Primary Circumferential Acetabular Labral Reconstruction

Achieving Outcomes Similar to Primary Labral Repair Despite More Challenging Patient Characteristics

John P. Scanaliato,* MD, Daniel L. Christensen,† MD, Catherine Salfiti,‡ BS, Mackenzie M. Herzog,§ MPH, and Andrew B. Wolff,‡‖ MD
Investigation performed at Washington Orthopaedics and Sports Medicine, Washington, DC, USA

Background: Treatment of acetabular labral tears with moderate or severe intrasubstance damage or segmental defects remains a substantial challenge. Circumferential labral reconstruction with iliotibial band allograft is a relatively new technique that has been proposed to restore stability and eliminate high-stress junction points.

Purpose: To compare outcomes between hips treated with primary allograft circumferential labral reconstruction and primary labral repair.

Study Design: Cohort study; Level of evidence, 3.

Methods: All consecutive hips between 2014 and 2015 that underwent primary reconstruction or primary repair by the senior surgeon were included and compared. Hips that had a prior intra-articular procedure were excluded. Patient-reported outcome (PRO) scores and visual analog scales were completed by patients within 1 week before surgery and between 22 and 26 months postoperatively. PROs included the modified Harris Hip Score, the International Hip Outcome Tool, and the 12-Item Short Form Health Survey for physical health. Pain and satisfaction were assessed with visual analog scales. Crude and inverse probability of treatment weighting comparisons of PROs between groups were performed.

Results: A total of 162 hips met the inclusion criteria for this study, including 99 labral repairs and 63 complete labral reconstructions. Patients who underwent labral reconstruction were, on average, older (43.4 vs 29.5 years; $P < .01$), had a slightly higher body mass index (24.6 vs 23.0; $P < .01$), had hips with a higher Tönnis grade (grade 1 or 2: 25% vs 9%; $P < .01$), had higher preoperative pain scores (49.9 vs 41.5; $P = .01$), and had hips with more severe pathology (68% vs 5%; $P < .01$) as compared with patients with labral repair hips. Five (5%) labral repair hips and 5 (8%) labral reconstruction hips failed treatment ($P = .48$). Among hips that did not fail (n = 94 repairs, n = 58 reconstructions), all demonstrated statistically significant improvements in PROs, and there was no statistical difference in PROs between groups after weighting ($P > .05$).

Conclusion: Primary circumferential labral reconstruction is a viable treatment option with promising short-term outcomes for hips that demonstrate moderate or severe labral damage. Despite less favorable preoperative characteristics, labral reconstruction offers similar outcomes when compared with labral repair in hips with less severe pathology.

Keywords: femoroacetabular impingement; labral reconstruction; hip arthroscopy

Acetabular labral tears are frequently associated with femoroacetabular impingement and can cause significant pain and disability.[6,31] Treatment of labral tears previously included either debridement or labral repair (also described as labral refixation), with repair typically demonstrating higher function and improved outcomes.[8,16,17,22,24] Labral injury exists on a continuum, from small tears with limited intrasubstance pathology that are easily treated with repair to extensive or complex tears where repair may be difficult or impossible.

Labral reconstruction has recently been introduced as a labral-preserving treatment option for patients with inadequate tissue for repair.[33] In the available literature, patients with irreparable labral tears or insufficient labral tissue are considered candidates for labral reconstruction.[32] Labral reconstruction has led to improvements in symptoms, function, and return to play among elite athletes.[2,29] In fact, Domb et al[7] demonstrated with a small cohort that reconstruction was superior to resection, while Matsuda and Burchette[19] demonstrated that despite more

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significant patient-reported symptoms, reconstruction had similar outcomes as compared with a repair group.

Labral reconstruction is hypothesized to restore the natural biomechanics of the labral suction seal while decreasing pain attributed to resection of the damaged labral tissue—a known pain generator.[12] In a cadaveric study, Nepple and colleagues[20] and Philippon et al[21] found that labral reconstruction improves the strength of the labral suction seal, restores stability against distraction to levels similar to those of a native labrum, and restores peak fluid pressurization levels to those similar to the intact labrum. Labral reconstruction was also shown to improve the hip joint contact area and contact pressure in an in vitro model.[18] Furthermore, the high level of free nerve ending expression in the labrum suggests that complete resection of damaged labral tissue may lead to pain relief.[12]

Multiple graft options exist for labral reconstruction, including autograft iliotibial band, gracilis, semitendinosus, and ligamentum teres, among others.[9,26] However, there is limited literature on the outcomes of allograft reconstruction.[5] Additionally, many labral reconstruction techniques focus on debridement of the tear back to a stable base and creation of a segmental graft that is fixed in this defect. There is concern that the junction points between the native labrum and the graft are inherently weak. Shorter segmental reconstruction procedures often position the junction points between native labrum and graft in regions of high stress and thus may provide less stability or higher risk of breakdown. Furthermore, segmental reconstruction techniques may not remove all of the pain-generating tissue and may hinder the ability to perform comprehensive pincer-type impingement correction.

Circumferential or complete labral reconstruction is performed by wider excision of the labrum, which eliminates the labrum-graft interface anteroinferiorly by fixation of the graft to the acetabulum at the anterior edge of the transverse acetabular ligament (TAL). Posteriorly, depending on the quality of posteroinferior labral tissue, the graft is extended either to the TAL or to the 8-o'clock position, where it is fixed to both the labrum and the acetabulum through vertical mattress suture anchor fixation, with the graft abutting the native labrum extra-articularly.

The existing literature has few reports of circumferential labral reconstruction with allograft tissue, although White et al[35] demonstrated favorable outcomes at postoperative 2 years for patients undergoing labral reconstruction with a similar front-to-back iliotibial band allograft. More recently, White et al[34] compared 29 patients who underwent primary labral repair on 1 hip and a primary reconstruction on the other, demonstrating a failure rate of 31% for the repair side versus 0% for the reconstruction side.

The purpose of this study is to compare patient-reported outcomes (PROs) between hips treated with primary allograft circumferential labral reconstruction and primary labral repair. Secondarily, we assessed the influence of tear severity, age, and Tönnis grade on PROs between the treatment groups. Our hypothesis was that hips treated with allograft circumferential labral reconstruction would have postoperative PROs equivalent to hips treated with labral repair despite less favorable patient- and hip-specific preoperative characteristics.

METHODS

Patient Population

All patients scheduled for hip surgery with the senior surgeon (A.B.W.) are prospectively enrolled in an online outcomes database; these data are collected as standard of care for all patients. All hips that underwent complete arthroscopic labral reconstruction or arthroscopic labral repair between 2014 and 2015 were selected from the prospective outcomes database for inclusion in this study (n = 210). Patients undergoing a revision procedure were excluded from this analysis (n = 20). Of the hips that met the inclusion criteria (n = 190), 4 (2.1%) were excluded owing to patient refusal to participate and 24 (12.6%) for lack of follow-up at postoperative 2 years. The total study population comprised 162 hips (85.3% follow-up) among 152 unique patients. This retrospective study was determined to be exempt from continuing review by the Western Institutional Review Board.

Indications for hip arthroscopy included hips that had symptoms of sufficient severity and duration to limit desired activity level and that had failed nonoperative management.[14] Nonoperative treatment typically spanned a minimum of 6 months and consisted of activity modification, physical therapy, intra-articular corticosteroid injections, and/or nonsteroidal anti-inflammatory medications. Failure of nonoperative management was defined as continued pain or symptoms despite the aforementioned protocol. Candidacy for arthroscopic surgery of the hip was further assessed by preoperative imaging, which included anterior-posterior pelvis, 45° modified Dunn lateral and false-profile view radiographs, and a 3-T magnetic resonance arthrography.[4,13] Treatment of the labrum was determined intraoperatively: labral tears with mild intrasubstance tearing were repaired, while those with severe intrasubstance damage, labral ossification, or segmental defects were reconstructed. In the group with more moderate damage, reconstruction was favored for patients >35 years of age and

‖Address correspondence to Andrew B. Wolff, MD, Washington Orthopaedics and Sports Medicine, 5215 Loughboro Rd NW, Suite 200, Washington, DC 20016, USA (email: andywolffmd@gmail.com).

*School of Medicine, Uniformed Services University, Bethesda, Maryland, USA.

†Department of Orthopaedic Surgery, Walter Reed National Military Medical Center, Bethesda, Maryland, USA.

‡Washington Orthopaedics and Sports Medicine, Washington, DC, USA.

§Professional Research Institute for Sports Medicine, LLC, Chapel Hill, North Carolina, USA.

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TABLE 1
Reconstruction vs Repair—Personal Indications and Preferences

Hips that "always" get reconstructed	Revision procedures Severe labral damage or missing/ossified labrum Collagen disorders (eg, Ehlers-Danlos) Severe pincer deformities (eg, coxa profunda)
Hips in which reconstruction is strongly favored	Patients >35 y with moderate labral damage
Other considerations to make me favor reconstruction	Long history of pain Severe synovitis Mild chondrosis Older female
Hips that "always" get repaired	Patients <25 y Mild intrasubstance labral damage
Other considerations to make me not favor reconstruction (ie, doing a repair or debridement)	Short duration of symptoms Coexistent pathology in the hip that appears to be predominate symptom generator • Can include patients with far more arthritis than anticipated from preoperative imaging • Tumor-like conditions (synovial chondromatosis, pigmented villonodular synovitis, etc)

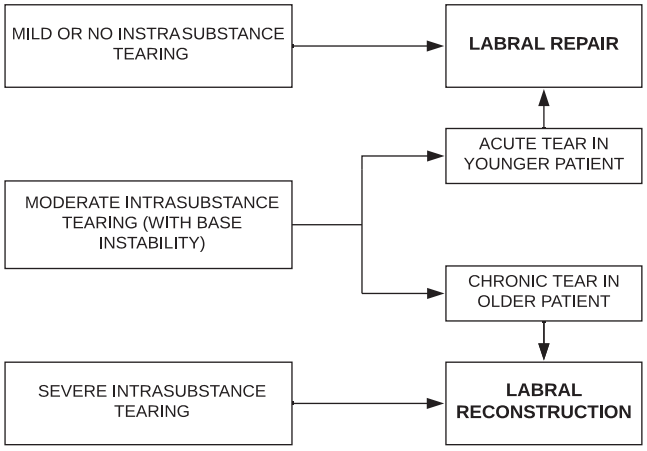

Figure 1. Algorithm for the arthroscopic management of acetabular labral tears.

patients requiring a larger pincer correction. Repair was favored in younger patients with a more predominate cam-type impingement (Table 1, Figure 1).

Data Collection

Patient characteristics were collected at the initial patient appointment and entered into an online outcomes database as part of our routine standard of care; PROs were collected electronically through the online outcomes database before surgery and at specified postoperative intervals (1 and 2 years). Tönnis grade was determined per preoperative radiographs, and labral tear severity was determined arthroscopically by the senior surgeon at the time of surgery. Labral tear severity was classified according to the guidelines established by the Multicenter Arthroscopic Study of the Hip (MASH) Study Group. A mild tear is described as a labrum with a stable rim configuration but evidence of some degree of fraying of the substance. Moderate labral tears are those with either (1) rim stability and evidence of intrasubstance damage that is more significant than fraying but still <50% of the substance at the site of tearing or (2) an unstable rim with evidence of intrasubstance damage <50% of the substance at the site of tearing. Severe labral tears are complex and multiplane, which include >50% of the labral substance at the site of the tear; stability at the rim may or may not be present. Severe tears are defined principally by the multiplane tearing and significance of the proportion of the substance affected at the tear site. Rim instability is not a prerequisite for a severe tear. The intrarater reliability of tear severity was assessed in a sidearm study, which returned a kappa value of 0.66, indicating moderate reliability. After surgery, the senior surgeon completed a postoperative form capturing intraoperative details, including intraoperative findings, procedures performed, and final diagnoses.

Three PROs were used in this study: the modified Harris Hip Score (mHHS), the International Hip Outcome Tool (iHOT-12), and the 12-Item Short Form Health Survey for physical health (SF-12 PH). The mHHS is a commonly reported PRO for hip joint preservation surgery.[27] The SF-12 PH provides a validated measure of general health with a relatively low responder burden. Finally, the iHOT-12, an abbreviated version of the iHOT-33, captures quality of life and changes after intervention in younger, more active patients.[10,30] Pain was assessed with a visual analog scale (VAS) from 0 (no pain) to 100 (worst imaginable pain). Overall satisfaction with surgery was also assessed with a VAS from 0 (very unsatisfied) to 100 (very satisfied). Failure was defined as need for subsequent intra-articular hip surgery or total hip arthroplasty (THA).

Surgical Technique

All procedures were performed by the senior surgeon. After the hip joint was accessed arthroscopically, the extent of the labral tear was assessed by visual inspection and

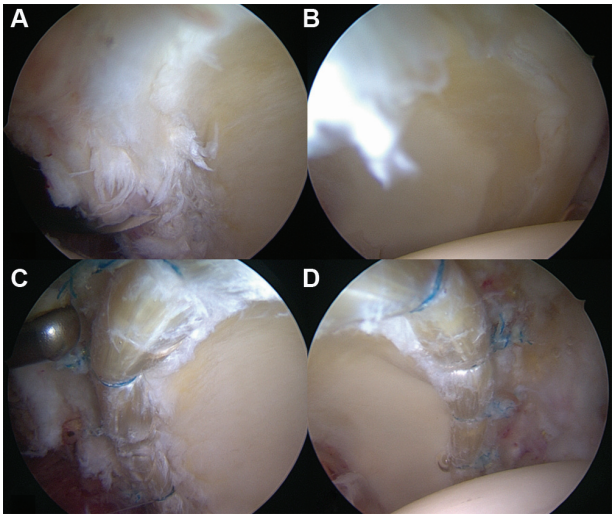

Figure 2. Pre- and postoperative labral reconstruction arthroscopic photographs. Top row: Before labral treatment. (A) A superior/posterior view demonstrating severe intrasubstance tearing deemed irreparable. (B) A superior/anterior view demonstrating more moderate tearing. Overall classification for this degree of labral pathology is severe. Bottom row: After labral treatment. (C, D) Views of the same patient after circumferential labral reconstruction.

probing, with careful observation for pathology identified on preoperative imaging. If the tissue was deemed reparable, the acetabular rim was decorticated to a bed of bleeding bone, or a pincer correction was performed if indicated, with careful attention to protect the labrum from further damage. Suture anchors were placed into the acetabulum as close to the rim as possible, and the sutures from the anchors were passed in a vertical mattress or simple loop configuration depending on the labral anatomy. A simple loop was used for more cylindrical and/or smaller labra, whereas vertical mattress sutures were preferred for larger and/or meniscoid labra.

For the labral reconstruction technique, damaged native labral tissue was excised between the TAL anteroinferiorly and the 8-o'clock position posteroinferiorly. If there was labral damage or ossification that extended farther than the 8-o'clock position, the resection and subsequent reconstruction were taken down to the level of the TAL posteroinferiorly. The rim of the acetabulum was decorticated throughout the length of the proposed reconstruction. Bony impingement was corrected as indicated. On the back table, a fascia lata allograft was tubularized to make a 6-mm diameter graft with a length between 85 and 110 mm. Length was determined by experience of the surgeon with the goal of never having a graft that is too short based on acetabular size and length of the defect. In this study, all grafts started anteriorly at the TAL and ended by overlapping with the native labrum posteroinferiorly (at or below 8 o'clock) or at the TAL posteroinferiorly. No grafts in this study were too short; thus, none left a segmental defect. Suture anchors were placed into the acetabular rim, and the graft was passed through a cannula down the suture from the most anterior-

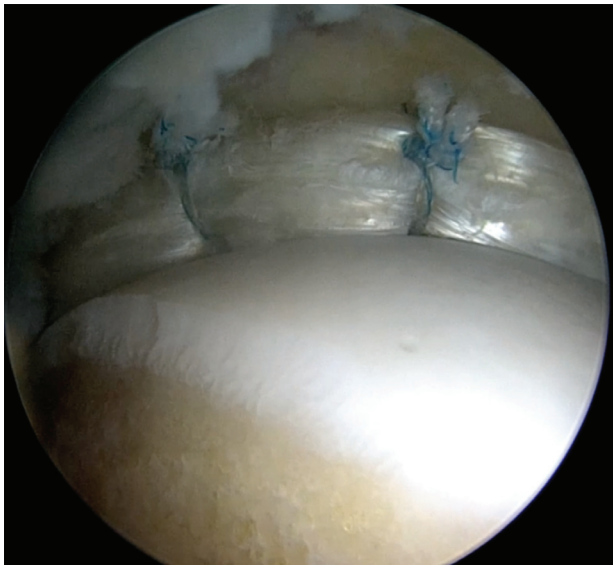

Figure 3. Postreconstruction arthroscopic view of the labral suction seal. Restoration of the labral suction seal after traction released.

inferior anchor, adjacent to the TAL. The remaining sutures (typically 9-12 in total) were then passed around and/or through the graft. Posteriorly, any remaining graft was sutured in a vertical mattress to the remaining posteroinferior labrum at approximately the 8-o'clock position with 1 or 2 suture anchors, with the remaining graft abutting the native labrum extra-articularly. This technique obviates the need to have a precise measurement of the defect, which has proven challenging (Figure 2).

After labral treatment, the hip was taken out of traction and brought through range of motion to ensure a complete restoration of the suction seal, as demonstrated in Figure 3. The capsule was either repaired or plicated in all patients in this study. Postoperatively, passive motion began immediately with a continuous passive motion machine or with a resistance-less stationary bike. Patients in both groups were instructed to use protected weightbearing with crutches until their gait normalized, typically 2 to 4 weeks postoperatively.

Statistical Analysis

All statistical analyses were performed with SAS (v 9.4; SAS Institute), and a P value $<.05$ was considered statistically significant. Comparisons of study population characteristics and concomitant procedures between the labral treatment groups were performed with 2-tailed Student t tests for continuous data and Fisher exact tests for categorical data. Pre- to postoperative PROs were compared within groups via paired Student t tests. To evaluate the average difference in failure rate and postoperative PROs between treatment groups, log-binomial or linear regressions were used to generate point estimates (beta) and 95% CIs.

Inherent differences exist between the hips that were selected to undergo labral repair and labral reconstruction

TABLE 2
Study Population Characteristics Stratified by Labral Treatment[a]

	Repair (n = 99)	Reconstruction (n = 63)	*P* Value
Age, y	29.5 ± 11.0	43.4 ± 10.7	<.01
Male	42 (42.4)	26 (41.3)	.89
Body mass index	23.0 ± 3.5	24.6 ± 3.8	.01
Severity			
Minimal	10 (10.1)	0 (0.0)	<.01
Moderate	84 (84.8)	20 (31.7)	
Severe	5 (5.1)	43 (68.3)	
Tönnis grade			
0	90 (90.9)	47 (74.6)	<.01
1	9 (9.1)	8 (12.7)	
2	0 (0.0)	8 (12.7)	
Preoperative measure			
mHHS	63.4 ± 17.1	60.2 ± 15.5	.24
iHOT-12	39.3 ± 18.0	37.8 ± 19.7	.62
SF-12 PH	37.4 ± 8.3	37.6 ± 9.4	.89
VAS pain	41.5 ± 19.9	49.9 ± 21.7	.01

[a]Data are provided as No. of hips (%) or mean ± SD. iHOT-12, International Hip Outcome Tool; mHHS, modified Harris Hip Score; SF-12 PH, 12-Item Short Form Health Survey for physical health; VAS, visual analog scale.

such that the labral reconstruction hips typically had lower preoperative subjective scores, more pain, and more intra-articular damage. Subsequently, crude comparisons of outcomes are limited. To adjust for some of the differences in baseline characteristics, inverse probability of treatment weighting (IPTW) was used to compare PROs between treatment groups.[15] Each hip was assigned a probability of undergoing labral reconstruction (ie, a propensity score) based on the following preoperative characteristics: age at the time of surgery, body mass index (BMI), Tönnis grade, preoperative pain score, and preoperative mHHS. Propensity scores were first described by Rosenbaum and Rubin[23] in 1983 as a method to address confounding between treatment groups, and since their development, propensity scores have been widely used in nonexperimental studies comparing outcomes after medical interventions. The propensity score for each hip was calculated with a logistic regression model, which calculated a probability of the exposure (labral reconstruction) given the preoperative characteristics (ie, age at the time of surgery, BMI, Tönnis grade, preoperative pain score, and preoperative mHHS). Age and BMI were treated as categorical variables because of the limited sample size. With the calculated probability of undergoing a labral reconstruction, hips were weighted to create groups that were most similar preoperatively by applying a weight equal to the inverse of the propensity score (ie, IPTW). Hips that underwent labral reconstruction were assigned a weight equal to 1 / propensity score, and hips that underwent labral repair were assigned a weight equal to 1 / (1 − propensity score). The weights were stabilized according to the methods described by Sturmer et al[28] in 2010, and hips without similar comparators between groups were trimmed out of the analytic population, resulting in a restricted but more comparable study population. Differences in PROs between treatment groups were then assessed with adjusted betas and 95% CIs generated with IPTW linear regressions.

RESULTS

A total of 162 hips met the inclusion criteria for this study, including 99 labral repairs and 63 complete labral reconstructions with iliotibial band allograft. Hips that underwent labral reconstruction were on average older (43.4 vs 29.5 years; $P < .01$); had a higher BMI (24.6 vs 23.0; $P < .01$), a higher Tönnis grade (grade 1 or 2: 25% vs 9%; $P < .01$), and higher preoperative pain scores (49.9 vs 41.5; $P = .01$); and were more likely to be rated as having severe labral pathology, defined principally as a multiplane tear with or without rim instability (68% vs 5%; $P < .01$) as compared with labral repair hips (Table 2). Labral reconstruction hips also had more concomitant procedures performed, on average, than labral repair hips (Table 3).

Among the 162 hips with 2-year follow-up data collected between 22 and 26 months, the mean follow-up time was 24.0 months (SD = 1.9 months). Five (5%) labral repair hips and 5 (8%) labral reconstruction hips failed treatment ($P = .48$). Of those, 4 labral repair hips required revision arthroscopic treatment and 1 required THA, while 3 labral reconstruction hips required revision arthroscopic treatment and 2 required THA. The hips that failed treatment were not included in the analysis of PROs.

Among hips that did not fail treatment (n = 94 repairs, n = 58 reconstructions), all patients demonstrated statistically significant improvements between pre- and postoperative PRO scores (Table 4). Crude comparison of labral repair hips with labral reconstruction hips suggests that repair hips have higher postoperative PRO scores and satisfaction and lower pain scores (Table 5), yet these differences diminished with IPTW after adjusting for differences in preoperative characteristics.

Results from IPTW yielded an adjusted population of 128 hips, with labral repair and labral reconstruction hips that were preoperatively similar in terms of age, BMI, Tönnis grade, and preoperative mHHS and pain

TABLE 3
Concomitant Procedures Stratified by Labral Treatment[a]

Procedure	Repair (n = 99)	Reconstruction (n = 63)	*P* Value
Osteoplasty			
Cam	81 (81.8)	61 (96.8)	<.01
Pincer	28 (28.3)	44 (69.8)	<.01
Subspine	2 (2.0)	5 (7.9)	.07
Fovea	0 (0.0)	2 (3.2)	.07
Chondroplasty			
Acetabular	54 (54.5)	56 (88.9)	<.01
Femoral head	7 (7.1)	9 (14.3)	.13
Unspecified	2 (2.0)	2 (3.2)	.64
Acetabular microfracture	0 (0.0)	1 (1.6)	.21
Excision of acetabular rim fracture	3 (3.0)	6 (9.5)	.08
Labral debridement	3 (3.0)	NA	NA
Debridement of intralabral calcifications	1 (1.0)	NA	NA
Ligamentum teres debridement	23 (23.2)	19 (30.2)	.33
Synovectomy	39 (39.4)	38 (60.3)	<.01
Capsular plication	27 (27.3)	11 (17.5)	.15
Loose body removal	5 (5.1)	6 (9.5)	.27
Drilling of subchondral cyst	1 (1.0)	1 (1.6)	.75
Synovial biopsy	2 (2.0)	0 (0.0)	.26
Excision			
Ganglion cyst	1 (1.0)	0 (0.0)	.42
Heterotopic ossification	1 (1.0)	0 (0.0)	.42
Trochanteric bursectomy	2 (2.0)	10 (15.9)	<.01
Repair of gluteus medius and/or minimus tear	0 (0.0)	3 (4.8)	.03
Lesser trochanter osteoplasty	2 (2.0)	1 (1.6)	.84

[a]NA, not applicable.

TABLE 4
Change in Patient-Reported Outcome Scores Stratified by Treatment Group[a]

Outcome Measure	Preoperative	Postoperative	Difference[b]	95% CI
Repair (n = 94)				
mHHS	63.4 ± 17.1	88.0 ± 15.1	24.2	20.3 to 28.1
iHOT-12	39.3 ± 18.0	71.2 ± 23.2	31.7	26.9 to 36.5
SF-12 PH	37.4 ± 8.3	50.0 ± 9.0	12.7	10.6 to 14.7
VAS pain	41.5 ± 19.9	14.1 ± 17.1	–27.7	−32.2 to −23.3
Reconstruction (n = 58)				
mHHS	60.2 ± 15.5	80.7 ± 16.4	20.4	15.6 to 25.1
iHOT-12	37.8 ± 19.7	65.8 ± 26.2	27.8	19.7 to 35.8
SF-12 PH	37.6 ± 9.4	47.1 ± 10.1	9.3	6.6 to 12.0
VAS pain	49.9 ± 21.7	23.6 ± 22.5	–25.6	−33.1 to −18.1

[a]Scores are given as mean ± SD. iHOT-12, International Hip Outcome Tool; mHHS, modified Harris Hip Score; SF-12 PH, 12-Item Short Form Health Survey for physical health; VAS, visual analog scale.
[b]The difference is the mean postoperative score minus the mean preoperative score. All *P* values for differences, $P < .01$.

scores (Table 6). When outcomes were compared between hips that underwent labral reconstruction and labral repair with this weighted population, there was no statistical difference in outcome scores between treatment groups (Table 7). In addition, there was a trend toward improvement on all measures except for patient satisfaction for the labral reconstruction group, although these changes were not statistically significant. For example, the point estimate for mHHS moved from an average −6-point difference between groups to an average −3-point difference, and the point estimate for postoperative pain moved from an average 10-point difference in pain score between groups to an average 4-point difference.

DISCUSSION

For primary arthroscopic treatment of labral pathology of the hip, labral reconstruction can provide similar outcomes to

TABLE 5
Postoperative Outcome Measures Stratified by Labral Treatment (n = 152)[a]

	Repair (n = 94)	Reconstruction (n = 58)	Difference[b]	95% CI	*P* Value
mHHS	88.0 ± 15.1	80.7 ± 16.4	–7.3	−12.4 to −2.1	<.01
iHOT-12	71.2 ± 23.2	65.8 ± 26.2	–5.5	–13.4 to 2.5	.18
SF-12 PH	50.0 ± 9.0	47.1 ± 10.1	–2.9	–6.0 to 0.2	.07
VAS pain	14.1 ± 17.1	23.6 ± 22.5	9.5	3.2 to 15.8	<.01
VAS satisfaction	81.9 ± 24.2	77.1 ± 27.0	–4.7	–13 to 3.6	.27

[a]Scores are given as mean ± SD. iHOT-12, International Hip Outcome Tool; mHHS, modified Harris Hip Score; SF-12 PH, 12-Item Short Form Health Survey for physical health; VAS, visual analog scale.
[b]The difference is the mean reconstruction score minus the mean repair score; negative values indicate that the reconstruction group had lower scores, on average, than the repair group.

TABLE 6
Restricted Study Population Characteristics Stratified by Labral Treatment: Pre– and Post–Propensity Score Weighting (n = 128)[a]

	Restricted Study Population: Raw Values			IPTW Study Population: Adjusted Values		
Preoperative Characteristic	Repair (n = 80)	Reconstruction (n = 48)	*P* Value	Repair	Reconstruction	*P* Value
Age, y			<.001			.40
<30	41 (51.2)	5 (10.4)		28.3 (34.5)	32.5 (52.3)	
30-39.9	23 (28.7)	13 (27.1)		20.7 (25.2)	12.5 (20.1)	
40-49.9	11 (13.8)	21 (43.8)		24.7 (30.1)	12.1 (19.4)	
≥50	5 (6.2)	9 (18.8)		8.4 (10.2)	5.1 (8.2)	
Body mass index			.71			.40
<20	5 (6.2)	4 (8.3)		6.7 (8.1)	2.9 (4.7)	
20-24.9	58 (72.5)	30 (62.5)		58.4 (71.2)	52.1 (83.8)	
25-29.9	12 (15.0)	10 (20.8)		11.8 (14.4)	4.8 (7.8)	
≥30	5 (6.2)	4 (8.3)		5.2 (6.3)	2.3 (3.7)	
Tönnis grade >0	7 (8.8)	7 (14.6)	.47	12.1 (14.7)	5.8 (9.3)	.49
Preoperative						
mHHS	63.7 ± 17.9	61.9 ± 16.2	.57	63.5 ± 17.4	65.1 ± 12.0	.54
VAS pain	45.3 ± 19.4	45.6 ± 20.3	.93	46.0 ± 18.2	40.3 ± 17.1	.15

[a]Values are presented as n (%) or mean ± SD. IPTW, inverse probability of treatment weighted; mHHS, modified Harris Hip Score; VAS, visual analog scale.

TABLE 7
Adjusted Postoperative Outcome Measures Stratified by Labral Treatment in the Restricted Population (n = 128)[a]

	Unadjusted			Adjusted With IPTW		
	Difference[b]	95% CI	*P* Value	Difference[b]	95% CI	*P* Value
mHHS	–6.4	−12.1 to −0.7	.03	–3.0	–8.4 to 2.4	.28
iHOT-12	–7.3	–15.9 to 1.4	.10	–2.8	–10.1 to 4.6	.46
SF-12 PH	–3.0	–6.5 to 0.5	.10	0.4	–2.7 to 3.4	.81
VAS pain	9.8	2.8 to 16.9	.01	4.1	–2 to 10.2	.19
Satisfaction	–3.6	–12.5 to 5.3	.43	–4.9	–12.5 to 2.7	.21

[a]iHOT-12, International Hip Outcome Tool; IPTW, inverse probability of treatment weighted; mHHS, modified Harris Hip Score; SF-12 PH, 12-Item Short Form Health Survey for physical health; VAS, visual analog scale.
[b]The difference is the mean reconstruction score minus the mean repair score; negative values indicate that the reconstruction group had lower scores, on average, than the repair group.

labral repair. These results are especially promising when the characteristics and pathology of the two groups are compared. The hips in the labral reconstruction group were significantly older, with a higher BMI, more severe labral tears, and higher Tönnis grades. These hips also had lower preoperative mHHS scores and higher preoperative pain

VAS scores. As highlighted in Table 3, reconstruction hips generally had more concomitant procedures performed, which suggests a worse preoperative intra-articular problem that necessitated a more complicated surgical procedure. At 2-year follow-up, there was no statistically significant difference in mHHS, iHOT-12, SF-12 PH, or pain VAS between the treatment groups, although repair hips tended to have slightly higher postoperative PROs and lower postoperative pain. There was also no difference in failure rates between the groups. In addition, there was no statistically significant difference in satisfaction at 2-year follow-up between the groups. For all-comers, there appears to be no difference in PROs between labral reconstruction and labral repair hips, suggesting that primary labral reconstruction may be an important treatment consideration for hips with significant labral pathology—particularly in the setting of other, less favorable characteristics, including advanced age, increased BMI, and increased chondrosis.

In our clinical experience, it has been a constant challenge predicting which hips will do well with labral repair alone versus those that may require a complete resection of native labral tissue with subsequent circumferential reconstruction. As our surgical technique continues to improve and our understanding of hip and labral pathology grows, so does our clinical judgment regarding patient selection for hip arthroscopy. Chandrasekaran et al[3] found that patients with Tönnis grade 2 osteoarthritis of the hip who were undergoing hip arthroscopy had significantly higher rates of failure with eventual conversion to THA when compared with patients with Tönnis grade 0 and 1 hips. In addition, a recently published review of the literature for outcomes after hip arthroscopy in patients aged $\geq$40 years revealed the overall reoperation rate for all-comers to be 20.8%, with risk factors for revision including increased patient age, a higher severity of arthrosis, and lower preoperative outcome scores.[11]

These findings suggest that a subset of hips has severe intra-articular injury in a traditionally difficult-to-treat patient group that may not find success with labral repair. We believe that primary complete labral reconstruction should be considered for these patients with a known propensity for suboptimal outcomes with labral repair, which, in our clinical experience, are older patients with more severe labral damage. Primary labral reconstruction, in a specific patient population, has the ability to offer similarly good outcomes when compared with younger patients undergoing labral repair for milder labral injury. Even more promising is that at postoperative 2 years, none of the Tönnis grade 1 and 2 hips included in this study exhibited signs of failure suggestive of the need for THA.

The acetabular labrum is a fibrocartilaginous structure similar in composition to the meniscus of the human knee.[25] It is well described in the knee literature that there exists a continuum of damage to meniscal tissue along which a patient moves from a candidate for a meniscal repair to one for debridement only.[37] This is also true of labral tears, with clinical presentation ranging from asymptomatic to debilitating pain. Despite the success achieved with repair of labral tissue with more minor tears, the applicability of labral repair as a treatment for severe tears remains unknown. However, given the similarities between labral and meniscal tissue and the poor outcomes associated with repair of severely damaged meniscal tissue, it is logical that less favorable results could be expected with more severely damaged labral tissue.

Labral reconstruction is a technically difficult procedure that has the potential to offer patients biomechanical stability and pain relief in settings where repair results may not be favorable. In our practice, labral repair is preferred for patients with an unstable or detached labral base with only mild or moderate intrasubstance tearing. Labral reconstruction is preferred for patients with segmental labral defects, severe intrasubstance damage, labral ossification, or severe pincer deformities; for older patients for whom there is concern regarding the healing of repaired tissue; or in cases when excessive synovitis concerning for chronic pathology is identified. A labral repair may restore anatomic function but fail to remove pain-generating tissue. In contrast, labral reconstruction, while far more technically demanding, not only restores anatomic function but removes pain-generating tissue. This assertion is supported by our data, which demonstrated a statistically significant improvement in pain-level and hip-specific outcomes, suggesting that the complete removal of pain-generating tissue has a marked effect on overall hip health. It is also important to consider the direct costs associated with each procedure. Labral repair necessitates the use of multiple arthroscopic anchors, and labral reconstruction typically requires more anchors and allograft tissue. These costs, while not insignificant, are marginal when compared with the cost of a revision procedure and the personal and societal costs associated with failed surgery; surgeons should accordingly consider these costs when evaluating outcomes and the survivability of these procedures in short- and long-term settings.

Two of the main technical decisions for labral reconstruction are length of reconstruction and graft choice. All labral reconstructions performed in this study utilized a fascia lata allograft, which, in our clinical experience, offers the senior surgeon the highest level of consistency with regard to final graft shape, size, and quality. Although the literature on anterior cruciate ligament (ACL) reconstruction suggests a higher failure rate for allograft reconstructions versus autograft, the ACL is subject to a different quantity and quality of forces than the acetabular labrum; as such, the applicability of the allograft ACL literature to labral reconstruction is questionable.[1] In terms of graft length, both the senior surgeon and the existing literature have indicated that longer grafts tend to lead to more favorable outcomes.[32,34-36] This relationship likely exists for several reasons: the circumferential labrum graft has either no junction points or 1 far posteroinferiorly in an area of low stress, and, as the labrum is a known pain generator, resecting more damaged labral tissue should result in decreased pain for the patient. Finally, complete labral reconstruction reduces the potential for undercorrection of a pincer deformity or undertreatment of an ossified labrum or os acetabuli owing to concerns about labral preservation or a lack of exposure of the acetabular rim.

It is important to note that direct comparison of surgical techniques within the study population with severe labral

pathology is limited in this study, given that treatment was influenced by preoperative characteristics. In particular, the hips that underwent primary labral reconstruction versus labral repair had preoperative characteristics that may predispose them to poorer outcomes. However, the advanced analytic method of IPTW was used to adjust for some of these differences in preoperative characteristics to facilitate comparison. This analytic technique weights the labral repair and labral reconstruction groups toward a "middle ground" of preoperative characteristics, which helps to compare the 2 procedures among a group of hips with more moderate preoperative patient characteristics. The results suggest that when some of the preoperative differences are accounted for, reconstruction outcomes move further toward equivalence or potentially improved outcomes over repair. Note that not all predictors of treatment choice were able to be measured and accounted for, as treatment choice is largely a subjective decision by the surgeon and patient. Optimization of treatment prediction, including better measurement of preoperatively identified pathology and subjective symptomology, may have improved our ability to compare treatment options. Nonetheless, we believe it is meaningful that the primary labral reconstruction groups, with greater known predictors for poorer outcomes, had outcomes equivalent to those of the primary labral repair group, which had less severe pre- and intraoperative pathology.

Limitations

This study is not without limitations. As in nearly all contemporary literature regarding arthroscopic hip surgery, there are often multiple concomitant procedures performed at the time of surgery. Attributing outcomes to the labral treatment can present a challenge; however, indications for treatment of concomitant pathology do not vary between labral treatment groups, which should reduce bias in the comparison of outcomes. As mentioned, it is also likely that confounding between treatment groups remains, despite attempts to adjust for some known confounding factors with IPTW. While it is possible that a randomized controlled trial comparing the outcomes of labral repair with labral reconstruction could eliminate much of this confounding, the recent evolution in hip arthroscopy and continuous generation of evidence regarding procedure outcomes in specific settings make it difficult for many surgeons, including the senior author (A.B.W.), to justify randomization. As randomized controlled trials are costly and require a long study period, nonexperimental studies like the present one can generate important real-world evidence to answer such questions if differences in treatment groups are addressed through, for example, implementation of IPTW. It is also important to acknowledge that this is a study of early outcomes. In particular, our mean follow-up of 2 years may not allow for enough time to fully capture revisions or failures. Furthermore, radiographic measurements of femoroacetabular impingement, such as alpha angle and lateral center-edge angle, were not included in our analysis. Finally, a single surgeon with extensive hip arthroscopy experience in a practice dedicated solely to hip arthroscopy treated all hips in this cohort study. Given the technical demands of circumferential labral reconstruction, the results of this study may not be generalizable to other patient populations.

CONCLUSION

Primary circumferential labral reconstruction is a viable treatment option with promising short-term outcomes for hips that demonstrate moderate or severe labral damage. Despite less favorable preoperative characteristics, labral reconstruction offers similar outcomes when compared with labral repair in hips with less severe pathology.

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