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OUTCOMES RESEARCH IN ORTHOPEDICS (O AYENI, SECTION EDITOR)

The Hip Labrum Reconstruction: Indications and Outcomes—an Updated Systematic Review

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Abstract

Purpose of Review To present an updated systematic review of the indications and outcomes of open and arthroscopic labral reconstruction. Due to the increasing popularity and recognition, the arthroscopic procedure has gained in recent years, the aim was to assess for changes in indications, graft selection, and improvement in outcomes within the last 5 years.

Recent Findings A total of nine eligible studies (six case series, one cohort, and two retrospective comparative studies) with a total of 234 patients (265 hips), and an average 12/16 (non-comparative studies) and 20/24 (comparative studies) quality on the MINORS score were included in this review. All patients underwent labral reconstruction, whether as primary surgery or revision (76% vs 24% respectively). There were 244 hips assessed at final follow- up (92%) with a reported mean range of 12 and 61 months. There were more graft variabilities found in this study compared with the previous review (iliotibial band allograft, gracilis tendon autograft, indirect head of rectus femoris autograft, semitendinosus allograft, peroneus brevis allograft, labrum allograft, ligamentum capitus femoris). Surgical approaches differed (open 7.9% (previously 18.7%), arthroscopic 86% (previously 81. 3 %), arthroscopic assisted mini-open technique (AAMOT) (6%)). Overall, improvement was observed in the patient-reported outcomes and functional scores, with variability in their statistical significance. The failure rate or conversion to total hip arthroplasty (THA) decreased compared with the previous review (20% vs 9.5% [conversion to THA was 5.7% and revision surgery rate was 3. 8%]). Indications for labrum reconstruction remained similar (i.e., young, active patients with no or minimal arthritis (Tonnis 0–1), irreparable or ossified labrum, and hypotrophic <2 mm or dysfunctional hypertrophic labrum >8 mm).

Summary According to recent evidence, hip labrum reconstruction is a new technique that showed short- and mid-term improvement in patient-reported outcomes and functional scores postoperatively. The primary indication for reconstruction remained similar over time. The failure rates and/or conversion to THA appear to have decreased over time. Long-term follow-up with higher quality studies was not available in the literature based on this review.

Level of evidence 2

Keywords Hip labrum · Reconstruction · Hip joint · Technique

This article is part of the Topical Collection on *Outcomes Research in Orthopedics*

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Introduction

In the past 10 to 15 years, more attention has been brought to the importance of hip labrum preservation, owing to the improvement in understanding the vital role of a normal hip labrum for joint stability, lubrication, and chondral nutrition, as well its proprioceptive and nociceptive properties [1–3]. Arthroscopic and biomechanical observations support the concept that labral disruption and joint degeneration are frequently part of a continuum of joint disease [4]. A study by Mook WR et al. [5] showed that patients

undergoing labral reconstruction have significant improvements in pain reduction, function, return to sports, and the avoidance of future hip arthroplasty, and high levels of satisfaction.

The labrum is a horseshoe-shaped fibrocartilage structure, attached circumferentially around the bony acetabulum, and is continuous with the transverse ligament. Vascular supply to the acetabular labrum was investigated by Morteza et al. [6]. The authors found that the acetabular labrum receives its blood supply from the radial branches of the periacetabular periosteal vascular ring that traverses the osseolabral junction on its capsular side and continues toward the labrum's free edge. This finding can be clinically relevant, where blood supply to the labrum remains intact in the majority of hips with labral tears.

Selders et al. [7] were able to demonstrate that an intact hip labrum contributes to hip stability through increasing the acetabular volume by 21% and articular surface area by 28%. A cadaveric study done by Philippon et al. [2] demonstrated the acetabular labrum to be the primary hip stabilizer to distraction forces until > 6 mm of distraction, after which the capsule became the primary stabilizer. To date, the operative options for preserving hip labrum include open or arthroscopic labral debridement, repair, or reconstruction using either auto- or allograft. Numerous studies have demonstrated a satisfactory outcome with labral repair [8–10]. However, challenging situations exist when the labrum is damaged beyond repair, or in the hypotrophic (< 3 mm) and hypertrophic (> 10 mm) non-functioning labrum, where labral repair is not ideal and reconstruction may be the procedure of choice [11].

Earlier in 2014, a systematic review was published on the indications and outcomes of hip labrum reconstruction, in which a total of five eligible studies were included [12–16]. The review showed an overall improvement in the patient-reported outcomes and functional scores, and a failure rate or conversion to THA of 20%. The most common indication for labrum reconstruction was a young, active patient with minimal arthritis and non-salvageable or deficient labrum. Other indications included instability, pain, and hypotrophic dysfunctional labrum.

As in the previous systematic review, this paper will explore three essential points when considering labral reconstruction: (1) indications and contra-indications for labral reconstruction, (2) ideal graft source for labral reconstruction, and (3) patient reported outcome following labral reconstruction, and if there is a correlation with graft type. The purpose of this updated review was to investigate any changes in the indications and outcomes related to labral reconstruction that may have occurred since the previous review and present them to aid surgeons when considering this procedure for potential patients.

Materials and Methods

Search Strategy

The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines were followed in the development of this study [17]. The online databases EMBASE, MEDLINE, and PubMed were searched from August 1, 2013, to August 1, 2018, for the literature addressing labral reconstruction of the hip. The research question and inclusion/exclusion criteria were determined in priori. The key terms "labrum," "reconstruction," "graft," "hip," and "acetabulum" were used, and the search results were limited to studies in English and studies on humans (Table 1). Studies were included if they (1) involved labral reconstruction by open surgery, arthroscopic, or/and AAMOT means; (2) reported graft type and outcomes; (3) were published in English; and (4) involved human subjects (i.e., no cadaveric studies) and included in the date range mentioned above (August 1, 2013 to August 1, 2018). There were minimal exclusion criteria to ensure comprehensive results. The exclusion criteria featured (1) studies reporting no surgical outcomes, such as radiographic studies, review articles, instructional course lectures, and (2) studies that did not evaluate the hip or acetabular labrum.

Study Screening

For this study, the title, abstracts, and full-text articles were screened in duplicate by two independent reviewers. Any disagreement was addressed via discussion between the two reviewers, with any potential unresolved conflicts mediated by a third senior reviewer.

Table 1 Search strategy—terms

#	Search terms
1	femoroacetabular impingement/ or hip dislocation/ or Acetabular Labral graft.mp. or arthroscopy/ or hip/
2	hip disease/ or hip injury/ or acetabulum/ or labral tears.mp.
3	pincer impingement.mp. or femoroacetabular impingement/
4	acetabuloplasty.mp. or acetabuloplasty/
5	femoroplasty.mp.
6	open surgical dislocation.mp.
7	cam.mp.
8	labrum.mp.
9	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10	reconstruction.mp.
11	allograft.mp. or allograft/
12	autograft/ or autograft.mp.
13	graft.mp.
14	10 or 11 or 12 or 13
15	9 and 14

Quality Assessment of the Included Studies

A quality assessment of the included articles was performed using the methodological index for non-randomized studies (MINORS) criteria. It is a validated scoring tool for non-randomized studies including a 12-item assessment. Each item can be given a score from 0 to 2 with an ideal score of 16 for non-comparative studies and a score of 24 for comparative studies. The agreement between the two reviewers scoring was calculated with an intraclass correlation coefficient (ICC).

Data Abstraction

Data were abstracted in duplicate by the two reviewers and recorded into a Microsoft Excel spreadsheet. The abstracted data included author, year of publication, the location of study, study design, patient demographics (sample size, age, sex, number of males and females, body mass index (BMI), etc.), type of surgery, length of follow-up, loss of follow-up, conversion to THA, and revision surgery. The outcome data were pre- and postoperative measurements of pain, complications, and patient-reported hip outcome scores.

Statistical Analysis

Assessment of inter-rater agreement was carried by calculating a weighted κ (kappa) for each stage of title, abstract, and full-text screening [18]. Intraclass correlation coefficient (ICC) was used for evaluating the quality assessment score agreement [18]. Reviewers leaned toward including studies (i.e., if one reviewer thought a study should be included at the title screening stage, it was included). We chose in priori a kappa value of $\kappa > 0.61$ to indicate substantial agreement, $0.21 < \kappa < 0.60$ to indicate moderate agreement, and $\kappa < 0.20$ to indicate slight agreement. Descriptive statistics for the included studies were presented.

Results

A total of 4479 studies were found across the three databases (PubMed, EMBASE, MEDLINE). Eight hundred sixty-seven duplicates were removed giving a total of 3612 studies. Of the initial 3612 studies found, 16 proceeded to full-text screening after title and abstract screening. Eight studies were excluded, including three which were excluded for being included in our previous systematic review (published in 2014). One review article, one letter, and two comparative studies were excluded for using and reporting data from another included study. Additional screening of the reference sections from the included studies yielded one additional study that was missed by the initial search strategy. Ultimately, nine studies were included in this review (Fig. 1).

Description of Agreements Between Reviewers

A meta-analysis was not feasible as there was no intra-study comparison data, and the nine studies exhibited excessive heterogeneity in study design, surgical approach, graft choice, and patient-reported outcome measures. There were six case series [11–21, 22•, 23], one prospective cohort study [24], and two retrospective comparative study [25•, 26]. In this review, the reviewers had a substantial agreement for selecting articles for inclusion at the title stage, with a kappa = 0.872 (95% CI 0.863 to 0.880), abstract screening stage kappa = 0.951 (95% CI 0.913 to 0.973), and full-text screening kappa = 1.0. A third reviewer for clearing discrepancies was not required. The agreement among quality assessment scores of included studies using MINORS criteria, with ICC = 0.728 (95% confidence interval 0.616–0.808). The included studies had an average MINORS score of 12/16 (non-comparative studies) and 20/24 (comparative studies) (Table 2).

General Comparison Between Previous and Current Review

Unlike the previous review where all the studies were conducted in the USA, in this review, 55% (5/9) of the studies were conducted in the USA, two in Switzerland, one in Spain, and one in the UK/Poland.

Sample sizes ranged from 4 to 152 hips (4 to 123 subjects) with 44% (4/9) of the studies examining at least 20 patients. The included studies followed patients over a mean range of 12–61 months postoperatively. All studies had a mean patient age of 40 years or less (mean 35 years). Arthroscopy was utilized in 67% (6/9) of studies compared with 60% in the previous review. Table 3 further summarizes the individual study data. Compared with our previous review, we noticed more female subjects in the current review (43.8% in the previous review vs. 53.4% in this review).

The studies in this review show that labral reconstruction, independent of graft choice, is indicated among young patients who have undergone previous hip surgery, or presented with an irreparable, hypotrophic < 2 mm or hypertrophic > 8 mm non-functional labrum, ossified labrum, and hips with 0–1 Tonnis grade on the radiograph.

A total of 265 hips (234 patients) through all the included studies underwent labral reconstruction.

There were 21 hips lost follow-up or had incomplete data at the end of the study, 15 hips converted to THA, and 10 underwent revision surgery due to adhesions, hip pain, non-union of the osteotomy, and trauma. While the remaining 244 hips (92%) completed a full follow-up assessment as per study

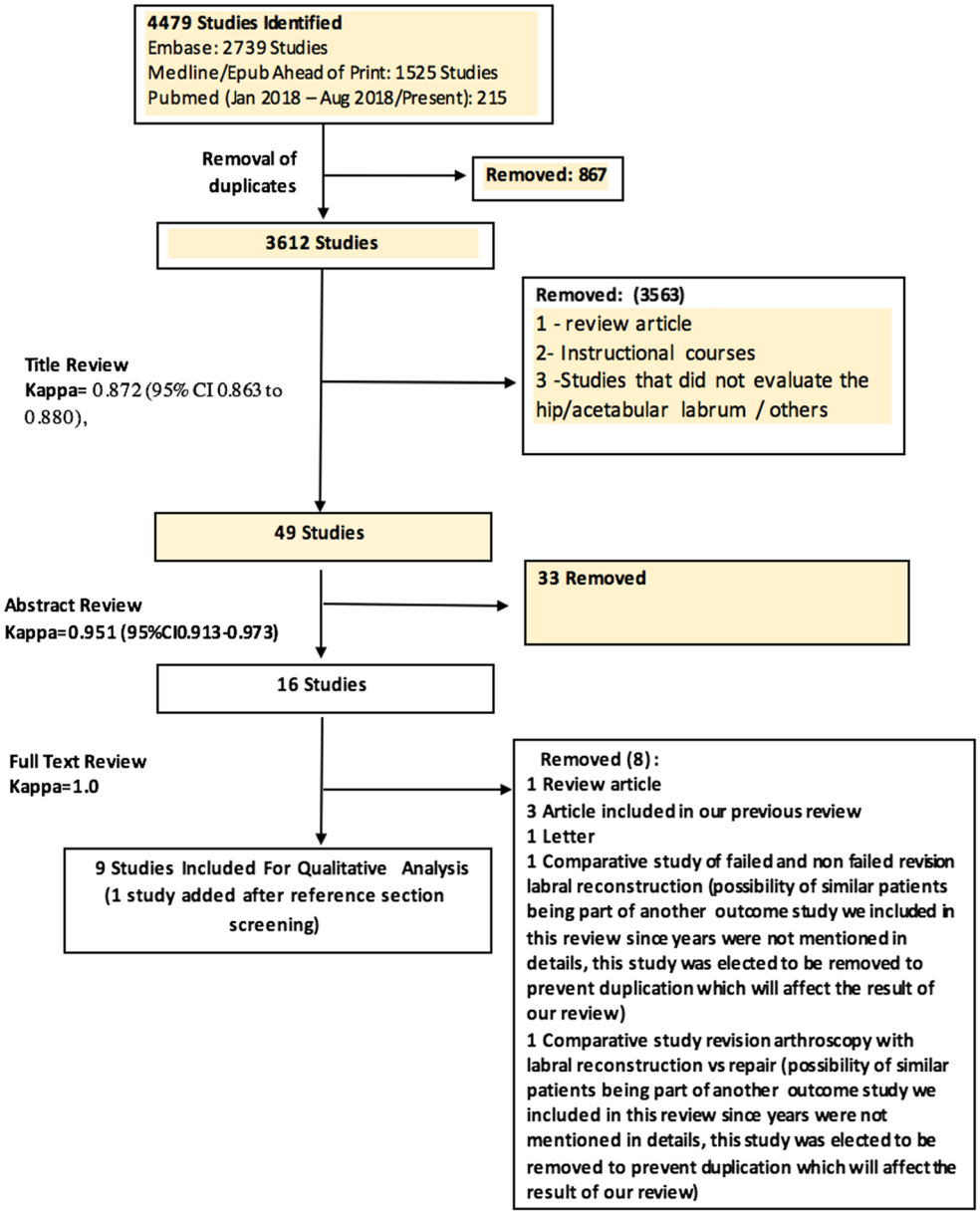

Fig. 1 Outline of systematic search strategy used

criteria. The function and health-related quality of life outcome scores are summarized in Table 4.

Graft Types and Reported Outcomes

Iliotibial Band

Iliotibial band (ITB) allograft was utilized as a graft option in two studies (181 hips), comprising 68. 3% of all hips. In these two studies that were conducted by White et al. [11, 25•], they also reported the mean number of anchors used was 6 (range 3–8). The patients' satisfaction rate in this group was reported as a median of 9 and 8.8 ± 2.6 out of 10, based on patient surveys. In the first study which was a case series, they reported mean modified Harris Hip Score (mHHS) improvement by 34 points ($P < .0001$), and the mean Lower Extremity Functional Score (LEFS) improvement by 27 points ($P < .0001$). Patients reported lower pain at rest ($P < .0001$), with activity of daily living (ADL) ($P < .0001$) and with sport ($P < .0001$) postoperatively [4]. Some hips had concomitant procedures such as microfracture, chondroplasty, psoas release (17.5%), os acetabuli resection, Ganz osteotomy, and femoroacetabular impingement (FAI) procedures (86%). There were seven hips with short-term complications, including flexor tendinitis, deep vein thrombosis (DVT), infection, mild motor nerve injury of the foot, and sacroiliac joint pain, all of which were completely resolved. Thirteen hips progressed into osteoarthritis and underwent THA with a mean time of 15 months from index procedure. Five hips went for revision with a mean time of 23 months from index

Table 2 Methodological index for non-randomized studies (MINORS) score

Criterion/Score	Brian J. White et al. 2016			Ritesh Rathi el al. 2018			Benjamin G. Domb et al. 2014			Brian J. White et al. 2018			Sivashankar Chandrasekaran et al. 2017			Camenzind et la. 2013			Esther Moya et al. 2016			ERIN NANCE et al. (Conference Abst). 2013			Costa Rocha P et al. 2013		
	1	2	C	1	2	C	1	2	C	1	2	C	1	2	C	1	2	C	1	2	C	1	2	C	1	2	C
Clearly stated aim	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Inclusion of consecutive patients	2	2	2	1	2	1	2	2	2	2	2	2	2	2	2	1	1	1	2	2	2	2	2	2	2	2
Prospective collection of data	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0
Endpoints appropriate for aim	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Unbiased assessment of endpoint	0	2	2	0	2	2	1	2	2	0	0	0	0	2	2	0	1	1	0	0	0	0	0	0	0	0
Appropriate follow-up period	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Loss to follow-up <5%	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Prospective calculation of study size	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional for comparative study																										
An adequate control group							2	0	2	2	0	2				2	2	2								
Contemporary groups							2	0	2	2	2	2				2	2	2								
Baseline equivalence of groups							2	0	2	1	1	1				0	1	1								
Adequate statistical analyses							2	2	2	2	2	2				1	2	2								
Total score	11	13	13	9	14	13	23	16	24	19	17	19	12	14	14	14	17	17	10	10	10	10	10	10	10	10
Ideal Score	16			16			24			24			16			24			16			16			16	

Scoring: (0) not reported, (1) reported but inadequate, (2) reported adequate Reviewer 1 (LA)
Reviewer 2 (VD)
Consensus (C)

Scoring: 0, not reported; 1, reported but inadequate; 2, reported adequate

Reviewer 1 (LA)

Reviewer 2 (VD)

Consensus (C)

procedure (four arthroscopic labral reconstructions, and one open dislocation, osteoplasty, and debridement).

The second study conducted by White et al. [25•] used ITB as a graft was a comparative study between hips undergoing labral reconstruction vs. labral repair. Both the reconstruction group and the non-failed repair group showed improvement in patient-reported outcomes. Result in this study showed that hips undergone primary labral repair had more failure rate than hips that underwent labral reconstruction (31% vs. 0%, respectively). Among hips that did not fail treatment in the repair group, there was no difference in patient-reported outcome scores compared with the reconstruction group.

Semitendinosus Allograft and Gracilis Autograft

Allograft semitendinosus and autograft gracilis were used in four of the nine studies (33 hips) 12.5% of all hips [21–24]. The gracilis tendon autograft was used because of its strong tensile properties and ease of harvest [24]. There was an improvement in all patient-reported outcomes (PRO), most were statistically significant [19, 20], except for one study [24] where Nonarthritic Hip Score (NAHS) and Hip Outcome Score-activity of daily living (HOS-ADL) were the only statistically significant PRO. One hip required revision arthroscopy secondary to hip trauma after 1.3 years; during the procedure, the reconstructed labrum showed complete adherence to the acetabular rim with intact chondrolabral junction. However, there was some softening of the acetabular cartilage adjacent to the reconstructed labrum [24]: two patients required a revision procedure for adhesions, and one patient required conversion to THA for presumed progression of osteoarthritis [19]. Short-term complications included medial knee pain at the harvest site, which was resolved at 6 weeks, one DVT in a 21-year-old female patient and one HO (heterotopic ossification) in a 20-year-old male, who both underwent open hip dislocation and labral reconstruction [21]. DVT has been resolved, while the latter was reluctant to have the HO excised.

Indirect Head of Rectus Femoris Autograft

In one of the studies that were conducted by Rathia et al. where they used the indirect head of rectus femoris tendon autograft in seven hips, all patients reported subjective improvement in preoperative pain and function. The mean modified Harris Hip Score (mHHS) improved significantly from 56 (54–60) preoperatively to 93 (90–97) at the latest postoperative follow-up, with the mean follow-up period being 15 months (12–18 months). The mean postoperative patient satisfaction score was 9.1 (0, lowest satisfaction, and 10,

Table 3 Characteristics of included studies

Study	Sample size (patient)	% Male	Mean age (range)	BMI	Mean follow-up (range, months)	% lost to follow-up	Progress to THA	Progress to revision	Surgical approach	MINORS score	Level of evidence	Type
Brian J. White et al. 2016	152 hips (123 patients)	43.9	39 (16–58)	NR	28 (24–39)	13.8%	13 hips (9.9%)	5 hips (3.8%)	Arthroscopic	10/16	IV	Therapeutic case series
Ritish Rathi et al. 2018	7 hips/patient	71.4	35 (25–41)	NR	15 (12–18)	0%	0%	0	Arthroscopic	9/16	IV	Therapeutic case series
Benjamin G. et al. 2014	11 Hips/patie-nt	63.6	33.0 ± 9.9 (18.63.6.0–44.9) &&&	24.5 ± 3.0 (21.5–30.-5)	26.4 ± 3.6 (24–32.4)	0%	0%	1 (9%) traumat-ic	Arthroscopic	25/26	III	Prospective cohort study
Brian J. White et al. 2018	29 hips/-patient	20.7	32.6 (14.9–51.6)	NR	40 (22–61)	0%	0%	0	Arthroscopic	21/26	III	Retrospective comparative study
Siyashankar Chandrasekaran et al. 2017	22 patients	36.4	32.2 (15-45)	25.2 ± 3.9	29.1 ± 6.9	0%	1 hip 4.54%	2 hips (9%)	Arthroscopic	12/16	IV	Therapeutic case series
Carnezind et la. 2013	13 hips (11 patient)	54.5	36 (22–51)	NR	21 (9–45)	0%	0%	1 hip (9%)	Open	16/26	III	Retrospective comparative study
Esther Moya et al. 2016	20 hips/-patient	80	34.5 (28–46)	NR	61.2 (24–90)	0%	1 THA 5%, 1 resurface 5%	1 (5%)	16 AAMOT, 4 open	10/16	IV	Therapeutic case series
Erin Nance et al. (conference abst.) 2013	7 hips/patient	85.7	40.3 (34–50)	NR	12.4 (2–23)	0%	0%	0%	Arthroscopic	10/16	IV	Therapeutic case series
Costa Rocha P et al. 2013	4 hips/patient	25	33 (20–47)	21.75 (19.3–26.-6)	19 (6–30)	0%	0%	0%	Open	10/16	IV	Therapeutic case series

THA total hip arthroplasty, *AAMOT* arthroscopic assisted mini open technique, *BMI* body mass index, *NR* not reported

Table 4 Outcomes per type of graft

Study	Graft type	Pain range (Pre-op)	Pain range (Post-op)	Function or HRQL score mean difference reported	Patient satisfaction score out of 10	Mean anchors#
Brian J. White et al. 2016	ITB Allograft (105 Freeze dry, 26 Frozen)	8 VAS	3 VAS	mHH S 34, LEFS 27, VAS rest 3, VAS ADL 4, VAS sport 5	9	6 (3–8)
Ritesh Rathi et al. 2018	Indirect head of rectus femoris autograft	NR	NR	mHH S 36 (30–43)	9.1	NR
Benjamin G. Domb et al. 2014	Gracilis autograft	6.5 + 1–2.1 (3.0–9.0). VAS	2.9 ± 1.8 (1.0–7.0) VAS	NAHS 24.8 ± 16.0, HOS-ADL 21.7 ± 16.5, HOS-SSS 21.4 ± 27. 3, mHHS 27.1 ± 19.9, VAS 3.6 ± 1.95	≥ 7	NR
Brian J. White et al. 2018	ITB allograft (8 freeze dry, 21 frozen)	6.1 ± VAS	2.0 ± 2.0 VAS	mHHS 29.6 ± 15.4, LEFS 23.9 ± 17. 8, VAS 3.6 ± 2.1	8.8 ± 2.6	6 (5–7)
Siyashankar Chandrasekaran et al. 2017	Semitendinosus allograft or a gracilis autograft	6.18 ± 2.63 (7.4–5.0) VAS	2.85 ± 1.97 (3.7–1.9) VAS	mHHS 11.0 ± 19.5, HOS-SSS 23.1 ± 30.9, NAHS 19.1 ± 17.5, VAS 3.33 ± 2.92	6.73 ± 2.96	4.5 ± 1.3
Carmenzind et la. 2013	Ligamentum capitis femoris	NR	NR	OHS 13.2 (SD 13.9), VAS 49.8 (VAS 1–100)	87.1/100(SD 14.2) VAS	NR
Esther Moya et al. 2016	11 peroneus brevis allograft, 8 labrum allograft	NR	NR	OHS 13.2 (SD 13.9), VAS 49. 8 (VAS l–100)	85% excellent-good	NR
Erin Nance et al. (conference abst) 2013	11 peroneus brevis allograft, 8 labrum allograft	NR	NR	HOS-ADL 383, HOS-SSS 44.5	NR	NR
Costa Rocha P et al. 2013	Fresh frozen semitendinosus allograft	NR	NR	HOS-ADL 19.8, OHS 6.3	GTO 50% helped a lot, 50% helped	8 (7–9)

ITB iliotibial band, *VAS* visual analog scale, *NR* not reported, *mHHS* modified Harris Hip Score, *LEFS* Lower Extremity Functional Scale, *ADL* activity of daily living, *NAHS* Nonarthritic Hip Score, *HOS-ADL* Hip Outcome Score-activity of daily living, *HOS-SSS* Hip Outcome Score-sport-specific subscale, *OHS* Oxford Hip Score, *GTO* Global Treatment Outcome Score

highest satisfaction). No radiological progression of arthritis or revision procedures were required.

Ligamentum capitis femoris was the choice of graft in 13 hips in one of the studies [26]. The reported mean improvement of OHS was 13.2 (SD 13.9). Patient satisfaction improved from preoperatively 37.3 (SD 33.3) to 87.1 (SD 14.2) on a VAS scale with a maximum of 100, with one revision for non-union of osteotomy done after 6 months.

Peroneus Brevis and Labrum Allografts

Twenty cases used peroneus brevis allograft and labrum in 11 and 9 hips respectively, with 17 hips resulted in satisfactory Dexeus combined score. In all cases, there was a mean improvement of 39 points in NAHS, from 47 (SD 17.6, CI 95%) to 86 (SD 10.5, CI 95%). Eighty-five percent of the cases had a satisfactory result, 14 hips (73.7%) had an excellent result and 5 (26.3%) good result. There were three different complications. One of the hips underwent revision arthroscopy, in which the labrum inspection showed excellent stability and tension [23].

The failure rate or conversion to THA rate has dropped in all available hips compared with the previous review where it was reported as 20%. Conversion to THA was 5.7%, while revision was 3.8%.

Discussion

The current study is an update of the previously published review on the indications and outcomes of hip labral reconstruction [27]. This review re-explored the three essential considerations when electing to proceed with labral reconstruction, which demonstrated the following:

1. The primary indication for reconstruction almost remained the same as the previous review, which was irreparable, calcific, non-functional labrum in young patients with no or minimal arthritis.
2. There is no consensus regarding a single ideal graft type for a successful labral reconstruction. This finding remained the same despite more variations in graft types were seen in this study (ITB, semitendinosus, gracilis, peroneus brevis, labrum allograft, indirect head of rectus femoris, ligamentum teres).
3. Labral reconstruction continued to show short and intermediate term improvement in patient-reported outcomes and functional scores postoperatively. With a secondary procedure rate of 9.5% (conversion to THA 5.7% and revision surgery rate 3.8%). Long-term data of outcomes are lacking.

Almost all of the studies agreed on the indications for hip labral reconstruction, which did not change from the indications mentioned in the previous studies [27]. Hip labrum reconstruction was in most cases a decision to be made intraoperatively following a thorough hip examination. Once the labrum is irreparable or dysfunctional, the decision was made to proceed with labral reconstruction. Thus, labral reconstruction may need to be added in surgical consents as a possibility when planning to perform a labral repair. Furthermore, allografts should be made available when required since imaging studies do not necessarily indicate labral deficiencies especially in the setting of FAI [20].

Most surgeons have suggested that joint space less than 2 mm is a contraindication for labrum reconstruction. Our analysis tried to determine if age, BMI, and sex have an impact on the patient-reported outcome when undergoing labrum reconstruction in these studies. Three studies have reported the BMI of patients who undergone labrum reconstruction (mean BMI 23.8) but did not mention its correlation with clinical outcomes. It was noted that several studies have less than 50 years old as inclusion criteria; meanwhile, one study has suggested that less than 50 years old with no osteoarthritis was considered ideal candidates for labrum reconstruction [24]. There were no appropriate correlations between complications and age. There was one study that stated no statistically significant age difference was found between the patient who had complications and those who did not post labral reconstruction [11].

More variations in graft choices among surgeons have been noticed. No ideal graft can be identified nor recommended based on the available literature. We have noticed that in more than 85% of the hips that undergone labral reconstruction, allograft was used as the graft of choice. Surgeons have favored allograft for several reasons. Such as avoiding donor site morbidity, shorter surgical time, being able to select graft size and length, and not disrupting hip biomechanics in cases where the graft is taken from around the hip joint. However, for allografts, the cost and admittedly low possibility of disease transmission and immune reaction should always be considered.

Rathi et al. [22•] reported the benefits of using the indirect head of rectus femoris autograft, which was no donor site morbidity since the harvesting and fixation are completed through the same portals, also maintaining blood supply to the graft is another added benefit. Domb et al. have used local capsular allograft for filling and repairing small labral defect where graft may not be necessary. However, this technique precludes the ability to close the capsule, which is believed to be important in cases with potential instability, and therefore should be used with caution in cases of borderline dysplasia or ligamentous laxity [28].

An interesting finding in this study was that, when comparing hips that underwent primary labral repair that did not fail with hips that underwent labral reconstruction, the short-term outcome scores reported by patients were similar between the two groups [25•, 26]. This suggests that both labral preserving procedures can obtain excellent results if performed according to appropriate indications. More detailed tear characteristics and prognostic factors for successful labral repair should be studied in the future in order to refine indications and avoid secondary procedures.

Strengths and Limitations

The methodological approach taken with a broad literature search using multiple databases and duplicate data abstraction and quality assessments has added strength to this systematic review. However, there exist several limitations. Variation in clinical outcome measures and discrepancy in follow-up durations among studies did not allow for data pooling. The available literature was also noted to be predominantly observational in design (six case series, two retrospective comparative, and one prospective cohort studies), lacking studies with high-quality level of evidence.

Conclusion

According to the available evidence at this time, hip labrum reconstruction is a relatively new technique that shows short and mid-term improvement in patient-reported outcomes and functional scores postoperatively. The main indication for reconstruction remained similar which was an irreparable, calcific, hypotrophic < 3 mm or hypertrophic >8 mm, and non-functional labrum in young patients with no or minimal arthritis (Tonnis 0–1). This review had larger study sample with reported decrease in failure rates compared with the previous review. Long-term follow-up results with higher quality studies were not available in the literature based.

Compliance with Ethical Standards

Conflict of Interest Latifah Al Mana, Ryan P. Coughlin, Veeral Desai, Nicole Simunovic, Andrew Duong.

Olufemi R. Ayeni is a section editor for *Current Reviews in Musculoskeletal Medicine*. Dr. Ayeni is on the speakers' bureau for Conmed and Smith and Nephew.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- • Of importance
- •• Of major importance

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