The Efficacy of Labral Reconstruction

A Systematic Review

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Background: With a greater understanding of the importance of the acetabular labrum in the function of the hip, labral repair is preferred over debridement. However, in some scenarios, preservation or repair of the labrum is not possible, and labral reconstruction procedures have been growing in popularity as an alternative to labral resection.

Purpose: To provide an up-to-date analysis of the literature to determine the overall efficacy of labral reconstruction when compared with labral repair or resection.

Study Design: Systematic review; Level of evidence, 3.

Methods: PubMed, Embase, and MEDLINE databases were searched for literature regarding labral reconstruction in the hip before July 21, 2020. The results were screened and evaluated by 2 reviewers, and a third reviewer resolved any discrepancies. The final studies were evaluated using the MINORS (Methodological Index for Non-randomized Studies) score.

Results: There were 7 comparative studies that fit the inclusion criteria, with 228 hips from 197 patients. The mean follow-up was 34.6 months, and the mean age of all patients was 38.34 years. There were slightly more female patients than male patients (105 vs 92). Arthroscopic reconstruction was performed in 86% of studies (6/7); open surgical techniques, in 14% (1/7). A variety of grafts was used in the reconstructions. The indications for labral reconstruction and outcome measures varied in these publications. Nine patients were lost follow-up, and 6 patients converted to total hip replacement postlabral reconstruction. The assessment of these comparative studies illustrated statistically equivalent results between labral reconstruction and labral repair. Comparisons of labral reconstruction with labral resection also showed statistically equivalent postoperative patient-reported outcome scores; however, the rates of conversion to total hip arthroplasty were significantly higher in the population undergoing resection.

Conclusion: The review of current available comparative literature, which consists entirely of level 3 studies, suggests that labral reconstruction does improve postoperative outcomes but does not demonstrate superiority over repair. There may, however, be benefit to performing labral reconstruction over resection owing to the higher rate of conversion to total hip arthroplasty in the labral resection group.

Keywords: reconstruction; labrum; labral; hip

The acetabular labrum is vital to the stability, kinematic function, durability, and proprioception of the hip joint.[3,5,12,19] The labrum is a fibrocartilaginous structure that extends from the osseous acetabular rim and the acetabular articular cartilage, effectively deepening the acetabular socket by 33% and increasing contact surface area by 22%.[12,19,21] The extended labrum provides a seal around the femoral head, which limits fluid flow in and out of the joint space as well as the articular cartilage, ensuring ample lubrication that contributes to stability, force distribution, and durability within the joint.[2,11,12,19] Crawford et al[7] conducted a cadaveric study that showed that the hip is 43% to 60% more easily distracted without a labrum presumably because of the loss of seal, maintenance of negative pressure, and loss of depth. Greaves et al[13] supported the theory that the acetabular labrum decreases mean and maximum stress in areas of the hip joint without a labrum—specifically, articular cartilage would exude fluid from within whereas a healthy labrum is relatively impermeable to the fluid. Without a labrum, the increase in friction and stresses within the articular cartilage in the hip likely contributes to degenerative changes associated with osteoarthritis.[12,23]

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Originally, debridement or labral resection was the most common treatment for a labral tear. However, as more studies have shown the importance of the labrum, biomechanically and clinically, techniques have been developed to preserve the labrum. As such, labral repair techniques have evolved, and studies have demonstrated increasingly high success rates.[10,14] However, because of the relative avascularity of the labrum, especially regarding intrasubstance tears and intralabral calcifications, ossification of the labrum can occur, making some labral tears irreparable. While some studies have demonstrated that labral-like tissue can regrow in areas of resection,[1] other alternatives including labral reconstruction have been sought. Labral reconstruction, initially introduced by Philippon et al[18] using an iliotibial band autograft, has seen an increase in popularity as the encouraging results of some case series have been published. Furthermore, there has been evolution of techniques and diversification of graft sources that have been utilized including allograft iliotibial band, autograft and allograft hamstring tendon grafts, and other tissues. As the published outcomes seem to be improving, indications for labral reconstruction have continued to broaden, resulting in surgeons adopting this procedure more frequently. However, this enthusiasm has been based mostly on level 3 and 4 evidence. Thus, the purpose of this systematic review was to compile and synthesize the English-language literature on the comparative outcomes of labral reconstruction in a methodologically sound manner to determine if this enthusiasm is warranted.

METHODS

Search Strategy

We searched PubMed, Embase, and MEDLINE databases for literature regarding labral reconstruction in the hip published before July 21, 2020, the date of the final search. The study question and inclusion criteria were determined before the search and data screening. The key search terms “labrum,” “reconstruction,” “graft,” “hip,” and “acetabulum” were used, and the results were limited to studies in English or Hebrew and studies on humans.

After initial screening of the titles, abstracts and full texts were reviewed by 2 investigators (N.S., E.R.). The senior author (E.A.) was present for confirmation and resolution of disagreements.

Inclusion/Exclusion Criteria

We included studies if they (1) involved labral reconstruction via open surgery and/or arthroscopic means, (2) compared reconstruction outcomes with resection or repair outcomes, (3) were published in English, and (4) involved live human participants (ie, no cadaveric studies). There were minimal exclusion criteria to ensure inclusiveness: (1) studies reporting no surgical outcomes, such as radiographic studies, review articles, or instructional course lectures; (2) studies that did not evaluate the hip/acetabular labrum; (3) studies with a follow-up <12 months; or (4) studies that did not include live human participants.[3]

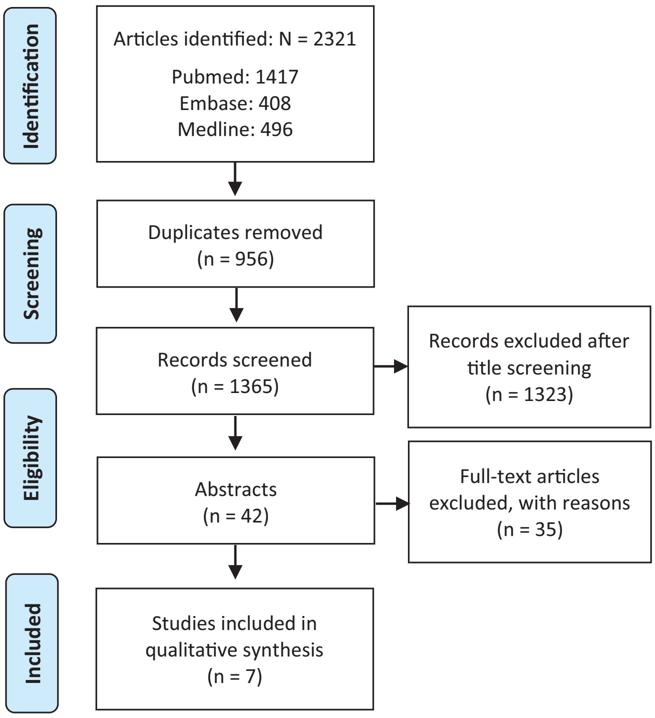

Figure 1. The study inclusion process as shown in a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram.

Data Abstraction

The initial literature search yielded 2321 articles, of which 42 abstracts proceeded to full-text screening. There were 35 screened articles that did not include all of the aforementioned inclusion criteria. Seven articles were identified that fulfilled the inclusion criteria (Figure 1). Data were then abstracted from the 7 articles and recorded in a spreadsheet. The extracted data included the following: author, year of publication, patient characteristics (sample size, age, sex), preoperative clinical and radiologic findings, indications for reconstruction, intraoperative findings, type of surgery (open or arthroscopic), concomitant procedures, graft choice, mean length of follow-up, percentage lost to follow-up, number of revisions, percentage progressed to total hip replacement, postoperative clinical and radiologic findings, outcome scores, level of evidence, and complications. The principal summary measures used in this study were patient-reported outcome (PRO) scores as well as comparative statistical analyses performed by the authors of the individual studies.

We determined that meta-analysis of the data and patient pooling were not feasible because the 7 studies showed extreme variability in design, graft type, postoperative rehabilitation, and outcome measurement tools. Therefore, a systematic review was chosen as the correct method to formulate and evaluate the efficacy of labral reconstructions with the current evidence available.

Quality Assessment

We scored each study according to the MINORS (Methodological Index for Non-randomized Studies)[22] criteria (Table 1). The index includes a 12-item assessment for comparative studies, with each item receiving a score between 0 and 2. The perfect score is 24 for comparative studies.

RESULTS

These 7 published studies ranged in size from 8 to 63 patients undergoing reconstruction (mean, 28). A total of 228 hips from 197 patients across all included studies underwent labral reconstruction. Nine patients were lost follow-up, and 6 hips were converted to total hip replacement postlabral reconstruction, with a survivorship of 222 hips. However, it is important to note that several articles written by the same authors may have duplicated patient data, where some patients were included in multiple studies, obscuring the exact number of unique data points.

The studies included patient follow-ups with a mean range of 24 through 56 months postoperatively (mean, 34.6 months). All studies had a mean patient age <46 years (mean, 38.3 years; range, 32.6-45.6 years). There were slightly more female patients than male patients (105 vs 92). Arthroscopic reconstruction was performed in 86% of studies (6/7) and 94.3% of hips (215/228), whereas an open surgical technique was used in 14% of studies (1/7) and 6% of hips (13/228). All but 8 patients recorded a Tönnis grade <2. Table 2 summarizes the descriptive data.

Additional preoperative information and the PRO and quality-of-life outcome scores for patients undergoing labral reconstruction are summarized in Appendix Table A1.

TABLE 1
Assessment of Individual Studies Using MINORS[a]

	MINORS Question[b]												
	1	2	3	4	5	6	7	8	9	10	11	12	Total[c] (%)
Camenzind[6] (2015)	2	2	2	2	2	2	2	2	0	2	1	1	2	20 (83)
Domb[8] (2014)	2	2	2	2	2	2	2	2	2	2	2	2	24 (100)
Maldonado[15] (2019)	2	0	2	2	0	0	0	0	2	1	2	2	13 (54)
Domb[9] (2020)	2	2	2	2	0	2	2	0	2	2	2	2	20 (83)
Matsuda[16] (2013)	2	0	2	2	0	2	2	0	2	2	1	2	17 (68)
Scanaliato[20] (2018)	2	2	2	2	0	2	1	0	2	2	1	2	18 (75)
White[24] (2018)	2	2	2	2	0	2	2	0	1	1	1	2	17 (68)

[a]MINORS, Methodological Index for Non-randomized Studies.
[b]1, clearly stated aim; 2, inclusion of consecutive patients; 3, prospective collection of data; 4, endpoints appropriate for aim; 5, unbiased assessment of endpoint; 6, appropriate follow-up period; 7, loss to follow-up <5%; 8, prospective calculation of study size; 9, an adequate control group; 10, contemporary groups; 11, baseline equivalence of groups; 12, adequate statistical analyses.
[c]The perfect score is 24.

Comparative Labral Studies

The 7 included studies were comparative studies designed to investigate the overall efficacy of labral reconstruction procedures. Among these studies, the researchers investigated the differences in outcomes between reconstruction and resection (2 articles[8,15]) or repair/refixation (5 articles[6,9,14,16,20]).

Reconstruction vs Resection

The strongest publication (as reflected by the highest MINORS score recorded among all included studies) regarding the comparative efficacy of labral reconstruction to labral resection was a 2014 article by Domb et al.[8] The study was a match-paired analysis. There were no statistical differences among the preoperative PRO scores between the groups. However, results showed a greater improvement in postoperative Non-arthritic Hip Score (NAHS) and Hip Outcome Score–Activities of Daily Living score for the labral reconstruction group as compared with the labral resection group ($P = .046$ and $P = .045$, respectively). The other incorporated PRO scores (Hip Outcome Score–Sports Specific Subscale, modified Harris Hip Score [mHHS], visual analog scale for pain [VAS]) revealed no statistical differences between the groups, although the authors noted

TABLE 2
Descriptive Data Extracted and Compiled From Each Study[a]

Study[b]	No. of Hips (M:F)	Mean Age, y	Mean Follow-up, mo	Lost to Follow-up, %	No. of Revisions	Progressed to THR, %
Camenzind[6] (2015)	13 (6:5)	36	38	0	2	0
Domb[8] (2014)	11 (7:4)	33	26.4	0	1	0
Maldonado[15] (2019)	38 (22:16)	43.2	42.4	0	2	5.3
Domb[9] (2020)	37 (18:19)	45.6	25.5	0	0	5.4
Matsuda[16] (2013)	8 (7:1)	34.6	30	0	0	0
Scanaliato[20] (2018)	63 (26:37)	43.4	24	15	3	3
White[24] (2018)	58 (6:23)	32.6	56	0	0	NR

[a]F, female; M, male; NR, not reported; THR, total hip replacement.
[b]For each study, level of evidence: 3.

trends in favor of the reconstruction group for these PRO scores.

A second study published by Maldonado et al[15] in 2019 compared labral reconstruction with labral resection in patients with severe acetabular chondral damage. The results showed no statistical differences between the groups regarding the pre- to postoperative changes in PRO scores for all outcome measurements (mHHS, NAHS, Hip Outcome Score–Sports Specific Subscale, VAS-Pain, 12-Item International Hip Outcome Tool, and patient satisfaction). However, total hip arthroplasty (THA) conversion rates were 5.3% for the reconstruction group and 21.1% for the resection group. This 4-times greater rate of THA in the labral resection group was statistically significant (relative risk, 4.0; 95% CI, 0.91-17.63).

Reconstruction vs Repair

Five studies compared labral reconstruction and labral refixation. Two compared segmental reconstructions: 1 open (although circumferential reconstructions were included) and 1 arthroscopic.[6,16] The other 3 studies compared arthroscopically performed circumferential labral reconstructions using allografts with arthroscopic labral repair.[9,20,24]

The first article reporting a comparison of segmental labral reconstruction with labral repair was authored by Camenzind et al.[6] They performed a matched-pair analysis of 13 hips in 11 patients undergoing open femoroacetabular impingement (FAI) surgery with segmental or circumferential labral reconstruction using a ligamentum teres graft. These hips were compared with 14 hips undergoing open FAI surgery with labral repair. While the article did not provide extensive comparative statistical analyses and it focused heavily on the labral reconstruction group, the investigators noted no significant difference between the reconstruction and refixation groups at a minimum 2-year follow-up (mean, 38 months; $P > .05$). This result supported the authors' approach of their open reconstructive technique and suggested that reconstruction is a "valuable option with no adverse effects" given the proper indications.

The second study comparing segmental labral reconstruction and labral refixation was a 2013 publication by Matsuda and Burchette.[16] These authors compared 8 patients who underwent arthroscopic labral reconstruction using a gracilis autograft during a 1-year period with 46 patients who underwent labral refixation over the same time. Both groups underwent surgery for combined-type FAI. The results demonstrated that the difference in the change of the PRO score used (NAHS) was significantly higher for the reconstruction group ($P = .02$). However, when a matched-pair analysis was performed, there was no statistically significant difference. The authors acknowledged the limitation of the small number of patients and noted that the quantitative measures were "at best suggestive," but they emphasized that the statistical analyses proved that reconstruction is at least as good as refixation.

The third study comparing the efficacy of arthroscopic labral reconstruction with labral repair involved 162 hips followed for a mean 24 months (range, 22-26 months) in a 2018 publication by Scanaliato et al.[20] A group of 99 consecutive hips treated using primary labral repair was compared with a group of 63 hips treated using primary circumferential reconstruction. The raw data of mHHS and VAS pain scores demonstrated significantly better results in the labral repair group. However, the descriptive data between the groups also revealed significant differences in preoperative pain, age, body mass index, Tönnis grades, and severity of labral pathology. Scanaliato et al attempted to account for these differences by applying weight equal to the inverse of the propensity score for additional statistical analyses. Using this reduced patient pool (128 hips), the authors found no statistical differences in the postoperative outcomes between labral reconstruction and repair. Overall, the study concluded that labral reconstruction offers similar outcomes as compared with labral repair despite less favorable preoperative characteristics than the labral repair group.

In a 2018 article, White et al[24] reported the results of a bilateral hip arthroscopic study in which patients had a labral repair procedure on 1 side of the hip and subsequently a labral reconstruction on the other. These 29 patients (58 hips) were followed for a minimum of 22 months from the reconstruction (mean, 56 months postrepair; 40 months postreconstruction). There were no failures within the follow-up period for the arthroscopic circumferential reconstructions using iliotibial band allograft as compared with a 31% failure rate for the repairs. However, White et al reported no statistically significant differences in the pre- to postoperative changes for the mHHS, Lower Extremity Functional Scale, VAS for pain, or patient satisfaction scores. This study presented several limitations that may have influenced the overall result. This was a sequential series, as the senior author's practice evolved to performing labral reconstructions instead of labral repairs. Thus, the initial side of the hip was repaired earlier in the author's surgical experience, and the other side of the hip was reconstructed later, making surgeon experience/skill and duration of follow-up both potential confounding variables.

Finally, a 2020 matched-pair analysis published by Domb et al[9] focused on comparing primary arthroscopic circumferential labral reconstruction using anterior tibialis allograft with labral refixation. This study of 37 patients (37 labral reconstructions) was matched to a group with 111 labral repairs. With a minimum 2-year follow-up, the authors found no significant differences in the pre- to postoperative changes in all PRO measurements between the groups. However, Domb et al[9] noted that, while the data seemed to demonstrate no difference between reconstruction and repair, the results should be interpreted with caution, as long-term studies have indicated the efficacy of repair given the presence of viable tissue.[4,17]

Complications

Camenzind et al[6] reported 1 complication of a nonunion of the osteotomy for open surgical dislocation, which was corrected after 6 months. Domb et al[8] reported 2 patients had

TABLE 3
Surgical Findings, Procedures, and Complications[a]

Study	Intraoperative Findings	Concomitant Procedures	Operative Complications
Camenzind[6] (2015)	Cam, 4; pincer, 6; combined, 3	Reconstruction, 13	1 nonunion
Domb[8] (2014)	Cam, 0; pincer, 3; combined, 8	Reconstruction, 11; acetabuloplasty, 33; femoroplasty, 28	2 patients reported knee pain at graft harvest site at 6 wk postoperatively
Maldonado[15] (2019)	Seldes classification (I, II, I + II): 3, 7, 28 ALAD classification (0-4): 0, 0, 0, 35, 3 Outerbridge classification of acetabulum (0-4): 0, 0, 0, 27, 11 Outerbridge classification of femoral head (0-4): 35, 0, 1, 1, 1	Reconstruction, 38; capsular plication, 12; capsular release, 26; acetabuloplasty, 38; femoroplasty, 38; acetabular microfracture, 11; ligamentum teres debridement, 8; iliopsoas fractional lengthening, 12; synovectomy, 1; notchplasty: 5	None reported
Domb[9] (2020)	Seldes classification (I, II, I + II): 0, 8, 29 ALAD classification (0-4): 1, 6, 16, 11, 3 Outerbridge classification of acetabulum (0-4): 1, 6, 13, 7, 10 Outerbridge classification of femoral head (0-4): 33, 0, 0, 3, 1 LT percentile class (0-3)[b]: 22, 6, 8, 1; LT Villar class (0-3)[c]: 22, 0, 8, 8	Reconstruction, 37; repair, 16; capsulotomy without repair, 21; acetabuloplasty, 37; femoroplasty, 37; acetabular microfracture, 8; femoral head microfracture, 0; trochanteric bursectomy, 13; gluteus medius repair, 5; suture staple, 2; transtendinous, 3	No operative complications
Matsuda[16] (2013)	None reported	Reconstruction, 8	No operative complications
Scanaliato[20] (2018)	None reported	Reconstruction, 63; acetabular microfracture, 1	None reported
White[24] (2018)	None reported	Reconstruction, 29	No operative complications

[a]ALAD, acetabular labral articular distraction; LT, ligamentum teres.
[b]LT percentile class: 0, 0%; 1, (range, 0%-50%); 2, (range, 50%-100%); 3, 100%.
[c]LT Villar class: 0, no tear; 1, complete tear; 2, partial tear; 3, degenerative tear.

pain at the harvest site of the hamstring autograft at 6 weeks postoperatively. The pain eventually resolved given time and rehabilitation. No conclusions can be drawn regarding any association between labral procedure and surgical complications, although it would be reasonable to expect that autograft labral reconstructions have the potentially added risk of morbidity attributed to graft harvest.

DISCUSSION

Chief Results

The results of this systematic review demonstrate that labral reconstructions show significant postoperative improvement in outcome scores and patient satisfaction. The outcomes from labral reconstruction are statistically equivalent to those of labral repair, suggesting statistically equivalent efficacy. Furthermore, while there was no statistical difference in outcome scores comparing labral reconstruction with resection, 1 study did demonstrate a 4-fold greater rate of conversion to THA after labral resection as compared with reconstruction.[15]

It is important to note that labral procedures in the hip are often accompanied by concomitant procedures, such as femoroplasty, acetabuloplasty, and microfracture. It is possible that short-term improvements in PROs could be attributed to the associated procedures and not to the labral reconstruction. Comparative studies, ideally with longer follow-up, are necessary to confirm the findings of this review, especially in regard to the difference in THA rates between labral reconstruction and labral resection.

Complications

The review of the current available literature does not allow for conclusive statements on the complication rates attributed to labral reconstruction and does not allow for direct comparisons among varying techniques owing to the lack of comparative graft-type studies. It can be said that patients who have undergone autograft procedures may experience donor site pain. Furthermore, although it was not reported, it is likely that patients who underwent open surgical techniques had higher levels of operative-site pain immediately after surgery because of the increased scope of the procedure and the added risk of complications associated with an open surgical dislocation including osteotomy nonunion and hardware complications. However, no data suggested statistically significant differences in postoperative complications specifically related to procedure choice (repair or reconstruction). Certainly, it was expected, but was not reported, that labral reconstruction, which is a longer and more complex surgical procedure, may have a higher complication rate when compared with labral resection.

Comparative Success

Labral reconstruction was shown using PROs to be statistically equivalent to labral resection and labral repair, regardless of the segmental or circumferential reconstruction technique in the few studies published. There may be confounding factors, such as those seen in the study of Scanaliato et al,[20] where the reconstructions may have been performed in patients with more advanced articular disease or in more challenging populations (older, greater body mass index), suggesting that even in a worse milieu, labral reconstruction can result in improved outcomes. Of note, however, 1 author found that the risk of conversion to THA was 4 times greater in patients with advanced chondral disease of the acetabulum when undergoing labral resection, as compared with labral reconstruction.[15]

Strength and Limitations

The strengths of this article include a scientific search method and the resulting comprehensive gathering of all relevant information. All previous reviews were thoroughly scanned to make sure that all relative studies were included. This article is mainly limited, however, by the significant variability associated with every aspect of an evolving surgical procedure, with nonstandardized techniques, small numbers of patients (197 in this systematic review), and nonstandardized reporting. Each study reported various concomitant procedures, intraoperative findings, and inconsistent surgical complications, limiting the strength of direct comparisons among outcomes (Table 3). Additionally, some investigators performed labral reconstruction to prevent development or progression of hip osteoarthritis. As such, the mean follow-up time of the included studies (34.6 months) was too short to determine if this goal could be achieved. Furthermore, there were no level 1 or level 2 studies addressing the efficacy of labral reconstruction and no comparative studies addressing graft type, intraoperative indications, or surgical technique or postoperative rehabilitation, limiting the effect of the findings from these included (level 3) studies.

Labral reconstruction is still a relatively new surgical procedure and has yet to be standardized. Such uncertainties, which could affect outcomes, include general indications for labral reconstruction, a normalized graft choice, and a standard rehabilitation procedure. Currently, diagnosis, procedure, and postoperative programs are entirely decided by the surgeon. Eventually, through further research, there will likely be more standard indications that may include factors, such as joint space, cartilage grade, and demographic range, to indicate labral reconstruction. Finally, multiple studies had small sample sizes, so the resulting rates of complication or progression to total hip replacement may be a poor representation of the surgical outcomes.

CONCLUSION

Overall, the results of this systematic review suggested that labral reconstructions yield positive postoperative results, and comparative studies suggested that labral reconstruction has statistically equal outcomes to labral repair. Additionally, labral reconstruction may yield better long-term results than may labral resection in the setting of severe acetabular chondral damage because of an increased risk of THA for cases of resection.

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APPENDIX

TABLE A1
Surgical Indications and Patient Results[a]

Study (Year)	Preop Radiological Findings and Parameters, Mean ± SD (Range)	Indications for Reconstruction	Surgery Type	Graft Used	PROs, Preop – Postop Mean ± SD (Range) (*P* Value)
Camenzind[6] (2015)	Tönnis grade: <2 Alpha angle: 62 (47-75) LCEA: 36 (26-50)	Insufficient labrum for repair	Open	Ligamentum teres	OHS: 29 ± 8 – 44 ± 4 (<.001) VAS rest: 45 ± 35 – 5 ± 7 (.0004) VAS load: 59 ± 26 – 16 ± 19 (.0007) Satisfaction: 44 ± 35 – 87 ± 15 (.002)
Domb[8] (2014)	Tönnis grade: <2 Alpha angle: 56.4 ± 13.5 (34.0-80.0) LCEA: 33.2 ± 2.2 (29.0-35.0)	Labrum too thin or too damaged	Arthroscopic	Gracilis autograft	NAHS: 52.9 ± 16.8 (25.0-79.0) – 77.6 ± 13.5 (58.8-97.5) (<.001) HOS-ADL: 58.6 ± 13.9 (29.0-72.0) – 80.3 ± 14.0 (60.9-98.5) (.001) HOS-SSS: 38.7 ± 22.6 (9.0-78.0) – 60.1 ± 32.0 (0.0-100.0) (.042) mHHS: 54.5 ± 26.1 (2.0-85.0) – 81.6 ± 13.7 (57.1-100.0) (.012) VAS: 6.5 ± 2.1 (3.0-9.0) – 2.9 ± 1.8 (1.0-7.0) (.001)
Domb[15] (2019)	LCEA: 33.7 ± 5.1 (25-42) ACEA: 34.0 ± 5.7 (23-43) Alpha angle: 63.3 ± 12.6 (39-90) Tönnis: 29 with grade 0, 9 with grade 1	Segmental labral defects or irreparable labral tears	Arthroscopic	Gracilis autograft or allograft	mHHS: 65.1 ± 17.7 – 86.7 ± 19 (<.0001) NAHS: 62.2 ± 18 – 84.9 ± 19.1 (<.0001) HOS-SSS: 40.8 ± 25.9 – 77.0 ± 26.0 (<.0001) VAS: 5.1 ± 2.1 – 1.9 ± 2.3 (<.0001) iHOT-12: 75.5 ± 25.7[b] Satisfaction: 8.5 ± 1.8[b]
Domb[9] (2020)	LCEA: 32.9 ± 7.0 (30.5-31.1) ACEA: 31.7 ± 9.0 (28.6-31.4) Alpha angle: 59.7 ± 13.8 (55-59.8) Tönnis angle: 4.9 ± 4.3 (3.51-6.28)	Irreparable damage: most or complete calcification or nonviable for repair	Arthroscopic	Anterior tibialis allograft	mHHS: 62.9 ± 15.1 (57.9-62.9) – 86.7 ± 18.4 (80.4-89.4) (<.0001) NAHS: 60.5 ± 16.3 (55.1-63.9) – 86.2 ± 18.6 (79.8-88.6) (<.0001) HOS-SSS: 38.7 ± 25.1 (29.4-41.5) – 78.4 ± 27.9 (67.9-80.7) (<.0001) VAS: 5.1 ± 2.1 (4.41-5.59) – 2 ± 2.5 (1.17-2.66) (<.0001)

(continued)

Table A1 (continued)

Study (Year)	Preop Radiological Findings and Parameters, Mean ± SD (Range)	Indications for Reconstruction	Surgery Type	Graft Used	PROs, Preop – Postop Mean ± SD (Range) (*P* Value)
	Flexion: 113.5 ± 13.2 (109.0-118.0) Internal rotation: 14.3 ± 9.7 (11.1-17.6) External rotation: 33.1 ± 10.2 (29.8-36.5)				iHOT-12: 34.9 ± 21.7 (27.5-39.2) – 77 ± 28 (67.5-82.6) (<.0001) SF-12 PCS: 38.2 ± 8.6 (35.2-36.9) – 48.9 ± 10 (45.5-50.7) (<.0001) SF-12 MCS: 50.4 ± 10.4 (46.8-52.5) – 54.9 ± 8.6 (52-55.9) (.0536) VR-12 M: 53.4 ± 10.3 (49.9-54.5) – 59.7 ± 9.4 (56.5-60.5) (.0041) VR-12 P: 39.6 ± 9.2 (36.4-39.2) – 49.9 ± 10.3 (46.4-51.9) (<.0001) Satisfaction: 8.1 ± 2.4 (7.28-8.52)[b]
Matsuda[16] (2013)	Tönnis grade: <2	Insufficient labrum for repair with little or no OA	Arthroscopic	Gracilis autograft	NAHS: 41.9 (25-64) – 92.4 (83-99) (.008)
Scanaliato[20] (2018)	Tönnis: 47 with grade 0, 8 with grade 1, 8 with grade 2	Intrasubstance damage, labral ossification, segmental defects	Arthroscopic	Iliotibial band allograft	mHHS: 60.2 ± 15.5 – 80.7 ± 16.4 (< .01) iHOT-12: 37.8 ± 19.7 – 65.8 ± 26.2 (< .01) SF-12 PCS: 37.6 ± 9.4 – 47.1 ± 10.1 (< .01) VAS: 49.9 ± 21.7 – 23.6 ± 22.5 (< .01)
White[24] (2018)	Tönnis grade: <2 Alpha angle: 66.7 ± 2.9 LCEA: 33.2 ± 4.7	NR	Arthroscopic	Iliotibial band allograft	mHHS: 58.2 ± 11.3 – 87.8 ± 16.3 LEFS: 45.5 ± 14.6 – 69.4 ± 17.8 VAS: 6.0 ± 1.0 – 2.4 ± 2.1 Satisfaction: 8.7 ± 2.4[c]

[a]ACEA, anterior central-edge angle; HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-SSS, Hip Outcome Score–Sports Specific Subscale; iHOT-12, 12-Item International Hip Outcome Tool; LCEA, lateral central-edge angle; LEFS, Lower Extremity Functional Scale; mHHS, modified Harris Hip Score; NAHS, Non-arthritic Hip Score; NR, not reported; OA, osteoarthritis; OHS, Oxford Hip Score; Postop, postoperative; Preop, preoperative; PRO, patient-reported outcome; SF-12 MCS, 12-Item Short Form Health Survey Mental Component Summary; SF-12 PCS, 12-Item Short Form Health Survey Physical Component Summary; VAS, visual analog scale; VR-12 M, Veterans RAND 12-Item Health Survey Mental Component; VR-12 P, Veterans RAND 12-Item Health Survey Physical Component.

[b]No preoperative score or *P* value given.

[c]*P* values in this study are comparative between the reconstruction and repair groups. There are no *P* values provided for pre- to postoperative values, although the raw data can be extracted from the article.