCA of the patellofemoral joint were not available independent of combined OCA groups.

Two independent reviewers (J.C. and M.C.S.) performed a review of the abstracts from all identified articles. Full-text articles were obtained for review if necessary to allow for further assessment of inclusion and exclusion criteria. Additionally, all references from the included studies were reviewed and reconciled to verify that no relevant articles were missing from the systematic review. If data were not specifically reported for patellofemoral OCA in studies that otherwise met inclusion criteria, authors were contacted to provide missing data points.[23]

Data Collection and Processing

The level of evidence of each study was assigned according to the classification system specified by Wright et al.[35] Data were abstracted from the full text or directly from the authors of all eligible articles via standardized data collection forms. Abstracted and recorded data included patient demographics, follow-up period, surgical techniques, postoperative imaging results (if reported), and objective and subjective outcomes. For continuous variables (eg, age, follow-up, outcome scores), the means, SDs, interquartile ranges, and ranges were collected (if reported). Data were recorded into a custom spreadsheet with a modified information extraction table.[15]

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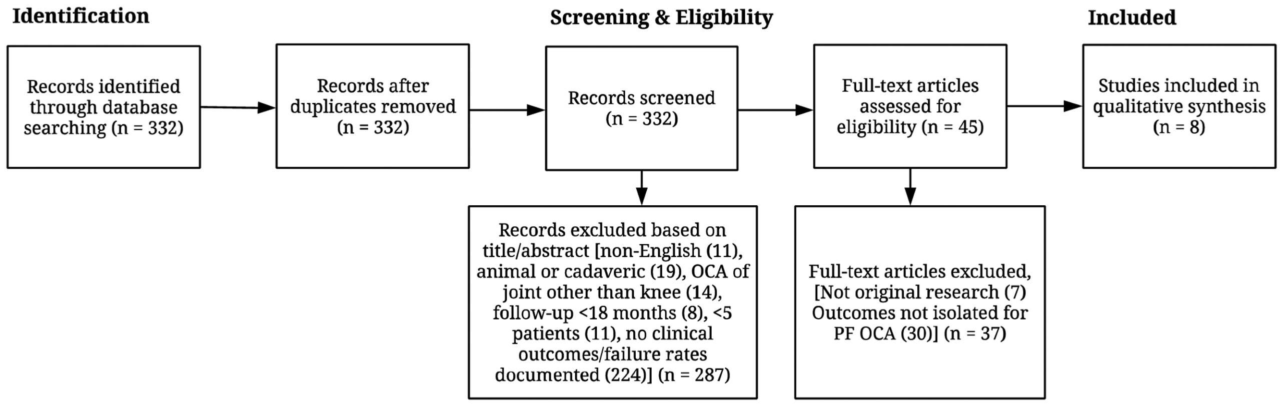

Figure 1. Study search strategy according to the PRISMA (Preferred Reporting Items for Systematic Meta-Analyses) guidelines.[25] OCA, osteochondral allograft transplantation; PF, patellofemoral.

Based on a preliminary survey of the most commonly used outcome scales, outcome scores were recorded for the following: modified d'Aubigné-Postel score, Lysholm Knee Score, International Knee Documentation Committee (IKDC) knee form, Knee injury and Osteoarthritis Outcome Score, and Knee Society Score–Function (KSS-F) score. If none of these scales were used, results were documented for the primary functional scale used in the study.

Literature Quality Evaluation

Two reviewers (J.C. and M.C.S.) used a modified version of the Coleman methodology score (mCMS) to assess the methodological quality of each study.[19] The 2-part mCMS grades cartilage-related studies based on 10 criteria. Part A includes study size, mean follow-up, number of surgical procedures, type of study, description of surgical procedure, postoperative rehabilitation, included patients' magnetic resonance imaging outcome, and inclusion patients histological outcome. Part B includes outcome criteria, procedure for assessing clinical outcomes, and description of patient selection process. The maximum score of the mCMS is 100, which indicates that a study largely avoids chance, biases, and confounding factors.

RESULTS

Study Selection

The systematic search performed with the previously mentioned keywords identified 8 studies after removal of duplicates and application of exclusion criteria. Following review of all references from the included studies, no additional studies met the inclusion criteria (Figure 1). Two independent reviewers (J.C. and M.C.S.) performed a methodological quality assessment of included articles. The mean Kon-Verdonk mCMS score of the included studies was 41.9 (range, 25-51) out of 100 points.[19]

Study Characteristics and Demographics

Three prospective and 5 retrospective case series met the inclusion criteria for this systematic review. Two studies evaluated OCA isolated to the femoral trochlea; 2 studies evaluated OCA isolated to the patella; and 4 studies evaluated OCA of the patellofemoral joint or OCA for bipolar chondral lesions (femoral trochlea and patella). The methods of procurement and storage time included fresh (121 patients, 93.8%) and cryopreserved (8 patients, 6.2%) grafts. The 8 studies included in the analysis reported on a total of 129 patients (range, 8-28 patients per study). The weighted mean patient age was 36.9 years (range, 12-64 years), and the weighted mean follow-up was 6.6 years (range, 1.8-30.1 years). Importantly, 91.2% of the patients had previous operations (mean, 2.85 procedures before OCA transplantation). The patient demographics, indications for OCA transplantation, concomitant procedures, and locations of the allograft transplant are described in detail in Table 1. Details regarding lesion size, plug size, and prior surgical treatment are outlined in Table 2.

Functional Outcomes

Pre- and postoperative patient-reported outcome scores for patellofemoral OCA were assessed in 7 studies (Table 3).[4,7,14,18,32-34] Sixteen outcome measures were reported in these 7 studies, of which the most commonly used were the IKDC form (4 studies),[7,14,33,34] modified d'Aubigné-Postel form (3 studies),[7,14,18] and KSS-F form (3 studies).[7,14,32]

All studies reported significant improvement in at least 1 clinical score. All 4 studies that utilized IKDC scores reported a significant improvement from baseline to postoperative follow-up ($P < .001$), with an aggregate preoperative IKDC score of 41.8 and postoperative IKDC score of 68.1.[7,14,33,34] The aggregate mean improvement in total IKDC score from preoperative to final follow-up was 26.3. Studies with the modified d'Aubigné-Postel scores reported significant postoperative improvement ($P < .001$), with mean preoperative 12.2, and mean postoperative of 15.9.[7,14,18] The aggregate

TABLE 1
Characteristics of Included Studies[a]

First Author[b]	Journal, Year, Study Type[b]	Age, y, Mean ± SD (Range)	Male Sex, n (%)	Patients (Knees), n	Location of Defect	Bipolar (Knees, n)	Technique (Knees, n)[c]	Etiology	Concomitant Procedures	Follow-up, Mean (Range), y
Cameron[7]	*AJSM*, 2016, retrospective	30.2 ± 10.6 (12-47)	20 (72.4)	28 (29)	Trochlea	None	Dowel (25), shell (4)	OCD, DCL, OA, trauma	Lateral retinaculum release (38%), diagnostic arthroscopy, hardware removal, debridement, PF soft tissue realignment, trochleoplasty, loose body removal, meniscus repair, lysis of adhesions, manipulation	7.0 (2.1-19.9)
Gracitelli[14]	*AJSM*, 2015, retrospective	33.7 (14-64)	13 (46.4)	27 (28)	Patella	None	Dowel, shell (>10 cm^2 or 75% of patella)	OCD, DCL, OA, trauma, AVN	Lateral retinaculum release (37%), realignment surgery for the extensor mechanism (1 vastus medialis imbrication, 1 tibial tubercle osteotomy with medial PF ligament reconstruction, 3 tibial tubercle osteotomies isolated)	9.7 (1.8-30.1)
Torga Spak[32]	*CORR*, 2006, retrospective	37 (24-56)	0 (0)	11 (14)	Patella (14), trochlea (12)	12	Shell	Trauma, OA, bony malalignment, patellar instability, iatrogenic cartilage shaving	Femoral (×2) and tibial osteotomies 1 to 3 y before OCA	10.0 (2.5-17.5)
Jamali[18]	*CORR*, 2005, retrospective	42 (19-64)	7 (39)	18 (20)	Patella (20), trochlea (12)	12	Dowel, shell	Trauma	Lateral retinaculum release (45%)	7.8 (2.0-18)
Wang [34,d]	*Cartilage*, 2018, prospective	37.1 ± 8.2 (23-52)	8 (80)	10 (10)	Trochlea	None		DCL, AVN, trauma	Realignment osteotomy	3.9 (2.0-10.7)
Wang[33,d]	*AJSM*, 2018, prospective	47.0 (40-53)	13 (68.4)	19 (19)	Patella (7), trochlea (16)	5	Dowel	OCD, DCL, OA	Realignment osteotomy	3.3 (2.0-6.8)
Frank[12,d]	*AJSM*, 2017, prospective	31.1 (24-48)	3 (37.5)	8 (8)	Patella (2), trochlea (6)	None	Dowel	GSW, trauma	TTT anteromedialization (4), microfracture to area other than OAT site, partial meniscectomy	4.4 (2.1-7.7)
Bakay[4]	*Int Orthop*, 1998, retrospective	NA	NA	8 (8)	Patella	None	Dowel[e]	Trauma	Lateral retinaculum release (75%)	NA

[a]*AJSM, American Journal of Sports Medicine*; AVN, avascular necrosis; *CORR, Clinical Orthopaedics and Related Research*; DCL, degenerative chondral lesion; GSW, gun shot wound; *Int Orthop, International Orthopaedics*; NA, not available; OA, osteoarthritis; OAT, osteochondral autograft transplantation; OCA, osteochondral allograft transplantation; OCD, osteochondritis dissecans; PF, patellofemoral; TTT, tibial tubercle transfer.

[b]Level of evidence: 4 (all studies).

[c]Type of graft: fresh (all studies unless noted otherwise).

[d]Data obtained from respective authors of studies.

[e]Cryopreserved graft.

mean preoperative KSS-F score was 53.4 and postoperative was 80.2.[7,14,32] All other patient reported outcomes are demonstrated in Table 3.

Radiographic Analysis

Postoperative radiographic results were reported for 2 studies. Torga Spak and Teitge[32] evaluated radiographs at final follow-up for graft incorporation, resorption, collapse, cyst formation, and osteophyte formation. Radiographs were used to measure the patellar thickness ratio; patellar height was measured with the Blackburne-Peel index and the Caton-Deschamps index. The patellar thickness ratio was defined as the length of the patella to the maximal thickness of the patella, as measured on lateral radiographs. The patellar thickness ratios of the bipolar shell allografts (6 of the 8 surviving allografts) showed a mean 14% volumetric reduction of the patellar allograft-host bone unit. The mean preoperative patellar thickness ratio of these grafts was 0.46 (range, 0.40-0.56), and at follow-up (mean, 8.1 years; range, 48-204 months) it was 0.40 (range, 0.13-0.56). At final follow-up, for the 8 patients with an intact allograft, radiographs demonstrated mild degenerative changes for 6 patients and no degenerative changes for 2 patients, as measured by the Fairbank grading scale.

Jamali et al[18] evaluated the radiographic outcomes of 12 patients. The mean radiographic follow-up was 70 months (range, 18-183 months). Patellofemoral arthrosis and tibiofemoral arthrosis in the medial and lateral compartments were classified with the modified Fairbank and Ählback criteria as described by Lundberg and Messner. Radiographs were evaluated for visibility of the allograft-host junctions, allograft radiodensity when compared with the

TABLE 2
Characteristics of Patients Included in the Studies[a]

First Author	Lesion Size, cm^2, Mean ± SD (Range)	Prior Surgery, %; Procedures per Patient, n (Mean)	Reoperations, n (%): Procedures Performed,[b] n	Reason for Failures	Allograft Survivorship	Failure, n (%)	Mean Time to Failure, mo (Range)
Cameron[7]	6.1 ± 3.6 (2.3-20.0)	89.7; 2.4	6 (21.4): MUA for arthrofibrosis (1), AS/D and partial meniscectomy (1), scar tissue removal (1), chondral flap debridement and loose body removal (1), debridement, chondroplasty of patella/LFC, and synovectomy (1), TKA (1)	TKA (1) for persistent pain (probable complex regional pain syndrome)	100 at 5 y, 91.7 at 10 y	1 (3.4)	91.2
Gracitelli[14]	10.1 (4-18)	92.9; 3.2	17 (60.7): AS/D (9), HR (6), ACLR (1), PF realignment (1), MUA (1), loose body removal (1), TKA (4), PFA (2), patellectomy (1), revision OCA (1)	TKA (4), PFA (2), revision OCA (1), patellectomy (1) (reasons unknown)	78.1 at 5 y, 78.1 at 10 y, 55.8 at 15 y	8 (28.6)	51.6 (6-165.6)
Torga Spak[32]	NA	100; 4.4	12 (86): HR (12), MPFLR (3), TTT (3), AS/D (2), IT rotational osteotomy (2), revision Maquet (1) FVO (1), TIR osteotomy (1)	Revision at 12 mo for graft fragmentation; conversion to TKA 20 mo after graft fragmentations[c]	86 at 5 y, 72 at 10 y	2 (14.3)	NA
Jamali[18]	13.2 (2.5-22.5)[d]	100, 2.6	13 (65): AS/D (7), ASC (2), HR (2), TKA (2), revision allograft (2), arthrotomy and fat pad debridement (1), arthrodesis (1)	TKA (2), revision allograft (2), arthrodesis (1)	67 at 10 y	5 (25)	32.2 (13-52)
Wang[34]	7.4 (1.0-15.3)	80; 2.7	3 (30): TKA (1), meniscectomy (1), HR, MUA, and open synovectomy (1)	TKA (1)	90 at 2 y	1 (10)	20.0
Wang[33]	7.1 (0.8-15.3)	79, 1.9	11 (58): TKA (5), UKA (3), ASC and loose body removal (2), I&D (1)	5 TKA, 3 UKA	89.5 at 2 y	8 (42.1)	33.6 (11-72)
Frank[12]	4.1 ± 1.8 (2.2-6.3)	100; 2.75	4 (50): trochlea (3), patella (1)[e]	Trochlea (2)[e]	87.5 at 5 y	2 (25)	40.4
Bakay[4]	NA	NA	NA	Hyperpressure of PF joint (1)	NA	1 (12.5)	NA

[a]ACLR, anterior cruciate ligament reconstruction; ASC, arthroscopic chondroplasty; AS/D, diagnostic arthroscopy with debridement; FVO, femoral varus osteotomy; HR, hardware removal; I&D, irrigation and debridement; IT, intertrochanteric; LFC, lateral femoral condyle; MPFLR, medial patellofemoral ligament reconstruction; MUA, manipulation under anesthesia; NA, not available; OCA, osteochondral allograft; PF, patellofemoral; PFA, patellofemoral arthroplasty; TIR, tibial internal rotation; TKA, total knee arthroplasty; TTT, tibial tubercle transfer; UKA, unicompartmental knee arthroplasty.

[b]Some patients had >1 procedure (n = number of knees undergoing reoperation).

[c]The 2 grafts that did not survive were in the same patient: the first unipolar allograft (patella) required revision 12 months after implantation; the revised bipolar allograft was converted to a TKA at 20 months.

[d]Trochlea (information only for 8 knees). Plug size (information for 3 knees): mean, 7.1 cm^2 (range, 1.8-17.8 cm^2).

[e]Reason for 2 failed trochlear grafts and reoperations not reported.

surrounding bone (increased, decreased, or the same), and the presence of subchondral cysts. Of the 12 knees evaluated radiographically, 4 had no evidence of patellofemoral arthrosis, 6 had mild arthrosis, and 2 had advanced arthrosis. The allograft-host interface was not visible radiographically in 9 patients and was identifiable in 3 patients. The radiodensity of the grafts was identical to the host in 8 patients and was increased in 4 patients. Although 4 grafts had subchondral lysis, 3 of them still had good or excellent clinical scores.

Satisfaction

Four studies reported patient satisfaction as a measured outcome.[4,7,14,18] Two studies assessed patient satisfaction with a 5-point scale (extremely satisfied to extremely dissatisfied), with an aggregate mean 89% of patients extremely satisfied or satisfied with the allograft surgery.[7,14] Jamali et al[18] assessed patient satisfaction with a similar 4-point ordinal scale and found that 87.5% of patients were extremely satisfied or satisfied with the allograft surgery. Bakay et al[4] used a modified Bentley score,[5] reporting 75% of patients with excellent or good results.

Reoperation and Failure Rates

The weighted mean failure rate for all 8 studies was 20.1% (n = 28 patients; range, 3.4%-42.1%) (Table 2). The definition of failure among the identified studies was highly variable; each study used a different definition for graft failure. Cameron et al[7] and Wang et al[33,34] defined failure as revision of the graft or conversion to arthroplasty. Gracitelli et al[14] defined failure as any reoperation resulting in removal of the allograft. Torga Spak and Teitge[32] defined failure as occurrence of any 1 of the following: (1) the clinical rating was <70 points on the KSS-F and Lysholm Knee Score scales; (2) there was radiographic evidence of resorption or collapse; or (3) the patient required total knee arthroplasty, fusion, or allograft revision. Jamali et al[18] defined failure as a poor modified d'Aubigné-Postel score (<11) with the need for revision allografting, patellectomy, arthrodesis, or total knee arthroplasty. Frank

TABLE 3
Outcomes Measures[a]

First Author: Outcome Measures	Preoperative	Postoperative	*P* Value
Cameron[7,b]			
Modified d'Aubigné-Postel	13.0 ± 2.1	16.1 ± 2.2	**<.001**
IKDC total	38.5 ± 14.2	71.9 ± 24.6	**<.001**
IKDC pain	5.5 ± 2.1	2.8 ± 3.1	**<.001**
IKDC function	3.3 ± 1.7	7.3 ± 2.5	**<.001**
KSS-F	65.6 ± 19.1	85.2 ± 19.3	**<.001**
UCLA activity score		7.9 ± 2.2	
Satisfaction			
Extremely satisfied		63.0%	
Satisfied		25.9%	
Somewhat satisfied		7.4%	
Somewhat dissatisfied		3.7%	
Dissatisfied		—	
Gracitelli[14,b]			
Modified d'Aubigné-Postel	12.0	15.2	**.003**
IKDC total	36.5	66.5	**.003**
IKDC pain	6.2	3.4	**.002**
IKDC function	3.5	7	**.001**
KSS-F	64.6	80.5	**.003**
Satisfaction, %		89[c]	
Torga Spak[32,d,e]			
Lysholm Knee Score	27	80	NA
KSS-F	30	75	NA
Jamali[18,e]			
Modified d'Aubigné-Postel	11.7	16.3	**.001**
Satisfaction (n = 16), %			
Extremely satisfied		50	
Satisfied		37.50	
Dissatisfied		12.50	
Improvement (n = 16), %			
Substantial improvement		56.25	
Somewhat improvement		25.00	
No change		12.50	
Substantially worse		6.25	
Wang[34,f]			
IKDC	45.5 ± 14.0	71.3 ± 12.4	**.015**
KOS-ADL	63.4 ± 5.6	86.3 ± 8.2	**<.001**
Marx Activity Scale	4.0 ± 4.9	4.0 ± 4.5	>.999
Overall condition	5.0 ± 1.0	7.8 ± 0.5	**.002**
SF-36			
General health	82.1 ± 16.5	82.0 ± 22.0	.990
Pain	56.4 ± 23.8	69.5 ± 28.8	.41
Physical functioning	49.3 ± 14.3	83.0 ±16.8	**.004**
Role limited per physical health	78.6 ± 30.4	65.0 ± 41.8	.527
Wang[33,f]			
IKDC	46.4 ± 16.7	62.5 ± 17.3	**<.001**
KOS-ADL	67.8 ± 15.9	80.2 ± 13.6	**<.001**
Marx Activity Scale	5.6 ± 5.3	4.6 ± 3.7	.581
Overall condition	4.1 ± 1.2	6.2 ± 1.7	**<.001**
SF-36			
General health	70.6 ± 11.2	69.6 ± 19.3	.859
Pain	51.1 ± 25.4	63.1 ± 24.5	.219
Physical functioning	51.8 ± 23.5	75.0 ± 22.6	**<.001**
Role limited per physical health	48.4 ± 38.5	72.9 ± 41.9	**<.001**

(continued)

TABLE 3
(continued)

First Author: Outcome Measures	Preoperative	Postoperative	*P* Value
Frank[12]: NA			
Bakay[4]			
Bentley score, %			
Excellent		25	
Good		50	
Fair		25	
Poor		0	

[a]All values are presented as mean ± SD unless noted otherwise. Bold indicates statistically significant value ($P < .05$). IKDC, International Knee Documentation Committee; KOS-ADL, Knee Outcome Survey–Activities of Daily Living; KSS-F, Knee Society Score–Function; NA, not available; SF-36, 36-Item Short Form Health Survey; UCLA, University of California, Los Angeles.
[b]Overall satisfaction with allograft surgery was determined using a 5-point scale with descriptors from extremely satisfied to dissatisfied.
[c]Extremely satisfied or satisfied with results.
[d]Study reported results only for surviving allografts.
[e]Outcomes from survival cohort.
[f]Data provided upon request from study authors.

et al[12] defined failure as revision OCA, conversion to knee arthroplasty, or gross appearance of graft failure at second-look arthroscopy. Bakay et al[4] defined failure as fragmentation of the graft or a fair/poor result as determined by Bentley score.[5] The most common treatment for failure was conversion to total knee arthroplasty (data available for 6 studies only, 13 of 25 patients). The weighted mean time to failure was 44.8 months (range, 20-91.2 months) (data available for 6 studies only).

Of the 8 articles reviewed, 7 reported reoperations after patellofemoral OCA. In these 7 studies, 66 of 128 knees underwent reoperation (Table 2), for a weighted mean reoperation rate of 51.6% (range, 21.4%-86%). The most common reoperation performed was hardware removal (32% of all reoperations, n = 21 knees),[14,18,32,34] which could have been from any of the concomitant procedures performed (eg, realignment procedures), followed by diagnostic arthroscopies, with or without debridement (27% of all reoperations, n = 18 knees).[14,18,32]

No study reported any intraoperative complications, and 3 studies (38%) reported no postoperative complications within the documented follow-up period. Torga Spak and Teitge[32] reported on 4 patients with persistent postoperative anterior knee pain, thought to be associated with unrecognized bony malalignment, as well as 1 patient who developed a skin rash 2 weeks after allograft implantation, which resolved with a course of prednisone. Additionally, all patients had low-grade synovitis that resolved spontaneously, with the worst case lasting 12 months. Wang et al[33,34] reported that 3 patients developed arthrofibrosis postoperatively, which was successfully treated with lysis of adhesions and scar excision. While no patients developed superficial or deep infections after OCA, 1 patient developed a septic joint after arthroscopic lysis of adhesions, which was treated with arthroscopic irrigation and debridement.[33] This patient ultimately underwent total knee arthroplasty in the same knee 45 months after arthroscopic irrigation and debridement.

Bakay et al[4] reported that a single patient experienced a hyperalgesic reaction on the fifth postoperative day but recovered within 2 days with steroid and calcium-derivative therapy. Frank et al[12] reported complications; however, the authors did not stratify complications based on graft location (patellofemoral specific).

Graft Survival

Seven studies performed Kaplan-Meier survival analysis for patellofemoral OCAs (Table 2). The weighted mean 5-year survival rate reported was 87.9%.[7,12,14,32] The mean 10-year survival rate was 77.2%,[7,14,18,32] and the 15-year survival rate was 55.8% (reported in only 1 study).[14]

DISCUSSION

The compelling findings of this study were that OCA transplantation for the patellofemoral joint yielded improved postoperative outcomes with high patient satisfaction and survival rates at short- to medium- and long-term follow-up (mean 10-year survival rate reported, 77.2%). Additionally, although the mean reoperation rate was 51.6%, the most common reoperation performed was hardware removal (31.8%), which is common in all patellar realignment series.[28] Finally, while heterogeneous definitions for failure were used among the reviewed studies, the overall mean failure rate was 20.1%, which is similar to various other biologic cartilage–restorative procedures at the tibiofemoral compartments.[10] Of note, all the studies included in this review had concurrent procedures performed at the time of the osteochondral transplantation (6 of the 8 had a bony realignment procedure), which does not allow for an exclusive analysis of OCA for the patellofemoral joint.

While there is extensive literature available regarding outcomes of OCA for cartilage defects of the femoral condyles, there is a paucity of information on the durability of this procedure in the patellofemoral joint. In this systematic review, we assessed the available literature on patellofemoral OCAs to better understand the long-term outcomes and failure rates of this osteochondral restoration technique. OCA was previously reported to yield inferior outcomes in the patellofemoral compartment when compared with the tibiofemoral compartments, which could be potentially attributed to more complex biomechanics and inherent challenges of topographically matching the native anatomy.[10] In this review, 94% of patellofemoral OCAs were fresh grafts, and the remaining 6% were cryopreserved. Today, only stored fresh grafts are available. In this regard, the majority of the current literature advises 28 days as the maximum storage period for a fresh allograft, with an ideal implantation time between the release date of 10 to 14 days and the "expiration date" of 28 days.[8] The most frequent technique performed was the dowel technique. The shell technique was more common in the older studies. In the more recent studies, it was usually indicated for larger lesions.[7,14]

Although several outcome measures were employed across the studies identified in this review, all studies reported improvement from presurgery to final follow-up, regardless of the reported outcome measure score utilized. This review found a mean aggregate improvement of 26.3 in preoperative to final IKDC score in the 4 studies reporting this measure and a mean aggregate final IKDC score of 68.1. The reported minimal clinically important difference for the IKDC score[16] is 11.5; thus, there was a >200% minimal clinically important difference in IKDC scores. The improvements in IKDC scores noted in this review are comparable with outcome scores reported in previous reviews for femoral condyle OCAs.[10,30,36] However, in a more recent study, Tirico et al[31] reported higher IKDC outcome scores for isolated femoral condyle OCA, with a mean total IKDC improvement of 24.9 points in small grafts (<5 cm^2) and 36.9 points in large grafts (>8 cm^2) and mean final IKDC scores of 73.9 and 80.0, respectively. Additionally, although no minimal clinically important difference has been established for the modified d'Aubigné-Postel and the KSS-F scores, significant functional improvements were also observed.

Objective imaging analysis was performed in only 2 of the 8 studies.[18,32] It is important to emphasize that for the evaluation of cartilage procedure outcomes, objective imaging data are valuable to determine graft survival, host edema and cyst formation, degenerative changes, and patellofemoral joint–specific measures, such as the patellar width (which is common in the arthroplasty literature), to avoid increased patellofemoral pressures and overstuffing of the patellofemoral joint and resultant loss of flexion. Torga Spak and Teitge[32] reported a similar patellar thickness ratio after a patellar osteochondral allograft when compared with the native knee, and at final follow-up, 75% of the patients demonstrated mild degenerative changes. Jamali et al[18] evaluated 12 knees, of which 4 had no evidence of patellofemoral arthrosis, 6 had mild arthrosis, and 2 had advanced arthrosis. Good integration of the graft could be noticed by a not-visible allograft-host interface and an identical radiodensity of the grafts in the majority of the patients. Subchondral lysis was present in 4 grafts; however, 3 of them still had good or excellent clinical scores.

Graft survival analysis for patellofemoral OCA demonstrated mean 5- and 10-year survival rates of 87.9%[7,12,14,32] and 77.2%,[7,14,18,32] respectively. One study reported a 15-year survival rate of 55.8%.[14] A previous systematic review of OCA[10] that included mainly femoral condyle allograft transplantation reported similar survival rates: mean 5-year survival across the studies included in this review was 86.7% (range, 64.1%-100%), while the mean 10-year survival was 78.7% (range, 39%-93%). Long-term mean survival was 72.8% at 15 years (range, 55.8%-84%) and 67.5% at 20 years (range, 66%-69%), and the weighted mean reoperation rate was 30.2%. Further reviews reported long-term failure rates of up to 24% for femoral condyle OCA.[30,36] In 2013, Levy et al[22] reported a failure rate of 24% for isolated femoral condyle OCA, with 10-, 15-, and 20-year survivorship of 82%, 74%, and 66%, respectively, with 47% of patients requiring reoperations.

A recent study on isolated femoral condyle osteochondral allografts reported a failure rate of 5.8% among 156 knees, and 24.4% required reoperation.[31] In our review, 51.6% of the patients required reoperations, which doubles the reoperation rates for femoral condyle OCAs. Of note, 23% of the reoperations were hardware removal, which in several cases corresponded to concomitant procedures performed with the OCA transplantation. Additionally, the studies in this review grouped reoperations for failed grafts and reoperations for successful grafts when determining the overall reoperation rate. The explanation for this is likely multifactorial and may involve the complex heterogeneity and force distribution across the patellofemoral joint or perhaps an evolution in the individual study authors' indications and surgical techniques over the years.

We acknowledge some limitations to the present study. First, there was heterogeneity in the reporting of subjective and objective outcomes. Furthermore, some of the included studies included concomitant pathology and/or procedures, which may have influenced outcomes. Some studies did not report on specific subgroup characteristics of the patellofemoral joint group; therefore, these data were not available for analysis. As with all systematic reviews, it is possible that relevant articles or patient populations were not identified with our search criteria. In addition, the quality of the included research was a limitation, as the mean calculated Kon-Verdonk mCMS score of the included studies was 41.9 (range, 25-51) out of 100 points.

CONCLUSION

OCA of the patellofemoral joint results in improved patient-reported outcome measures with high patient satisfaction rates. Five- and 10-year survival rates of 87.9% and 77.2%, respectively, can be expected after this procedure. These findings should be taken with caution, as a high percentage of patellofemoral osteochondral allografts were associated with concomitant procedures; therefore, further research is warranted to determine the effect of isolated osteochondral transplantations.

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