Systematic Review

Systematic Review of Autogenous Osteochondral Transplant Outcomes

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Purpose: The goal of this systematic review was to present the current best evidence for clinical outcomes of osteochondral autograft transplantation to elucidate the efficacy of this procedure. **Methods:** PubMed, CINAHL, and the Cochrane Central Register of Controlled Trials were searched (key terms "knee," "osteochondral autograft transfer," or "mosaicplasty") to identify relevant literature between 1950 and 2013 in the English language. This evaluation included studies in pediatric and adult patients with grade 3 or 4 articular cartilage injuries; the studies had a minimum of 25 patients and at least 12 months of follow-up and compared osteochondral autograft transfers/mosiacplasty with another treatment modality. Articles were limited to full-text randomized controlled trials or cohort studies. Main outcomes studied were patient-reported and functional outcome, with secondary outcomes including effect of lesion size, return to sport and sport function, radiographic outcomes, and reoperation rates. **Results:** There were a total of 9 studies with 607 patients studied in this systematic review. When osteochondral autologous transfer/mosaicplasty (OATM) was compared with microfracture (MF), patients with OATM had better clinical results, with a higher rate of return to sport and maintenance of their sports function from before surgery. Meanwhile, patients who underwent MF trended toward more reoperations, with deterioration around 4 years after surgery. When compared with autologous chondrocyte implantation (ACI), clinical outcome improvement was not conclusive; however, at 10-year follow-up, a greater failure rate was found to be present in the OATM group. **Conclusions:** Current evidence shows improved clinical outcomes with OATM when compared with preoperative conditions. These patients were able to return to sport as early as 6 months after the procedure. It could be suggested from the data that OATM procedures might be more appropriate for lesions that are smaller than 2 cm^2 with the known risk of failure between 2 and 4 years. Further high-quality prospective studies into the management of these articular cartilage injuries are necessary to provide a better framework within which to target intervention. **Level of Evidence:** Level II, systematic review of Level I and II studies.

Articular cartilage has an important role in minimizing friction between articulating surfaces while transferring load to the subchondral bone.[1] Injury to the articular cartilage of the knee is a common occurrence in athletic individuals, and full-thickness articular defects have little potential for self-repair based on poor vascularity. Individuals with this injury may complain of knee pain as well as the presence of joint effusion. These defects can contribute to the early onset of degenerative joint disease.[2] Despite significant time and collaboration in research investigations, treatment remains a clinical dilemma for patients who sustain these injuries and the physicians who treat them.

There are multiple procedures described to address full-thickness articular cartilage defects (ACDs). These techniques include MF, osteochondral allograft transfer, autologous chondrocyte implantation (ACI), and osteochondral autologous transfer (OAT)/mosaicplasty. OAT/mosaicplasty is a procedure that addresses these lesions while maintaining the hyaline cartilage by replacing these defects with an osteochondral autograft.[3,4] This technique focuses on transferring one large graft or multiple smaller cylindrical grafts (mosaicplasty) from minimally weight-bearing portions of the femur to address lesions in regions with greater weight-bearing.

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The authors report the following potential conflict of interest or source of funding: A.M. receives support from Arthrosurface, Stryker, Smith & Nephew, Zimmer, Arthrex, and DJO.

Received July 12, 2014; accepted November 13, 2014.

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0749-8063/14600/$36.00
http://dx.doi.org/10.1016/j.arthro.2014.11.018

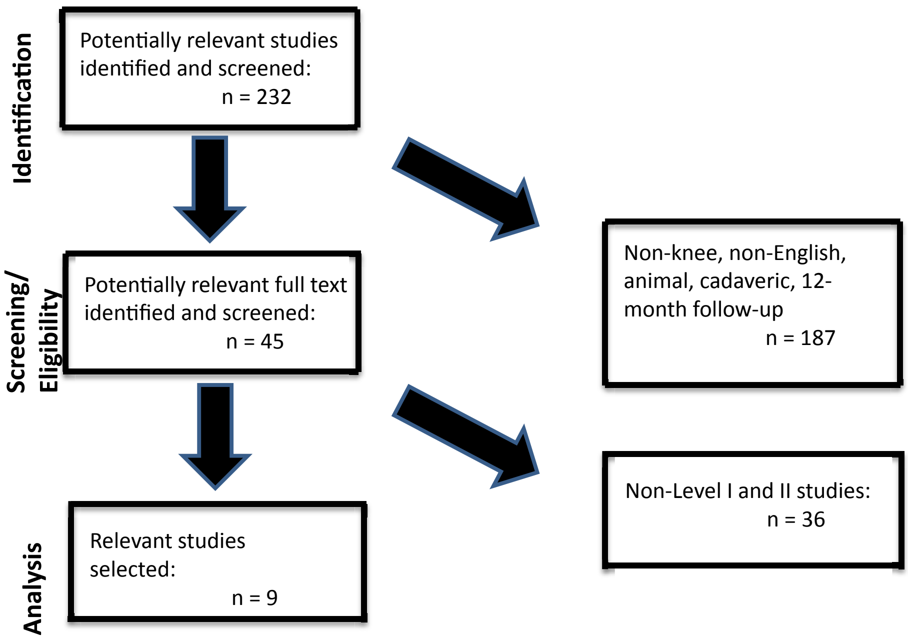

Fig 1. Search strategy according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Nine studies were identified for inclusion.

Although multiple studies have compared osteochondral autograft transplantation to the various other cartilage restoration techniques, most studies lack large numbers of patients. The purpose of this systematic review was to pool the data from multiple high-level studies and critically evaluate OATM in addressing full-thickness cartilage defects of the knee. More specifically, the goal was to evaluate patient-reported clinical as well as functional outcomes of OATM in patients with these articular cartilage injuries.

Methods

A systematic review of outcomes after osteochondral autograft transfer was performed to help summarize patient prognosis in the available English-language literature according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards and a PRISMA checklist (Fig 1). To identify studies, a literature search was performed in December 2013, which included PubMed (1950 to present), CINAHL (Cumulative Index to Nursing and Allied Health Literature; 1994 to present), and the Cochrane Central Register of Controlled Trials (1994 to present) databases. Inclusion criteria for the search included a minimum of 12 months of follow-up, English language, and studies involving the knee. The following search terms were included: “knee AND osteochondral autograft transfer OR mosaicplasty.”

The search was performed in duplicate by 2 authors (T.S.L., R.M.P.), with a senior author (A.M.) used in the event of adjudication. A total of 232 articles were identified for inclusion in the review. Determination of study evidence level was based on recommendations by the Center for Evidence-Based Medicine and included high-quality randomized controlled trials and lesser-quality randomized controlled trials and prospective comparative studies as Level I and Level II, respectively. The 232 articles identified were reviewed, and 45 articles met the inclusion criteria of peer-reviewed English-language articles. Exclusion criteria included non-Level I and II studies, non-English, irrelevant subject matter, systematic reviews, conference and meeting abstracts, and cadaveric studies. This resulted in the inclusion of 9 studies.

Publications were included in this review if they were prospective comparative studies comparing results of full-thickness (grade 3 or 4) articular cartilage injuries. Studies were required to include a minimum of 25 patients with at least a12-month follow-up that compared OAT/mosaicplasty with another treatment modality. We identified 5 randomized controlled trials[5-9] and 4 prospective comparative trials.[10-13] All the references in the selected articles were reviewed manually for other possible studies, and none were identified.

An evidence-based medicine literature review template was used in the preparation of the systematic review.[14] Demographic data evaluated included year of publication, author, journal, surgical procedures evaluated, total number of participants, mean patient age, method of randomization, percentage of traumatic lesions, interval from injury to surgery, and lesion size and location (Table 1). Follow-up data were collected and included mean follow-up, details of follow-up evaluation, the presence of cointerventions, and rehabilitation protocols (Table 2). Finally, primary and secondary clinical outcomes, results of arthroscopic and

Table 1. Clinical, Arthroscopic, and Histologic Data

Level	Year of Study	Study	Journal	Group1	Group 2	Group 3	Total Enrolled Participants	Mean patient Age, yr	Method of Randomization	Percent Traumatic, %	Duration of Symptoms	Lesion Size, cm^2	Lesion Location
II	2014	Ulstein et al.[13]	*KSSTA*	OATM	MF	None	25	32.3	Block randomization	44	MF 111 OAT 75.8	MF 2.6 (2-5.2) OAT 3 (2-6)	MFC 80% LFC 12% Trochlea 8%
II	2013	Gudas et al.[10]	*Arthroscopy*	OATM	MF	Debridement	102	34.1	Envelope	100	19.3	2.6 (2-4)	MFC 100%
I	2012	Gudas et al.[7]	*AJSM*	OATM	MF	None	60	24.3	Envelope	56	21.3	2.8 (1-4)	MFC 84% LFC 16%
I	2012	Bentley et al.[5]	*JBJS-BR*	OATM	ACI-P 6 ACI-C 46	None	100	31.3	Random number	46	86.4	4.66 (1-12.2)	MFC 53% LFC 18% Patella 25% Tibial plateau 1% Trochlea 3%
II	2012	Lim et al.[12]	*CORR*	OATM	MF	ACI	70	28.5	Envelope	NR	NR	2.74 (1-4)	MFC 79% LFC 21%
I	2009	Gudas et al.[8]	*JPO*	OATM	MF	None	50	14.3	Random number	NR	23.5	3.2	MFC 82% LFC 18%
I	2005	Gudas et al.[9]	*Arthroscopy*	OATM	MF	None	60	24.3	Envelope	56	21.3	2.8 (1-4)	MFC 84% LFC 16%
I	2003	Bentley et al.[6]	*JBJS Br*	OATM	ACI-P 6 ACI-C 46	None	100	31.3	Random number	46	86.4	4.66 (1-12.2)	MFC 53% LFC 18% Patella 25% Tibial plateau 1% Trochlea 3%
II	2003	Horas et al.[11]	*JBJS Am*	OATM	ACI-P	None	40	33.4	Alternating	100	NR	3.75 (3.2-5.6)	MFC 842% LFC 18%

NOTE. Values expressed as mean (range) when available.

ACI-C, autologous chondrocyte implantation—collagen cover; ACI-P, autologous chondrocyte implantation—periosteal cover; AJSM, American Journal of Sports Medicine; CORR, Clinical Orthoaedics and Related Research; LFC, lateral femoral condyle; JBJS-BR, The Journal of Bone and Joint Surgery. British Volume; JPO, Journal of Pediatric Orthopaedics; KSSTA, Knee Surgery, Sports Traumatology, Arthroscopy; MF, microfracture; MFC, medial femoral condyle; NR, not reported; OAT, osteochondral autograft transplant; OATM, osteochondral autograft transplantation/mosaicplasty.

Table 2. Follow-up Information

Study	Follow-up Length	Participants Evaluated Clinically, n (%)	Participants Evaluated Arthroscopically, n (%)	Participants Evaluated Histologically, n (%)	Cointerventions	CPM	Time to Partial Weight Bearing	Time to Full Weight Bearing
Ulstein et al.[13]	9.8 yr*	23 (92)	None	None	None	Yes	Immediate	8 wk
Gudas et al.[10]	36.1 mo	97 (95)	None	None	ACLR	No	Immediate	6 wk
Gudas et al.[7]	10.4 yr	57 (95)	None	None	None	No	4 wk	8 wk
Bentley et al.[5]	10 yr†	95 (95)	None	None	None	No	None	1 d
Lim et al.[12]	5.7 yr	70 (100)	52 (74.3)	None	None	Yes	Immediate	8 wk
Gudas et al.[8]	4.2 yr	47 (94)	21 (44.7)	None	None	No	3-4 wk	6-8 wk
Gudas et al.[9]	3 yr	57 (95)	34 (57)‡	25 (42)‡	None	No	4 wk	8 wk
Bentley et al.[6]	1 yr	100 (100)	60 (60)§	19 (19)¶	None	No	None	1 d
Horas et al.[11]	2 yr	40 (100)	12 (30)‡	11 (28)‡	None	Yes	2 wk	12 wk

ACI, autologous chondrocyte implantation; ACLR, anterior cruciate ligament reconstruction; CPM, continuous passive motion; OATM, osteochondral autograft transplant/mosaicplasty.
*Median follow-up.
†Minimal 10-year follow-up, no mean given.
‡Nonrandom selection of patients to evaluate arthroscopically and obtain biopsy samples.
§Sixty-four percent of patients underwent ACI, and 55% of patients underwent OATM.
¶All from ACI groups.

histologic evaluations, and the use of independent examiners were documented (Table 3).

Results

Overall, there were 9 studies reviewed with a total of 607 patients. Two of these articles were long-term 10-year follow-up reports from previously published short-term studies that are also in this review. Four of the reviewed articles compared OATM to MF: Gudas et al.[9] found that the OATM group had better clinical results ($P < .01$), more normal-appearing cartilage on visual inspection ($P = .004$), and a subjectively greater percentage of hyaline cartilage on histologic evaluation. In a pediatric population, Gudas et al.[8] showed a significant superiority of OATM over MF, with deterioration present in the MF group at 4-year follow-up. At 10-year follow-up, Gudas et al.[7] revealed that the OAT procedure in an athletic population allowed for a higher rate of return to play and maintenance of sport at the preinjury level when compared with MF. Ulstein et al.[13] showed that there was no difference between OAT and MF in patient-reported outcomes, muscle strength, or radiologic outcomes; however, there was a trend toward more reoperations in the MF group.

In the setting of anterior cruciate ligament (ACL) reconstruction, Gudas et al.[10] compared OATM to MF as well as to simple debridement. The authors concluded that subjective IKDC scores were better for the OATM group versus MF or debridement. Meanwhile, Lim et al.[12] did not find a difference in functional scores and postoperative MRI evaluations between OAT, MF, and ACI at 3-year follow-up. Finally, Horas et al.[11] and Bentley et al.[5,6] compared OAT with ACI. Horas et al. reported improved clinical scores with OAT compared with ACI; however, Bentley et al. (2003) noted more normal ($P < .01$) cartilage on arthroscopic evaluation in the ACI group, with improved clinical scores at short-term 18-month follow-up.[6] At 10-year follow-up, Bentley et al.[5] found continued improvement in clinical scores in the ACI group with a greater failure rate in the OATM group (23 of 42 [55%]) compared with the ACI group (10 of 58 [17%]).

Lesion Size

Two of the 9 studies in this systematic review analyzed the effect of lesion size on outcomes. Gudas et al.'s[8] pediatric article reported clinical outcomes that were worse in patients with a lesion greater than 3 cm^2 who underwent OATM. Meanwhile, in the long-term study by Gudas et al.,[7] the authors found that a lesion size less than 2 cm^2 was associated with a significantly higher rate of return to sport when compared with larger lesions after undergoing the OATM procedure. Regarding location of the lesion, there was no difference in clinical outcome between location of the lesion either on the medial or lateral femoral condyle; however, Bentley et al.[6] revealed that all 7 patellar lesions treated with OATM had failed at 1.7 years of follow-up.[6]

Outcome Measures

The 6 studies that reported preoperative clinical scores found improvement in clinical outcomes measures in the OATM treatment group at final follow-up when compared with scores preoperatively. Gudas et al.[9] showed that the Hospital for Special Surgery (HSS) score improved from a mean of 77 preoperatively to 91 at 37-month follow-up.[9] Additionally, International Cartilage Repair Society (ICRS) scores improved from 51 to 75. In the pediatric study of Gudas et al.,[8] the ICRS improved from 51 preoperatively to 92 at 1-year follow-up and then decreased to 83 at 4 years after surgery. Their long-term 10-year study found that ICRS scores before surgery were 61 in patients with ACDs and 51 in patients with osteochondral dissecans.[7] In these patients, the score increased to 93 in the patients with ACDs and to 88 in the patients with osteochondral dissecans at long-term follow-up ($P < .001$). Meanwhile, specifically looking at ACDs in the ACL reconstruction article by Gudas et al.,[10] the OAT-ACL Tegner preinjury score was 7.3, with a 3-year score of 7.1. The delta decline (0.2) was smaller for the OATM group compared with the delta values in either the MF or debridement group. Furthermore, IKDC subjective scores were 45.5 before surgery, with a score of 88 at 3-year follow-up in the OATM group.

Horas et al.[11] noted an increase in Lysholm scores from 27 to 70 over 2 years, improvement in Meyers scores from 8 to 17, and an increase in Tegner activity score from 2 to 5 during the same period. Ulstein et al.[13] found improvement in Lysholm scores from 49.2 to 62.6 at long-term follow-up as well as an increase in Knee Injury and Osteoarthritis Outcome Score (KOOS) from baseline within the OATM cohort. Finally, Lim et al.[12] found an increase in the Lysholm scale score from 53 to 85 at 5 years.[12] They also found improvement in average Tegner scores from 2.7 to 5.3 and HSS scores from 79 to 88.

Return to Sport

Four of the 9 studies evaluated reported return to athletic activity. Both in the short-term and long-term studies, Gudas et al.[7,9] found that patients who underwent OATM were able to return to play at an average of 6.5 months. The investigators also found that a lesion smaller than 2 cm^2 was correlated with a higher return to sport compared with larger lesions. In the short-term study, younger athletes (younger than 30 years) had better clinical and functional outcomes than those older than 30 years ($P = .008$).[9] At long-term follow-up, these younger athletes were more able to maintain their preinjury activity levels compared with individuals who were older at the time of the index procedure.[7] In the pediatric population, Gudas et al.[7] found that 84% of patients achieved their preinjury activity level at 11.7 months after surgery, with 81% of these athletes continuing to participate at the same level at 4-year follow-up. In the OATM/ACL reconstruction cohort of Gudas et al.,[10] the average return to play for athletes was 10.2 months, with 3 athletes (8.8%) returning as early as 6 to 8 months.[10]

Radiographic Outcomes

In this systematic review, radiographic evaluation was included in 4 of the 9 articles. Gudas et al.[9] found no arthritic changes on plain radiographs either before surgery or at 3-year follow-up. They also performed magnetic resonance imaging (MRI) in 25 patients in the OATM group, which showed that incorporation of the osseous component was complete in 23 of these patients (92%). At 10-year follow-up, 7 (25%) patients had evidence of Kellgren-Lawrence grade I osteoarthritis, but these findings did not influence the final ICRS scores ($P = .094$).[7] Magnetic resonance imaging (MRI) evaluation at this final follow-up also did not show any signs of osseous loosening. Additionally, joint surface congruency was also found to be restored in 24 of the 25 patients (96%). Gudas et al.[8] reported performing MRI in 21 of 25 pediatric patients treated with OATM.[8] Assessment using the ICRS evaluation system showed good to excellent repairs in 19 of 21 (91%) patients, and all osteochondral transplants (100%) had completely healed without any degenerative changes. Ulstein et al.[13] evaluated their cohort with plain radiographs at long-term follow-up. Two of the 12 (16.7%) patients in the OATM group were found to have Kellgren-Lawrence scores greater than II, with one of these individuals presenting with osteoarthritis in the contralateral knee.

Reoperations

Reoperations were studied in 3 of the 9 studies. Lim et al.[12] reported one reoperation resulting from limited range of motion that required secondary arthroscopy for a prominent osteochondral plug (1 of 22 [4.5%]). Meanwhile, Ulstein et al.[13] reported 5 reoperations (5 of 14 [36%]): 4 of the procedures were diagnostic arthroscopies/debridement, with one procedure being an opening wedge osteotomy. Finally, Bentley et al.[5] reported 23 reoperations at long-term follow-up. The mean time from the index procedure to revision surgery was 4.3 years (range, 1 to 9 years). These procedures included 9 ACIs, 5 unknown procedures, 3 matrix-induced chondrocyte implantations, 3 unicondylar knee replacements, 1 patellofemoral joint replacement, 1 combined medial and patellofemoral joint replacement, and 1 total knee arthroplasty.

Discussion

In an era of an ever-changing economic climate for hospitals and surgeons, there is increasing importance for the role of evidence-based medicine in the physician decision-making process. The evidence-based medicine hierarchy places importance on controlled trials, specifically randomized controlled trials, as well as controlled prospective cohort studies. In this systematic review, we present data from 9 Level I and II studies, thus providing the best data to date to assess clinical outcomes of osteochondral autograft transplants/mosaicplasty.

Although limitations (see further on) prevent us from making recommendations regarding the superiority of one procedure over another, these long-term studies do help to give us insight into the natural history of the knee after osteochondral autograft transfer/mosaicplasty. Gudas et al.[7] found at 10-year follow-up that OATM techniques allowed for a higher rate of return to sport and maintenance of sport at the preinjury level

Table 3. Selected Demographic Data from Included Studies

Study	Total Enrolled Participants	Primary Clinical Outcomes	Secondary Clinical Outcomes	Arthroscopic Findings	Histologic Findings	Independent Observer	Additional Findings
Ulstein et al.[13]	25	Lysholm OAT 62.6 MF 69.7	ΔKOOS pain OAT 11.8 MF 20.6 ΔKOOS symptoms OAT 8.5 MF 17.4 ΔKOOS ADL OAT 7.5 MF 13.0 ΔKOOS sport/recreation OAT 41.3 MF 32.4 ΔKOOS quality of life OAT 25.0 MF 34.6	NC	NC	NR	No change in isokinetic muscle strength of knee flexion/extension Osteoarthritis with Kellgren-Lawrence $\geq$ II OATS 2 of 12 (16.7%) MF 5 of 11 (45.5%)
Gudas et al.[10]	102	Tegner OAT 7.1 MF 6.9 Debridement 6.2 Control 7.5	Percent RTP OAT 88% MF 82% Debridement 79% Control 94%	NC	NC	Yes	Intact articular cartilage during ACLR yields more favorable IKDC subjective scores, but if defect is present, subjective IKDC scores are subjectively better for OATM compared with MF or debridement
Gudas et al.[7]	60	ICRS ($P < .001$) MF 73.9 ± 1.5 MF-ACD 64.8 ± 1.7 OAT-OCD 50.9 ± 1.8 OAT-ACD 61.3 ± 1.7	Tegner MF-OCD 6.1 ± 0.7 MF-ACD 6.2 ± 0.4 OAT-OCD 6.7 ± 0.4 OAT-ACD 7.0 ± 0.4 Continuation of sport MF-OCD 0 of 5 (0%) MF-ACD 5 of 10 (50%) OAT-OCD 4 of 14 (29%) OAT-ACD 6 of 14 (43%) Failure OAT 14% MF 38%	NC	NC	Yes	Younger athletes (< 30 yr) had better clinical and functional outcomes than those older than 30 yr ($P = .008$)

(continued)

Table 3. Continued

Study	Total Enrolled Participants	Primary Clinical Outcomes	Secondary Clinical Outcomes	Arthroscopic Findings	Histologic Findings	Independent Observer	Additional Findings
Bentley et al.[5]	100	Modified Cincinnati > 55 ($P = .02$) OATM 9 of 15 (60%) ACI 35 of 48 (73%)	Failure OAT 55% ACI 17%	NC	NC	No	
Lim et al.[12]	70	Lysholm OAT 84.8 ± 5.5 MF 85.6 ± 6.8 ACI 84.6 ± 6.1	Tegner OAT 5.7 ± 1.2 MF 5.1 ± 1.5 ACI 5.2 ± 1.3 HSS OAT 88.1 ± 4.2 MF 87.6 ± 4.5 ACI 87.5 ± 4.6	ICRS grade 1 or 2 OAT 14 of 17 (82%) MF 16 of 20 (80%) ACI 12 of 15 (80%)	None	NR	Postoperative MRI at 1 yr with Outerbridge grade I/II OAT 17 of 20 (85%) MF 20 of 25 (80%) ACI 13 of 16 (81%)
Gudas et al.[8]	50	ICRS OATM 19 of 23 (85%) MF 12 of 19 (63%)		ICRS grade 1 or 2 OAT 5 of 5 (100%) MF 3 of 16 (18.8%)	NC	No	Postoperative MRI 18 mo with ICRS good to excellent OATM 19 of 21 (91%) MF 10 of 18 (56%)
Gudas et al.[9]	60	HSS ($P < .01$) OAT 91.1 ± 4.1 MF 80.6 ± 4.6	ICRS ($P < .001$) OAT 89 ± 4 MF 75 ± 4 Percent RTP OAT 93% MF 52%	Percent CRA 8-12 ($P = .004$) OAT 79% MF 45%	OAT: 100% hyaline cartilage MF: 57% fibrocartilage 43% fibroelastic tissue	Yes	Patients younger than 30 yr had better HSS score in both groups ($P = .008$) Patients with a traumatic defect had better HSS scores that those with osteochondritis dessicans in both groups ($P = .004$) Lesions > 2 cm^2 in central medial femoral condyle had lower HSS scores in MF group ($P < .05$) but no significant difference in OAT group
Bentley et al.[6]	100	Modified Cincinnati > 55 ($P = .27$) ACI 88% OAT 69%		Percent with CRA 8-12 ($P < .01$) ACI = 82% OAT = 34%	Percent with hyaline-like or mixed hyaline of fibrocartilage-like ACI = 74% OAT = NR	No	7 poor results, all in OAT group Technique documented placing plugs slightly prominently

(continued)

Table 3. Continued

Study	Total Enrolled Participants	Primary Clinical Outcomes	Secondary Clinical Outcomes	Arthroscopic Findings	Histologic Findings	Independent Observer	Additional Findings
Horas et al.[11]	40	Lysholm ($P < .05$) OAT = 74 ± 6 ACI-P = 67 ± 8	Tegner (NS) OAT = 5 ± 1 ACI-P = 5 ± 1 Meyers (NS) OAT = 17 ± 2 ACI-P = 16 ± 3	No objective data	OAT patients with hyaline cartilage not integrated into surrounding cartilage ACI-P specimens with mainly fibrocartilage, focalized areas of hyaline-like cartilage deep	No	

NOTE. A delta symbol (Δ) indicates a change or different in quantity. Values expressed as mean ± standard deviation when available. Clinical outcome measures used were Hospital for Special Surgery clinical score (higher score indicates increased function), International Cartilage Repair Society clinical score (higher score indicates increased function), modified Cincinnati score (higher score indicates increased function), Lysholm score (higher score indicates increased function), International Knee Documentation Committee subjective score (higher score indicates increased function), Tegner activity score (higher score indicates increased level of activity), Meyers rating scale (higher score indicates increased function), and International Cartilage Repair Society cartilage repair assessment (higher score indicates more normal cartilage; 12 ¼ normal cartilage).

ACD, articular cartilage defect; ACI, autologous chondrocyte implantation; ACI-P, autologous chondrocyte implantation—periosteal patch; ACLR, anterior cruciate ligament reconstruction; ADL, activities of daily living; CRA, International Cartilage Repair Society cartilage repair assessment (higher score indicates more normal cartilage; 12 = normal cartilage); HSS, Hospital for Special Surgery clinical score (higher score indicates increased function); ICRS, International Cartilage Repair Society clinical score (higher score indicates increased function); IKDC, International Knee Documentation Committee; KOOS, Knee Injury and Osteoarthritis Outcome Score; MF, microfracture; MRI, magnetic resonance imaging; NC, not collected; NR, not reported; NS, not statistically significant; OAT, osteochondral autograft transplant; OATM, osteochondral autograft transplant/mosaicplasty; OCD, osteochondral defect; RTP, return to play.

when compared with MF. There were 4 failures (14%) in the OATM group that required surgical intervention compared with 11 failures (38%) in the MF group. One of these OATM failures occurred at 3 months after the index procedure, whereas the other 3 failures occurred at an average of 5.8 years. Of these revisions, 2 were to treat an additional articular cartilage defect and the other 2 revisions required the addition of osteochondral plugs to the original defect. There were no signs of osseous loosening in the OATM group on MRI performed at long-term follow-up. Ulstein et al.[13] found that long-term outcomes after OATM and MF were comparable. There were 5 reoperations in 14 patients (36%) in the OATM group, whereas there were 6 reoperations in the 11 patients (55%) in the MF group.

However, Bentley et al.[5] revealed that functional outcomes were better with ACI than with OATM at long-term follow-up. There were 23 failures in 42 (55%) patients in the OATM group compared with 10 failures in 58 (55%) patients in the ACI group ($P < .001$). The mean size of the defect in the ACI group was 4.4 cm,[2] and in the OATM group it was 4 cm^2. The OATM group did well for the first 2 years and then experienced a steep failure over the next 2 years, with a suggestion of leveling out thereafter. The authors suggest that this failure might reflect the known pattern of deterioration of fibrocartilage.

Limitations

There are substantial limitations in the literature review for this article, the first being that there are only 9 Level I and II studies that have been conducted for OATM. This should lead to systematic bias in the validity of the evidence. Additionally, all the articles showed improvement in patient-reported outcomes and functional scores; however, only one of these studies meeting inclusion criteria included a placebo group. This lack of a control group limits interpretation of these data to comparison between treatment methods. The relatively small number of trials available with heterogeneous outcome measures also prevents performing a meta-analysis of the results.

Conclusions

This systematic review of 9 Level I and II studies shows improved clinical outcomes compared with preoperative values. Autogenous osteochondral transfers have been found to allow athletes to be able to return to play at a high rate at about 6 months after surgery, particularly athletes younger than 30 years of age. At long-term follow-up, MRI and radiographs showed incorporation of the bone plugs with restoration of the articular surface as well as a minimal presence of osteoarthritis. Additionally, it could be suggested that OATM might be more appropriate for lesions smaller than 2 cm^2 with the known risk of failure between 2 and 4 years. However, the most appropriate way to address the issue would be a large multicenter trial comparing all techniques (OATM, MF, and ACI), simple debridement, and a nonoperative control with the use of validated patient-reported outcome measures. The results from this systematic review might help orthopaedic surgeons in the preoperative decision-making process and in the informed consent process with the patient by counseling the patient on short- and long-term outcomes after OATM. Finally, this review can serve as a platform for further higher-level investigations.

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