Osteochondral allografts for the treatment of shoulder instability

a systematic review and meta-analysis

From Iranian Tissue Bank and Research Center, Tehran University of Medical Sciences, Tehran, Iran

Correspondence should be sent to S. M. J. Mortazavi
smjmort@yahoo.com

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M. Poursalehian,[1,2] R. Ghaderpanah,[1,2] N. Bagheri,[1,2] S. M. J. Mortazavi[1,2]

[1]Iranian Tissue Bank and Research Center, Tehran University of Medical Sciences, Tehran, Iran
[2]Joint Reconstruction Research Center, Tehran University of Medical Sciences, Tehran, Iran

Aims
To systematically review the predominant complication rates and changes to patient-reported outcome measures (PROMs) following osteochondral allograft (OCA) transplantation for shoulder instability.

Methods
This systematic review, following PRISMA guidelines and registered in PROSPERO, involved a comprehensive literature search using PubMed, Embase, Web of Science, and Scopus. Key search terms included "allograft", "shoulder", "humerus", and "glenoid". The review encompassed 37 studies with 456 patients, focusing on primary outcomes like failure rates and secondary outcomes such as PROMs and functional test results.

Results
A meta-analysis of primary outcomes across 17 studies revealed a dislocation rate of 5.1% and an increase in reoperation rates from 9.3% to 13.7% post-publication bias adjustment. There was also a noted rise in conversion to total shoulder arthroplasty and incidence of osteoarthritis/osteonecrosis over longer follow-up periods. Patient-reported outcomes and functional tests generally showed improvement, albeit with notable variability across studies. A concerning observation was the consistent presence of allograft resorption, with rates ranging from 33% to 80%. Comparative studies highlighted similar efficacy between distal tibial allografts and Latarjet procedures in most respects, with some differences in specific tests.

Conclusion
OCA transplantation presents a promising treatment option for shoulder instability, effectively addressing both glenoid and humeral head defects with favourable patient-reported outcomes. These findings advocate for the inclusion of OCA transplantation in treatment protocols for shoulder instability, while also emphasizing the need for further high-quality, long-term research to better understand the procedure's efficacy profile.

Take home message
- Osteochondral allograft (OCA) transplantation shows promise as a treatment for shoulder instability, addressing defects in both the glenoid and humeral head.
- This systematic review indicates favourable patient-reported outcomes and functional improvements, although complication rates such as dislocation, reoperation, and allograft resorption are notable.
- The study advocates for the inclusion of OCA in treatment protocols while emphasizing the need for further high-quality, long-term research to fully assess its efficacy.

Introduction

The management of recurrent shoulder instability, particularly in the presence of bone loss, presents considerable challenges. The rate of recurrence after soft-tissue stabilization procedures may reach as high as 90% when subcritical bone loss is involved.[1,2] In the context of shoulder instability, "subcritical" bone loss refers to the presence of bone loss that is insufficient to significantly affect the stability of the shoulder joint, yet it would lead to a clinically significant decrease in patients' quality of life.[3] "Critical" bone loss is defined as the threshold of bone loss at which the stability of the shoulder joint is compromised.[3,4] The dichotomy of shoulder instability pivots on the direction of dislocation, with anterior instability typically resulting from traumatic abduction and external rotation leading to anterior glenoid bone loss.[5] Here, the anterior rim of the glenoid fossa is compromised, undermining the static stability of the joint. Conversely, posterior instability, often initiated by anteroinferior force on the arm, results in posterior glenoid bone loss, which is less common but equally impactful on joint mechanics.[6] Humeral head defects – Hill-Sachs lesions following anterior dislocations, and reverse Hill-Sachs lesions post posterior dislocations – further complicate the clinical picture.[7] These lesions not only influence static stability but also the dynamic glenoid track, the breadth of which is crucial for concavity compression and, by extension, the overall biomechanical stability of the glenohumeral joint.

Several reconstruction procedures have been developed to address the anatomical disruption of the humerus and glenoid, including the Latarjet procedure, iliac crest bone graft augmentation, free bone block transfers, and Bankart repair with or without reimplissage.[8] Among these, the Latarjet procedure has demonstrated good to excellent clinical outcomes in terms of recurrence of instability, and has become the current gold standard for managing anterior glenoid bone loss.[9] However, this approach has potential disadvantages, such as the morbidity of tissue harvest, absence of articular bone cartilage restoration for posterior glenoid bone defects and humeral bone defects, limitation for large bone defects, and nonanatomical geometry of the graft.[10]

Recent years have seen a growing interest in osteochondral allograft (OCA) transplantation as a versatile alternative for addressing shoulder instability, offering the potential to correct anatomical defects.[11] OCAs provide an opportunity to restore both bone and cartilage using donor tissue, and can be applied in primary or revision settings.[11,12] Our systematic review aims to critically evaluate the effectiveness and safety of OCA transplantation in treating shoulder instability due to glenoid and humeral defects, with a focus on patient-reported outcomes, complications, and radiological evidence.

Methods

Study design

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines to ensure a rigorous and transparent methodology.[13] We used a predefined protocol for this review, which was registered in the PROSPERO prospective register of systematic reviews (CRD42023431327). Our protocol was also reviewed by our institutional review board (IR.TUMS.IKHC.REC.1402.073)

Search strategy

We developed a comprehensive search strategy to identify all relevant studies. The search strategy was designed to capture published articles in PubMed, Embase, Web of Science, and Scopus. The search was carried out from inception of the databases until 2023. The language of publication was not restricted. The search strategy included a combination of controlled vocabulary (e.g. MeSH in PubMed) and free-text terms related to OCA for shoulder instability. For example, the search strategy for PubMed was (osteochondral allograft AND (shoulder OR glenoid* OR humer*)). We also searched the references of included studies and relevant reviews using Citation Chaser (R 2019; R Foundation for Statistical Computing, Austria) to identify additional eligible studies.[14]

Study selection

After the removal of duplicates, two reviewers (MP, RG) independently screened the titles and abstracts of the studies identified through the search strategy. Full-text articles were obtained for studies that potentially met the inclusion criteria, which were then independently reviewed for eligibility. Disagreements were resolved through discussion, or by involving a third reviewer (NB) when necessary.

Inclusion criteria

The inclusion criteria were as follows: adult patients diagnosed with shoulder instability, undergoing OCA transplantation aimed at treating shoulder instability; and studies reporting on at least one of the following outcomes: patient-reported outcome measures, surgical complications, postoperative stability, or radiological outcomes following OCA transplantation. All levels of evidence, including randomized controlled trials, cohort studies, case-control studies, and case reports, were considered.

Exclusion criteria

The exclusion criteria were as follows: any patients presenting with primary shoulder fractures, primary shoulder osteoarthritis (OA), or any malignancy affecting the shoulder girdle; studies focusing on interventions other than OCA transplantation for shoulder instability; studies that did not report specific outcomes related to the effectiveness or safety of OCA transplantation; and editorials, letters to the editor, commentary articles, and reviews without original data.

Furthermore, OA was defined as primary degenerative joint disease evident on radiological imaging, presenting with joint space narrowing, osteophyte formation, subchondral sclerosis, and/or subchondral cyst formation, and excluded if it was the primary diagnosis. Studies discussing aetiologies of bone loss from conditions other than instability, such as avascular necrosis, infectious aetiologies, or metabolic bone diseases, were also excluded to maintain the focus on instability-induced bone loss.

Data extraction

Two independent reviewers (MP, RG) extracted data from the included studies using a pre-designed data extraction form. Extracted information included study design, study

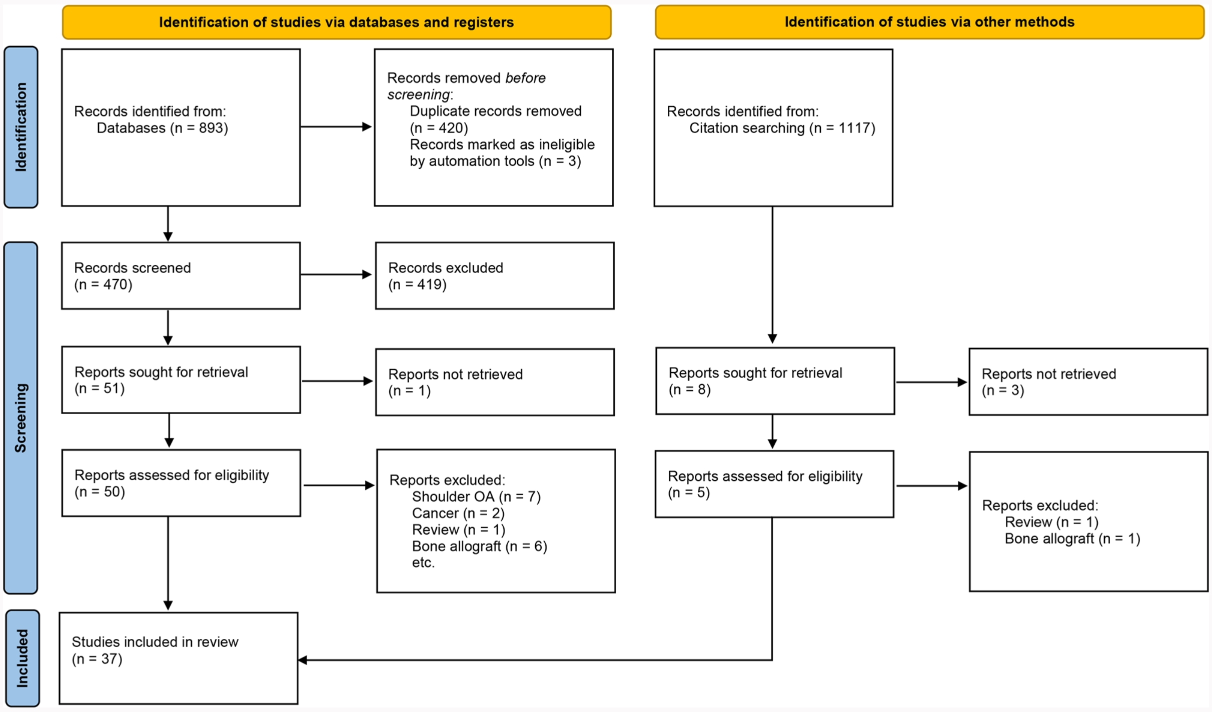

Fig. 1
PRISMA flow diagram illustrating the study selection process for the systematic review. OA, osteoarthritis.

population, intervention, outcome measures, and results. Discrepancies were resolved through discussion, or by involving a third reviewer (NB) if needed.

Quality assessment

The methodological quality (or risk of bias) of the included non-case report studies was assessed independently by a reviewer (RG) using the Newcastle-Ottawa Scale (NOS) for cohort studies.[15]

Data synthesis

Results were synthesized and reported narratively with respect to study characteristics findings. When sufficient homogeneity existed among studies in terms of design, participants, interventions, and outcomes, a random effects model meta-analysis was performed using the CMA v3.1 (Biostat, USA). Statistical heterogeneity was assessed using the chi-squared statistic. If the heterogeneity was high among the reported outcomes, a sensitivity analysis was performed to find the outlier study. Then, the publication bias was assessed using Egger's test. If publication bias was detected, we used the trim-and-fill method to reduce this.[16] Finally, if the heterogeneity was high after sensitivity analysis, a meta-regression was performed to find the possible causes of heterogeneity. We used age of patients, percentage of revision cases, type of graft used, source of graft used, direction of instability, type of surgery, and follow-up duration of the study for meta-regression.

Results

Study selection

The database searches yielded a total of 625 records. After removing duplicates, 270 records were screened by title and abstract, of which 68 were selected for full-text review. Following full-text review, 37 studies were found to meet the inclusion criteria and were included in the systematic review (Figure 1).

Study characteristics

The 37 included studies were published between 2002 and 2022. They were mostly conducted in the USA (n = 18) and Canada (n = 5), and encompassed a total of 456 participants, ranging from one to 73 participants per study. The majority of studies were case reports (n = 20) and case series (n = 15). Two studies were retrospective cohorts.

Case reports

The patients in these case reports varied in age from 15 to 69 years, with a higher frequency of males represented. Two types of graft preservation were used, with fresh-frozen being the most common, followed by cryopreserved grafts. The source of the grafts used for the humerus was predominantly from the femur (n = 10 cases) followed by the humerus (n = 8 cases). The source of the grafts used for the glenoid was predominantly from the distal tibia (n = 6 cases) followed by the glenoid (n = 2 cases). A detailed overview of the case report studies is provided in Table I.

The majority of the cases involved posterior instability (n = 13 cases), with few reported anterior instabilities (n = 11 cases). Some cases used arthroscopic techniques (n = 5 cases), and others also used press-fit techniques as their fixation (n = 4 cases). The size of the glenoid defect ranged from 25% to 40%; the size of the humeral defect ranged from 20% to 50%. Despite the variability in procedure and defect size, the final outcome was consistently reported as accepta-

Table I. Summary of case report studies.

Study	Sex	Age, yrs	Fresh/ cryopreserved allograft	Humerus/ glenoid defect	Graft source	Posterior/ anterior instability	Open surgical/ arthroscopic	Concomitant procedure	Fixation	Size of defect, %	Final outcome	Follow-up, mths
Barbier et al, 2010[17]	M	42	C	H	Femur	P	OS	-	Screws	30 to 40	Acceptable	12
Black et al, 2016[18]	M	24	FF	H	H	P	OS	-	Press-fit	33	Acceptable	32
Camp et al, 2015[19]	M	25	FF	G	DT	A	OS	-	Screws	-	Acceptable	12
Chapovsky and Kelly, 2005[20]	M	16	FF	H	H	A	Arth	Anterior inferior ligament repair	Press-fit	-	Acceptable	121
Dubey et al, 2021[21]	3M	32, 45, 54	FF	H	Femur	P	OS	-	Screws	40 to 50	Acceptable	18
Elmalı et al, 2015[22]	M	59	C	H	Femur	P	OS	Lesser tuberosity transfer	Screws	30, 40	Acceptable	14
Gupta et al, 2013[23]	M	29	FF	G	DT	P	Arth	-	Screws	25	Acceptable	12
Kropf and Sekiya, 2007 [24]	M	19	NR	H	H	A	Arth	-	Press-fit	-	Acceptable	12
Mastrokalos et al, 2017[25]	M	29	FF	H	Femur	P	OS	-	Screws	40	Acceptable	12
McCarty and Cole, 2007[26]	F	16	FF	H	H	A	Arth	-	Screws	-	Acceptable	24
Millett et al, 2013[27]	2M	15, 16	FF	G	DT	P	OS	-	Screws	-	Acceptable	24
Nathan and Parikh, 2012[28]	M	16	FF	H	H	A	OS	-	Screws	30	Acceptable	30
Patrizio and Sabetta, 2011[29]	M	57	NR	H	Femur	P	OS	Lesser tuberosity transfer	Screws	20 to 30	Acceptable	8
Petrera et al, 2013[30]	M	54	FF	G	G	P	OS	-	Screws	-	Acceptable	24
Quinn et al, 2017[31]	M	17	FF	G	DT	P	OS	-	Screws + sutures	28	Acceptable	14
Sochacki et al, 2020[32]	M	19	FF	H	H	A	Arth	Anterior inferior ligament repair	Screws	38	Acceptable	168
Tjoumakaris et al, 2007[33]	M	33	NR	G, H	H, G	A	OS	-	Screws	30	Acceptable	12
Woodard et al, 2022[34]	M	16	FF	G, H	H, DT	A	OS	-	Screws	30 to 40 right, 100 left	Acceptable	24
Yagishita and Thomas, 2002[35]	M	69	C	H	Femur	A	OS	Bankart repair	Press-fit	-	Acceptable	24
Yi et al, 2015[36]	2M	38, 46	NR	H	Femur	A	OS	IC allograft for G	Screws	30 to 50	Acceptable	60

A, anterior instability; Arth, arthroscopic; C, cryopreserved; DT, distal tibia; FF, fresh-frozen; G, glenoid; H, humerus; IC, iliac crest; NR, not reported; OS, open surgical; P, posterior instability.

ble across all cases, with no recurrence of dislocation and no reoperations.

Case series

A detailed overview of the case series studies is provided in Table II. In total, 432 patients were included, with a mean age range of 21.7 to 54.5 years, and a higher proportion of

Table II. Summary of case series studies.

Study	N	Sex	Mean age, yrs	Number of revision cases	Fresh/cryopreserved allograft	Humerus/glenoid defect	Graft source	Posterior/anterior instability	Open surgical/arthroscopic	Concomitant procedure	Fixation	Size of defect, %	Mean follow-up, mths
Amar et al, 2018[37]	42	29 M, 13 F	26.7	20	FF	G	DT	A	Arth	-	Screws	30	6
De Giacomo et al, 2018[38]	36	26 M, 10 F	35	NR	FF	G	DT	A	NR	-	NR	NR	15
Diklic et al, 2010[39]	13	10 M, 3 F	42	NR	FF	H	Femur	P	OS	Biceps tenodesis in 3 patients	NR	25 to 50	54
Frank et al, 2018[11]	50	48 M, 2 F	25.6	32	FF	G	DT	A	OS	-	Screws	25	45
Gerber et al, 2014[40]	14	18 M, 4 F	47	0	FF	H	Femur, H	P	OS	-	Screws	45	143
Gilat et al, 2020[41]	10	8 M, 2 F	24	7	FF	G	DT	P	Arth	Posterior labral repair in 4, posterior capsular repair in 7	Screws	26	34
Liwski et al, 2021[42]	58	38 M, 20 F	28.8	NR	NR	G	DT	NR	Arth	-	Screws	NR	10.8
Marcheggiani et al, 2021[43]	12	NR	54.5	0	FF	H	H	P	OS	-	Screws	30 to 50	66
Martinez et al, 2013[44]	6	6M	31.6	0	FF	H	H	P	OS	-	NR	40	122
Murphy et al, 2018[45]	5	3 M, 2 F	53	0	FF	H	H	P	OS	-	Screws	30 to 50	34
Provencher et al, 2017[46]	27	27 M	31	5	FF	G	DT	A	OS	-	Screws	23	45
Roach et al, 2022[47]	10	8 M, 2 F	27	5	FF	H	H	A	OS	Capsulolabral repair	Screws	20.80	57.6
Robinson et al, 2021[48]	12	10 M, 2 F	26	7	NR	G	DT	A	OS	Arthrosurface procedures to fill a large humeral head defect in 4	Screws	25 to 50	28
Weng et al, 2009[49]	9	7 M, 2 F	34.6	9	NR	G	Femur	A	OS	-	Screws	30	54
Wong et al, 2018[50]	36	NR	29.7	NR	NR	G	DT	A	Arth	-	Screws	> 20	26.1
Wong et al, 2020[51]	73	52 M, 21 F	28.8	NR	FF	G	DT	A	Arth	-	Screws + anchor sutures	> 15	56.4
Zhuo et al, 2019[52]	19	12 M, 7 F	21.7	NR	FF	H	Femur, H	A	OS	-	Screws	35	27.8

A, anterior instability; Arth, arthroscopic; C, cryopreserved; DT, distal tibia; FF, fresh-frozen; G, glenoid; H, humerus; NR, not reported; OS, open surgical; P, posterior instability.

male patients across studies. Most studies used fresh-frozen grafts (n = 13); other studies did not report their graft type. The graft source for humeral defects (n = 7) was primarily the humerus (n = 6) or femur (n = 2). The graft source for glenoid defects (n = 10) was primarily the distal tibia (n = 9); one study used a femoral graft for a glenoid defect. There was an almost equal split of anterior (n = 11) and posterior (n = 7) instability across the studies. Several studies employed arthroscopic techniques (n = 5). Fixation was achieved using screws in all studies. The reported size of the glenoid defect varied across studies, ranging from 15% to 50%. The reported size of the humeral defect also varied, ranging from 20% to 50%. Follow-up periods ranged from six to 143 months.

Quality assessment

The quality of the included studies varied according to the NOS; most studies had a high level of quality. Details of the quality assessment can be seen in Table III.

Table III. Newcastle-Ottawa quality assessment scale results.

Study	Selection	Comparability	Outcome	Overall quality
Amar et al, 2018[37]	***	**	***	High
De Giacomo et al, 2018[38]	***	**	***	High
Diklic et al, 2010[39]	***	**	***	High
Frank et al, 2018[11]	****	**	***	High
Gerber et al, 2014[40]	***	*	**	High
Gilat et al, 2020[41]	***	**	**	High
Liwski, 2021[42]	****	*	**	High
Marcheggiani, 2021[43]	***	**	**	High
Martinez, 2013[44]	***	*	**	Moderate
Murphy, 2018[45]	***	*	**	Moderate
Provencher, 2017[46]	***		***	Moderate
Roach, 2022[47]	***		***	Moderate
Robinson, 2021[48]	***		**	Moderate
Weng, 2009[49]	***	**	**	High
Wong, 2018[50]	****	*	***	High
Wong, 2020[51]	***		***	High
Zhuo, 2019[52]	***	**	***	High

Table IV. Meta-analysis of primary outcomes of osteochondral allograft transplantation.

Outcome	Rate (95% CI; I^2)	Sensitivity	Publication bias	Meta-regression
Dislocation (17 studies)	5.1% (3.1% to 8.5%; 0%)	-	-	-
Reoperation (17 studies)	9.3% (5.0% to 16.7%; 60%)	-	0.02 to 5 studies trimmed – 13.7% (7.7% to 23.2%)	Higher follow-up had higher reoperations
Hardware removal (14 studies)	7.4% (4.6% to 11.7%; 0%)	-	-	-
Conversion to TSA (14 studies)	5.7% (2.5% to 12.4%; 42%)	-	0.00 to 6 studies trimmed – 12.1% (5.6% to 24.3%)	Longer follow-up had higher conversion
Osteoarthritis or osteonecrosis (14 studies)	6.7% (2.7% to 15.9%; 60%)	-	0.00 to 5 studies trimmed – 14.0% (6.1% to 28.8%)	Longer follow-up had higher OA or AVN

AVN, avascular necrosis; CI, confidence interval; OA, osteoarthritis; TSA, total shoulder arthroplasty.

Outcomes

In this study, outcomes were categorized into primary and secondary measures. The primary outcome was defined as recurrent instability, reoperation, conversion to shoulder arthroplasty, and occurrence of OA/osteonecrosis. Complementing this, secondary outcomes were patient-reported outcome measures, functional tests, and radiological evaluations.

In our meta-analysis of primary outcomes for OCA transplantation encompassing 17 studies (Table IV), key findings include a dislocation rate of 5.1% with no observed heterogeneity, and a reoperation rate of 9.3% which increases to 13.7% after accounting for publication bias. Hardware removal occurred in 7.4% of cases, while conversion to total shoulder arthroplasty (TSA) was initially at 5.7%, rising to 12.1% post-bias adjustment, particularly with longer follow-up. Similarly, the rate of OA or osteonecrosis increased from 6.7% to 14.0% following bias adjustment, with longer follow-up periods correlating with higher incidence. These findings highlight the importance of considering long-term follow-up when evaluating OCA transplantation outcomes. Forest plots of meta-analysis are available in the Supplementary Material.

In the collection of studies examined, there was notable variation in PROMs and functional tests (Table V). However, a common finding across all studies was observed – an improvement in these patient-reported measures and functional test results. Radiological evaluations, with a specific focus on allograft resorption, were a prominent feature in several studies.[37,39,42,43,50–53] Across these studies, allograft resorption was consistently observed. Resorption (grade 1 or higher) rate was reported between 33% and 80% of cases.

Table V. Secondary outcomes of case series.

Study	ASES	ROM	CS	WOSI	Other outcomes	Allograft resorption
Amar et al, 2018[37]	-	-	-	-	Sagittal dimension of glenoid: 24.0 preop to 34.1 postop	< 50% in 13, > 50% in 5
De Giacomo et al, 2018[38]	-	Abd: 102.2 preop to 82.6 postop; Flex: 125.8 preop to 137.9 postop; ER: 46.1 preop to 43.2 postop; IR: 47.8 preop to 52.3 postop	-	-	DASH: 50.7 preop to 37 postop; SANE: 32.5 preop to 75.8 postop; VAS: 5.6 preop to 43.2 postop	-
Diklic et al, 2010[39]	-	-	43 preop to 98 postop	-	-	-
Frank et al, 2018[11]	60.0 preop to 90.3 postop	-	-	35.0 preop to 84.8 postop	SANE: 39.6 preop to 88.0 postop; SST: 58.1 preop to 91.4 postop; VAS: 2.9 preop to 1.1 postop	-
Gerber et al, 2014[40]	-	-	37 preop to 77 postop	-	SSV: 33 preop to 88 postop	-
Gilat et al, 2020[41]	-	Flex: 154 preop to 148 postop; Abd: 167 preop to 149 postop; ER: 73 preop to 62 postop	-	-	SF-12 (P): 32.5 preop to 41.8 postop; (M): 57.3 preop to 46.5 postop	-
Liwski et al, 2021[42]	-	-	-	Sensitized vs non-sensitized: 24.9 vs 40.1	Zhu resorption grade (sensitized vs non-sensitized): (21.9% vs 14.3%, 21.9% vs 28.6%, 43.8% vs 28.6%, and 12.5% vs 28.6% for respective resorption grades 0 to 3)	< 50% in 39
Marcheggiani et al, 2021[43]	N/A preop to 94.2 postop	Flex: N/A preop to 166.6 postop; ER: N/A preop to 82.5 postop	N/A preop to 82.3 postop	N/A preop to 11.2% postop	-	-
Martinez et al, 2013[44]	-	Flex: N/A preop to 116.6 postop; ER: N/A preop to 69.1 postop; IR: N/A preop to 69.1 postop	N/A preop to 69.1 postop	-	-	-
Murphy et al, 2018[45]	-	-	N/A preop to 83 postop	-	-	-
Provencher et al, 2017[46]	63 preop to 93 postop	-	-	43% preop to 11% postop	50 preop to 90 postop	3% allograft lysis
Roach et al, 2022[47]	N/A preop to 67 postop	-	N/A preop to 67 postop	-	SST: N/A preop to 9.4 postop; SF-12 (P): N/A preop to 44.1 postop; (M): N/A preop to 50.6 postop	-
Robinson et al, 2021[48]	50.2 preop to 90.5 postop	Flex: N/A preop to 161.4 postop; ER: N/A preop to 49.5	37.6 preop to 86.2 postop	-	SST: 7 preop to 11.4 postop; SANE: 32.2 preop to 85 postop; DASH: 42.9 preop to 8.9 postop; VAS: 4.6 preop to 1.1 postop	-

(*Continued*)

(*Continued*)

Study	ASES	ROM	CS	WOSI	Other outcomes	Allograft resorption
Weng et al, 2009[49]	-	-	-	-	Rowe score: 24 preop to 84 postop	-
Wong et al, 2018[50]	-	-	-	-	-	> 50% in 3, and < 50% in 27
Wong et al, 2020[51]	-	-	-	71.1 preop to 25.6 postop	DASH: 27.4 preop to 13.8 postop	> 50% in 9, and < 50% in 39
Zhuo et al, 2019[52]	96.9 preop to 53.2 postop	Flex: 150 preop to 160 postop ER: 54 preop to 61 postop	81.1 preop to 88.8 postop	-	Rowe score: 23.6 preop to 97.6 postop	Graft resorption was observed in 8

Abd, abduction; ASES, American Shoulder and Elbow Surgeons; CS, Constant Score; DASH, Disabilities of the Arm, Shoulder, and Hand; ER, external rotation; Flex, flexion; IR, internal rotation; N/A, not available; ROM, range of motion; SANE, Single Assessment Numeric Evaluation; SF-12 (M), 12-item Short Form Mental Component Summary; SF-12 (P), 12-item Short Form Physical Component Summary; SST, Simple Shoulder Test; SSV, Subjective Shoulder Value; UCLA, University of California, Los Angeles shoulder score; VAS, visual analogue scale for pain; WOSI, Western Ontario Shoulder Instability Index.

Comparative studies

The 2018 study by Frank et al[11] compared the outcomes of distal tibial allograft (n = 50) with the Latarjet procedure (n = 50). Their results demonstrated that both groups had similar outcomes in terms of visual analogue scale (VAS), American Shoulder and Elbow Surgeons Score (ASES),[54] Western Ontario Shoulder Instability Index (WOSI),[55] Single Assessment Numeric Evaluation (SANE), rate of complications, reoperation, and instability. However, the Latarjet procedure showed superior outcomes in the Simple Shoulder Test (SST), with a significant difference ($p = 0.011$).[11]

A 2018 study by Wong et al[50] compared distal tibial allograft (n = 36) with the Latarjet procedure (n = 12). Their results indicated that the distal tibial allograft demonstrated similar bony union, but had a higher resorption rate compared to the Latarjet procedure. However, no statistically significant difference was observed between the two procedures regarding final graft surface area, size of grafts, and the anteroposterior dimensions of the reconstructed glenoid.

Discussion

This systematic review analyzed the effectiveness and safety of OCA transplantation for the treatment of shoulder instability. Drawing from an array of 37 studies, encompassing both case reports and case series, we identified critical insights into the application of this emerging technique. The results illustrated a promising role for OCA transplantation in treating shoulder instability, with an overall acceptable failure rate and good patient-reported outcome measures and functional tests across studies.

The primary outcomes of our meta-analysis yield notable findings that have substantial implications for clinical practice. The observed dislocation rate of 5.1% indicates a relatively low risk of instability post-transplantation, a reassuring finding for both surgeons and patients. However, the increase in reoperation rates in the long-term studies raises concerns about the potential under-reporting of complications in the existing literature. The conversion to TSA rate was 5.7%; however, this rate increased to 12.1% after bias adjustment using the trim-and-fill method. These outcomes suggest that while OCA transplantation can be effective, a considerable subset of patients may require subsequent TSA. Additionally, the increase in rates of OA or osteonecrosis from 6.7% to 14.0% following bias adjustment, particularly with longer follow-ups, indicates the potential long-term joint degeneration associated with this procedure. This correlation between longer follow-up periods and increased complications highlights the critical need for long-term monitoring of OCA transplantation patients.

The reported allograft resorption rates, ranging from 33% to 80%, are indicative of the variability in graft integration and longevity. This wide range might be attributed to differences in surgical techniques, graft preservation methods, or patient-specific factors. The consistent observation of allograft resorption across studies, however, underscores a critical area for future research and innovation in graft processing and transplantation techniques.

A systematic review with long-term follow-up of Latarjet procedures by Hurley et al[9] revealed an 8.5% recurrent instability rate, a 3.7% revision rate, and arthritic changes in 38.2% of patients. Despite their excellent functional outcomes and high return-to-sport rate, their results fell short of our findings, likely due to the long duration of their study.

In a complication-focused review of Latarjet procedures, Cho et al[56] documented an overall complication rate of 16.1% and a reoperation rate of 2.6%. They noted that severe complications were rare in short-term follow-up. Interestingly, they found a higher rate of intraoperative complications when the arthroscopic approach was used, although instability-related complications were lower compared with the open approach. Notably, none of the studies we examined evaluated the failure rate of open surgical OCA versus arthroscopic OCA.

In the arthroscopic study by Moga et al,[57] distal tibial allografting (DTA) was deemed faster to learn and execute than the Latarjet procedure in treating recurrent anterior shoulder instability with significant glenoid bone loss across surgeons of varying experience.

Harper et al[58] studied the comparison between suture button fixation and screw fixation for DTA, suggesting a comparable learning curve and similar surgical duration. This method did not compromise the optimal accuracy of graft placement, and demonstrated superior α angle fixation.

A biomechanical study by Rodriguez et al[59] indicated that DTA and Latarjet techniques offer comparable glenohumeral kinematics, thus ensuring functional stability after anterior glenoid bone reconstruction. They suggested that DTA reconstruction might be more advantageous for large (25%) anterior glenoid bone defects associated with shoulder instability due to favourable joint compression load and articular contact pressure distribution.

In a cost analysis of 44 arthroscopic Latarjet procedures and five arthroscopic distal tibial allografts, it was found that DTA was nearly three times more expensive than the Latarjet procedure.[60]

Comparative studies included in our review revealed that OCA transplantation demonstrated comparable PROMs to the Latarjet procedure, which is considered a successful treatment for shoulder instability. These studies provide preliminary evidence supporting OCA transplantation as a viable alternative to other treatments, especially in cases where other methods have been unsuccessful.

Regarding donor HLA sensitization, Liwski et al's[42] study added valuable insights, suggesting that HLA sensitization did not increase the risk of adverse outcomes or higher grades of resorption. This finding expands the potential pool of patients who could benefit from this procedure, including those sensitized against donor HLA.

The limitations of our study are multidimensional. Primarily, the geographical focus on the USA and Canada may restrict the broader applicability of the findings, as this concentration could lead to a lack of representativeness for other global regions. Additionally, the reliance on case reports and series, which are generally considered lower in the evidence hierarchy, raises potential issues of selection bias and questions the strength of the evidence. The participant demographics, characterized by small, diverse sample sizes with a predominance of male subjects spanning a wide age range, may not accurately represent the broader population, potentially limiting the relevance of the findings. Furthermore, the heterogeneity introduced by the varied surgical techniques, graft types, and sources used across studies complicates the ability to draw firm conclusions. Variations in outcome measures and follow-up durations add further complexity to comparing and synthesizing results. Post-publication bias adjustments revealing changes in outcomes hint at possible biases affecting the perceived effectiveness and safety of the procedures. Radiological evaluation inconsistencies, notably in allograft resorption rates, challenge the reliability of these aspects of the findings. Comparative studies included in the review, while informative, are constrained by their own limitations such as small sample sizes and inherent biases, which could influence their conclusions. Notwithstanding this, our study's strengths lie in its methodical approach. The systematic review methodology ensures a rigorous and comprehensive examination of the literature, providing a solid foundation for the findings. The variety of study designs, including case reports and series, offers a richer perspective on clinical practices and patient outcomes, thereby enriching the overall understanding of the subject matter.

To conclude, our findings indicate a generally favourable profile for OCA transplantation, with a dislocation rate of 5.1% and reoperation rates ranging from 9.3% to 13.7% post-publication bias adjustment. The study also revealed notable increases in the rates of conversion to TSA and the occurrence of OA/osteonecrosis over longer follow-up periods, emphasizing the importance of long-term monitoring in these procedures. Patient-reported outcomes and functional tests showed significant improvements across the studies, indicating positive patient experiences and functional recoveries post-transplantation.

Supplementary material

Meta-analysis forest plots.

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Author information

M. Poursalehian, MD, Research Fellow
R. Ghaderpanah, MD, Research Fellow
N. Bagheri, MD, Orthopaedic Shoulder and Elbow Surgeon
S. M. J. Mortazavi, MD, Professor of Orthopaedic Surgery, Hip and Knee Surgeon
Iranian Tissue Bank and Research Center, Tehran University of Medical Sciences, Tehran, Iran; Joint Reconstruction Research Center, Tehran University of Medical Sciences, Tehran, Iran.

Author contributions

M. Poursalehian: Conceptualization, Investigation, Writing – original draft, Writing – review & editing, Data curation, Formal analysis, Methodology, Visualization.
R. Ghaderpanah: Investigation, Data curation, Writing – review & editing.
N. Bagheri: Supervision, Writing – review & editing.
S. M. J. Mortazavi: Supervision, Writing – review & editing.

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Data sharing

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