Prospective Analysis of Arthroscopic Hip Anatomic Labral Repair Utilizing Knotless Suture Anchor Technology

The Controlled-Tension Anatomic Technique at Minimum 2-Year Follow-up

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Background: Labral tears are the most common abnormalities in patients undergoing hip arthroscopic surgery. Appropriate management is crucial, as it has been shown that better overall outcomes can be achieved with labral restoration.

Purpose: To report the patient-reported outcomes (PROs) at minimum 2-year follow-up of patients who underwent hip arthroscopic surgery for labral tear repair using the knotless controlled-tension anatomic technique in the setting of femoroacetabular impingement syndrome (FAIS).

Study Design: Case series; Level of evidence, 4.

Methods: Data were prospectively collected for patients who underwent hip arthroscopic surgery for FAIS for labral tear repair using the knotless controlled-tension anatomic technique. Patients were excluded if they had prior hip conditions, prior ipsilateral surgery, Tönnis grade >1, a lateral center-edge angle (LCEA) <25°, or workers' compensation claims. Preoperative and postoperative scores at minimum 2-year follow-up were recorded for the modified Harris Hip Score (mHHS), Nonarthritic Hip Score (NAHS), Hip Outcome Score–Sport-Specific Subscale (HOS-SSS), International Hip Outcome Tool (iHOT-12), and visual analog scale (VAS) for pain. The proportion of patients who achieved the minimal clinically important difference (MCID) or patient acceptable symptomatic state (PASS) for the mHHS, HOS-SSS, and iHOT-12 were also reported.

Results: A total of 309 hips were included. The mean patient age was 36.2 years (range, 12.8-75.9 years). The mean preoperative LCEA and alpha angle were 31.9° and 57.1°, respectively. A significant improvement on the mHHS (62.6 ± 15.7 preoperatively vs 86.9 ± 16.2 at 2-year follow-up), NAHS (63.1 ± 16.7 vs 86.1 ± 16.7), and HOS-SSS (39.8 ± 22.0 vs 74.2 ± 27.3) was found ($P < .001$ for all). A significant decrease was shown for VAS scores ($P < .001$). Also, 78.6% and 82.2% of patients achieved the MCID and PASS for the mHHS, respectively; 60.8% and 69.9% of patients met the MCID and PASS for the HOS-SSS, respectively; and the MCID for the iHOT-12 was met by 77.3% of patients.

Conclusion: In the setting of FAIS and labral tears, patients who underwent hip arthroscopic surgery for labral tear repair using the knotless controlled-tension anatomic technique demonstrated significant improvement in several validated PRO measures, the VAS pain score, and patient satisfaction at a minimum 2 years of follow-up. Based on this evidence, labral tear repair using the knotless controlled-tension anatomic technique seems to be a safe option.

Keywords: hip arthroscopic surgery; labral tear; femoroacetabular impingement; patient-reported outcomes

The importance of the labrum in the biomechanics of the hip joint is well recognized.[49] Anatomic labral repair is one of the key steps to fulfill the criteria for the restoration of hip anatomy, which include reestabilishing (1) continuity of the chondrolabral junction transitional zone, (2) triangular cross-sectional labral geometry, and (3) the suction seal as critical goals.[8,24,58] Different configurations have been used to repair the labrum. Initially, a simple circumferential loop stitch was described; however, this may lead to nonanatomic repair with no restoration of the labral "suction

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seal."[50,51,58] Striving for anatomic labral repair, the labral base technique was proposed; although anatomic repair was possible, the amount of tension applied to the construct is difficult to control, and this technique cannot be performed efficiently in small/hypotrophic labra.[20,24] In a matched comparison study, Jackson et al[32] found no difference in outcomes based on the type of labral repair performed (labral base repair vs circumferential loop repair) using knotless anchor technology. More recently, knotless controlled-tension anatomic repair was introduced to overcome potential disadvantages of prior labral repair techniques.[18,71] In a 2019 systematic review, Riff et al[63] reported that a shift in hip labral management has occurred. Between 2009 and 2019, they noted that 80% of labral abnormalities were treated with debridement versus 20% with labral repair; however, between 2014 and 2017, this shifted to 72% for labral repair versus 28% for labral debridement.[63]

Appropriate techniques for safe acetabular anchor drilling and placement to avoid complications, such as acetabular cartilage penetration or psoas irritation, have been described and analyzed.[15,53,74] Shah et al[68] performed a systematic review on the anchor safety profile in hip arthroscopic surgery and found that large-diameter suture anchors were more likely to violate articular cartilage at vulnerable positions (3- to 4-o'clock position at the acetabular rim). In general, smaller suture anchors and smaller diameters for labral penetrator devices are currently the trend.[20,69]

In shoulder arthroscopic surgery, knotless anchor technology has been implemented, with comparable results to the knot-tying alternative.[22,61] Moreover, it has the potential benefits of avoiding knot-tying difficulty and avoiding pain due to knot space occupation irritating surrounding tissue or due to potential articular abrasion.[2] Although these principles have been adopted in hip arthroscopic surgery, biomechanical requirements may not be the same between shoulder and acetabular labral repair. Most of the data reported in the literature, although supportive of knotless technology in hip arthroscopic surgery, are based on non–in vivo studies.[21,66] To our knowledge, there has been only 1 study that reported outcomes with the specific use of knotless technology in hip arthroscopic surgery.[62] The current ongoing study is one of the first to include a large case series with this distinctive technology and the concept of controlled-tension anatomic labral repair.[71]

The purpose of this study was to report the patient-reported outcomes (PROs) of patients who underwent hip arthroscopic surgery for labral repair using the knotless controlled-tension anatomic technique in the setting of femoroacetabular impingement syndrome (FAIS). It was hypothesized that patients who underwent primary labral repair using this technique would experience significant improvements in several PROs at minimum 2-year follow-up.

METHODS

Patient Selection

Institutional data for this institutional review board–approved study were prospectively collected from February 2015 to January 2017 for patients who underwent hip arthroscopic surgery for FAIS and labral repair by the senior surgeon (B.G.D.) (Figure 1).[71] All patients had their labra repaired using a knotless suture anchor with the controlled-tension anatomic technique. We excluded patients with a lateral center-edge angle (LCEA) $<25^{\circ}$, Tönnis grade >1, previous hip conditions (history of slipped capital femoral epiphysis; avascular necrosis; Legg-Calve-Perthes disease; and inflammatory, connective tissue [Ehlers-Danlos syndrome], or neoplastic [pigmented villonodular synovitis] conditions), any previous ipsilateral hip surgery, workers' compensation claims, or an unwillingness to be a part of research. In addition, patients who had revision surgery or who were converted to total hip arthroplasty were not included in the PRO analysis.

The following PROs were recorded preoperatively and postoperatively at minimum 2-year follow-up: modified Harris Hip Score (mHHS),[1] Nonarthritic Hip Score (NAHS),[13] Hip Outcome Score–Sport-Specific Subscale (HOS-SSS),[47] and visual analog scale (VAS) for pain.[11] In addition, at follow-up, the International Hip Outcome Tool (iHOT-12),[28] the physical and mental portions of the

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This study was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki. This study was carried out in accordance with relevant regulations of the United States Health Insurance Portability and Accountability Act (HIPAA). Details that might disclose the identity of the participants under study have been omitted.

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Ethical approval for this study was obtained from Advocate Health Care (No. AHC-5276).

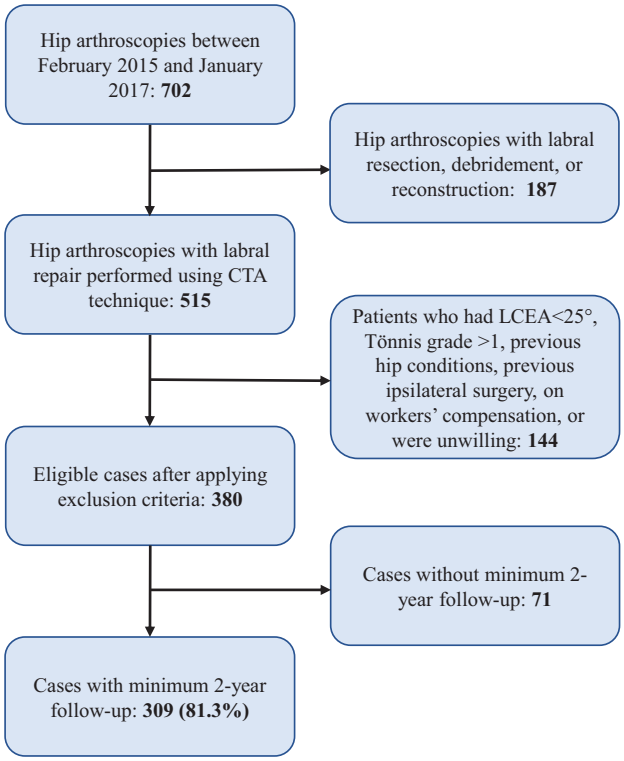

Figure 1. Patient selection process. CTA, computed tomography angiography; LCEA, lateral center-edge angle.

Veterans RAND 12-Item Health Survey (VR-12), and the physical and mental portions of the Short Form–12 (SF-12) were also reported for the patient cohort. Finally, the proportion of patients who achieved the minimal clinically important difference (MCID) and/or patient acceptable symptomatic state (PASS) for the mHHS, HOS-SSS, and iHOT-12 were reported.[10,40,46]

Participation in the American Hip Institute Hip Preservation Registry

All patients participated in the American Hip Institute Hip Preservation Registry. While the present study represents a unique analysis, data on some patients in this study may have been reported in other studies. All data collection received institutional review board approval.

Imaging Protocol

Before surgery, all patients underwent a radiographic evaluation that included an anteroposterior pelvic view, a 45° Dunn view, a cross-table lateral view, and a false profile view.[14,60] Using the anteroposterior pelvic view, the degree of osteoarthritis based on the Tönnis classification was assessed as per Domb et al.[17] The LCEA was measured according to the method described by Wiberg[72] and modified by Ogata et al,[55] and the alpha angle was measured on the 45° Dunn view according to the method by Nötzli et al.[54] A cam deformity was defined as an alpha angle $\geq$55°.[6] The anterior center-edge angle was measured on the false profile view according to the method delineated by Lequesne and de Seze.[39] The American Hip Institute's radiographic measurements have demonstrated good interobserver reliability in previously published studies.[19,42]

Surgical Indication

All patients underwent nonoperative treatment (rest, injections, physical therapy, and nonsteroidal anti-inflammatory medication) for their symptoms. Patients refractory to at least 3 months of nonoperative treatment were recommended for surgery.[5,27]

Surgical Technique

All hip arthroscopic procedures were performed using the anterolateral, midanterior, and distal anterolateral accessory portals with the patient in the modified supine position (Figures 2 and 3 and Supplemental Video).[16,36,41] Diagnostic arthroscopic surgery was performed in all cases to assess the overall health of the joint. The Outerbridge,[57] Seldes,[67] and acetabular labrum articular disruption (ALAD)[9] classification systems were used to classify the degree of cartilage damage. Additionally, the condition of the ligamentum teres was assessed with the Villar[26] and the Domb[4] classification systems.

After identification, the torn hip labrum was anatomically repaired with 3.0-mm PEEK Knotless Hip SutureTak suture anchors (Arthrex) in a sequential fashion from anteromedial to posterolateral (Figure 4 and Supplemental Video).[71] Minimal rim trimming was used to provide a bleeding bone surface for labral repair healing. If needed, acetabuloplasty without labral detachment was performed to correct pincer-type FAIS, and spherical femoroplasty was performed to correct cam-type FAIS.[45,56,59] In cases of Outerbridge grade 4 cartilage damage, microfracture was performed, as described by Steadman et al.[70] Capsular treatment was based on the patient's range of motion and generalized ligamentous laxity; however, capsular repair is the current choice for the senior author (B.G.D.).[12,44,65]

Rehabilitation

Patients were instructed to use a fitted hip brace for 2 weeks. Patients were limited to a 20-lb flat-foot weightbearing restriction on the operative extremity for 2 weeks. In cases when microfracture was required, the weightbearing restriction was extended to 8 weeks. On postoperative day 1, all patients began physical therapy, which included using a continuous passive motion machine or recumbent bicycle daily for 8 weeks. In addition, patients were prescribed 4 weeks of oral anti-inflammatory medication to be taken twice daily.

Statistical Analysis

Data were analyzed using Excel (Microsoft) and the Real Statistics Add-In. The Shapiro-Wilk test assessed the

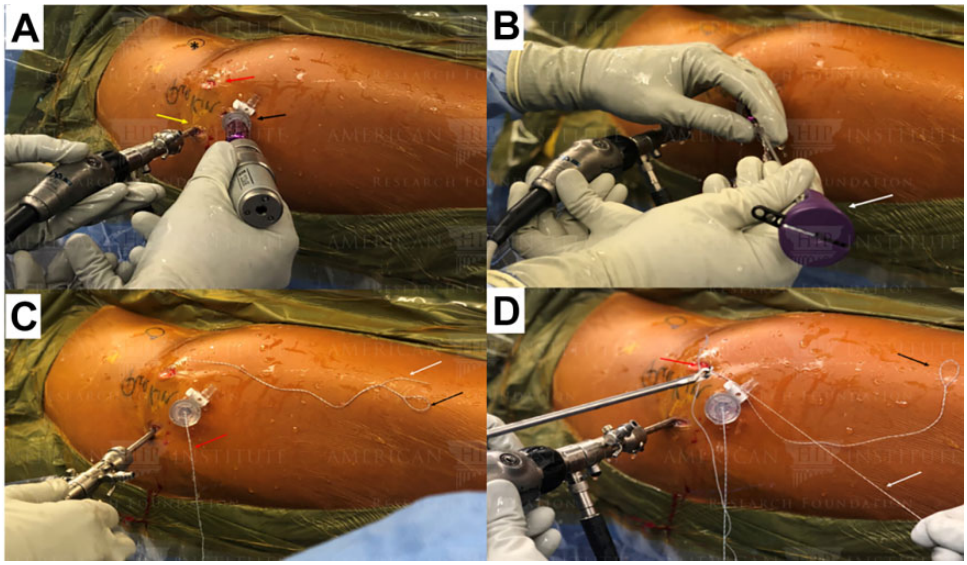

Figure 2. The right hip of a patient in the modified supine position with the head toward the left and feet to the right during the knotless anchoring procedure for labral repair. (A) The 70° arthroscope was placed in the anterolateral portal (yellow arrow) for direct visualization during acetabular drilling. The drill was placed in the distal anterolateral accessory (DALA; black arrow) and midanterior (red arrow) portals, and the anterior superior iliac spine (*) was marked. (B) After drilling, the drill guide was kept in the DALA portal, and the anchor (white arrow) was inserted. (C) The anchor was already tapped and deployed, the "repair suture" (red arrow) was kept in the DALA portal, and the "passing" (looped black arrow) and "tension" (white) sutures had been retrieved from the DALA portal to the midanterior portal. (D) The "repair" suture was assembled in the self-retrieved suture passer (red arrow) and passed through the chosen point at the chondrolabral junction in a looped fashion. The "passing" (looped black arrow) and "tension" (white) sutures were identified.

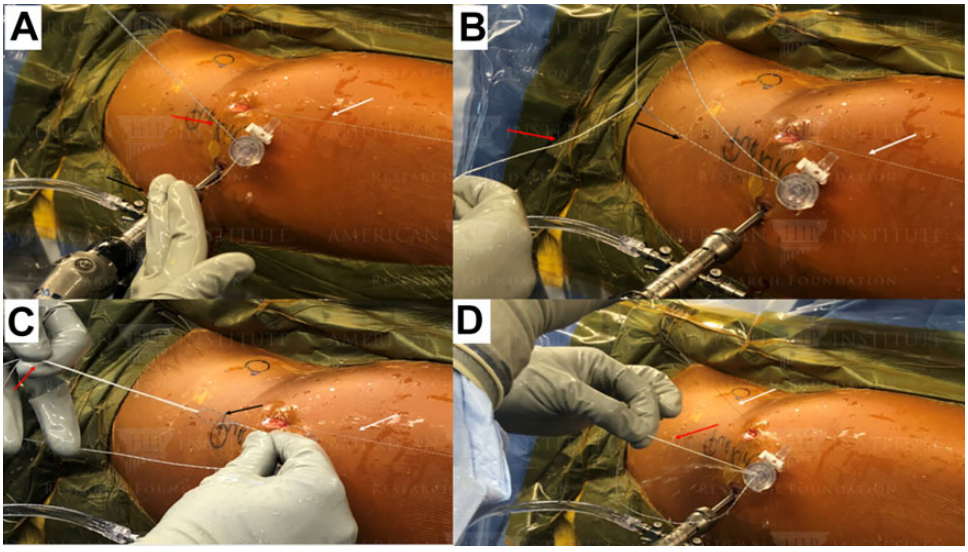

Figure 3. The right hip of a patient in the modified supine position with the head toward the left and feet to the right during the knotless anchoring procedure for labral repair. (A) With the "repair" suture (red arrow) kept in place, the "passing" suture (black arrow) was retrieved from the midanterior portal to the distal anterolateral accessory (DALA) portal. Tension was maintained in the "control-tension" suture during this phase (white arrow). (B, C) The "repair" suture (red arrow) was introduced through the loop of the "passing" suture (black arrow) and assembled properly. The "tension" suture was marked (white arrow). (D) Traction was applied from the midanterior portal to the "tension" suture (white arrow), allowing the "repair" suture (red arrow) to be pulled from the DALA portal to the midanterior portal. Once outside the midanterior portal, tension was applied to the "repair" suture until the desired amount of force was achieved (control-tension), as shown in the Supplemental Video.

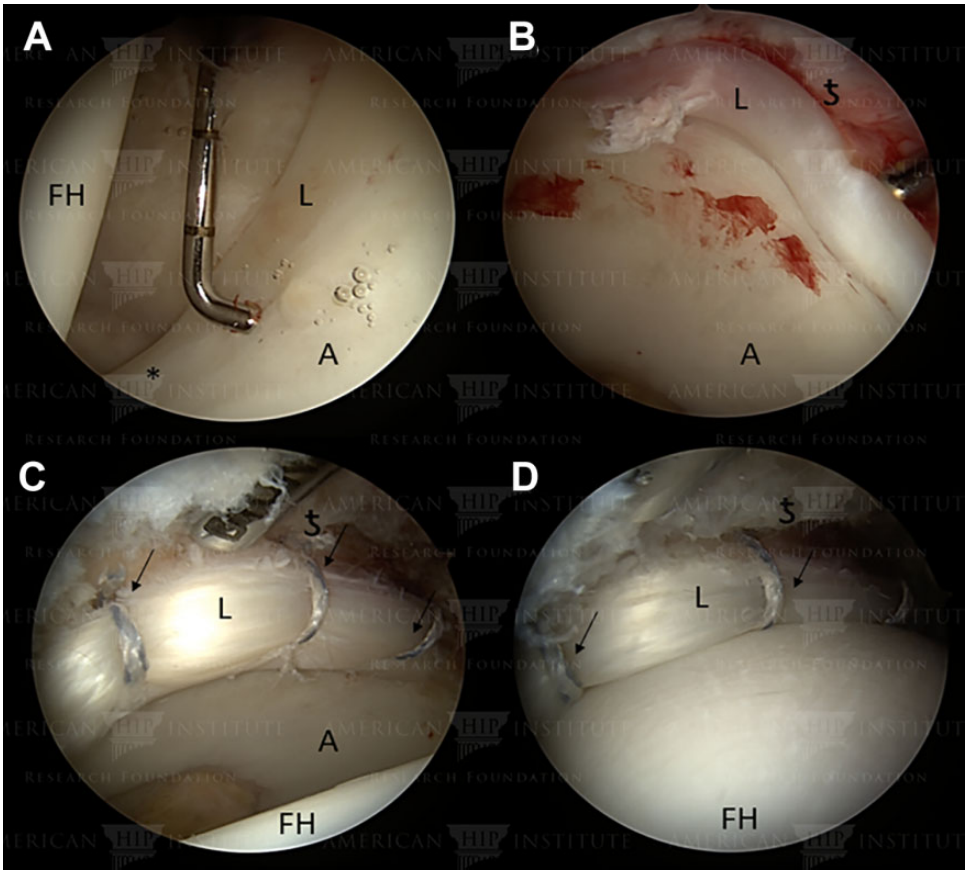

Figure 4. Intraoperative controlled-tension anatomic labral repair of a left hip with the patient in the modified supine position. The anterolateral portal was used as a visualization portal with the 70° arthroscope. (A) During the diagnostic phase, the most anteromedial part of the labrum was assessed. (B) A labral tear was identified, and a decision for anatomic labral repair was made. (C) Anatomic labral repair was performed using the controlled-tension anatomic technique with a circumferential looped configuration. (D) Traction was released, and anatomic labral–femoral head sealing was performed. A, acetabulum; FH, femoral head; L, labrum; *, 3-o'clock position, ɜ; 12-o'clock position; black arrows, knotless suture anchors.

parametricity of continuous outcomes, with $P > .05$ indicating a normal distribution. A paired 2-tailed t test was then used to compare preoperative and postoperative outcomes. Statistical significance was considered as $P < .05$.

RESULTS

Patient Demographics and Characteristics

The complete patient selection process is detailed in Figure 1. There were 309 (81.3%) hips that met the inclusion criteria. The patient cohort consisted of 211 (68.3%) female and 98 (31.7%) male hips, and the mean age was 36.2 years (range, 12.8-75.9 years) (Table 1). The mean ± SD follow-up period is 30.59 months ± 6.38. According to the radiographic findings, the mean preoperative LCEA was 31.9°, and the mean preoperative alpha angle was 57.1° (Table 2).

TABLE 1
Patient Demographics and Characteristics[a]

	Eligible After Exclusion Criteria (n = 380 Hips)	At Minimum 2-Year Follow-up[b] (n = 309 Hips)
Side, n (%)		
Left	184 (48.4)	152 (49.2)
Right	196 (51.6)	157 (50.8)
Sex, n (%)		
Female	251 (66.1)	211 (68.3)
Male	129 (33.9)	98 (31.7)
Age at surgery, y	34.7 ± 13.6 (12.8-76.5)	36.2 ± 14.5 (12.8-75.9)
Body mass index, kg/m^2	26.3 ± 4.4 (15.1-48.1)	25.8 ± 4.9 (16.4-47.3)

[a]Data are shown as mean ± SD (range) unless otherwise indicated.
[b]The mean ± SD follow-up is 30.59 months ± 6.38.

TABLE 2
Preoperative Radiographic Measurements

	Mean ± SD
Lateral center-edge angle, deg	31.9 ± 4.9
Alpha angle, deg	57.1 ± 11.7
Anterior center-edge angle, deg	32.4 ± 6.9

TABLE 3
Intraoperative Findings[a]

	n (%)
Seldes type	
0	0 (0.0)
I	98 (31.7)
II	61 (19.7)
I and II	150 (48.5)
ALAD grade	
0	42 (13.6)
1	106 (34.3)
2	95 (30.7)
3	59 (19.1)
4	7 (2.3)
Outerbridge grade (acetabulum)	
0	46 (14.8)
1	104 (33.6)
2	88 (28.4)
3	48 (15.5)
4	23 (7.4)
Outerbridge grade (femoral head)	
0	283 (91.6)
1	0 (0.0)
2	8 (2.6)
3	8 (2.6)
4	10 (3.2)
LT percentile (Domb classification)	
0 (0%)	217 (70.2)
1 (0%-<50%)	50 (16.2)
2 (50%-<100%)	32 (10.4)
3 (100%)	10 (3.2)
LT class (Villar classification)	
0 (no tear)	217 (70.2)
1 (complete tear)	10 (3.2)
2 (partial tear)	43 (13.9)
3 (degenerative tear)	39 (12.6)

[a]ALAD, acetabular labrum articular disruption; LT, ligamentum teres.

Intraoperative Findings and Surgical Procedures

The intraoperative findings and procedures performed are provided in Tables 3 and 4, respectively. The largest proportion of patients had combined Seldes type I and II tears, ALAD cartilage damage of grade 1, acetabular Outerbridge defect of grade 1, and no femoral head defects. In addition to undergoing anatomic labral repair, 245 (79.3%) patients underwent capsular repair, and 64 (20.7%) patients underwent capsulotomy without repair. All patients underwent femoroplasty, and 290 (93.9%) underwent minimal rim trimming or acetabuloplasty. The mean traction time for this cohort was 53.5 minutes.

TABLE 4
Intraoperative Procedures Performed

	n (%) or mean ± SD
Labral repair	309 (100.0)
Capsular repair	245 (79.3)
Capsulotomy without repair	64 (20.7)
Rim trimming/acetabuloplasty	290 (93.9)
Femoroplasty	309 (100.0)
Acetabular microfracture	21 (6.8)
Femoral head microfracture	6 (1.9)
Ligamentum teres debridement	22 (7.1)
Traction time, min	53.5 ± 17.8

TABLE 5
Patient-Reported Outcomes at Baseline and Minimum 2-Year Follow-up[a]

	Preoperative	Postoperative	*P* Value
mHHS	62.6 ± 15.7 (60.9-64.4)	86.9 ± 16.2 (85.1-88.7)	**<.001**
NAHS	63.1 ± 16.7 (64.9-61.2)	86.1 ± 16.7 (84.2-88.0)	**<.001**
HOS-SSS	39.8 ± 22.0 (37.3-42.3)	74.2 ± 27.3 (71.1-77.2)	**<.001**
iHOT-12	36.7 ± 20.3 (34.5-39.0)	77.6 ± 24.5 (74.9-80.4)	**<.001**
SF-12 mental	51.4 ± 10.5 (50.2-52.5)	55.4 ± 8.5 (54.4-56.3)	**<.001**
SF-12 physical	36.7 ± 9.3 (35.6-37.7)	49.2 ± 9.3 (48.2-50.3)	**<.001**
VR-12 mental	54.0 ± 10.0 (52.9-55.1)	60.1 ± 8.5 (59.1-61.0)	**<.001**
VR-12 physical	38.9 ± 9.7 (37.8-40.0)	50.7 ± 8.8 (49.7-51.6)	**<.001**
VAS	5.0 ± 2.3 (4.7-5.2)	2.0 ± 2.4 (1.7-2.2)	**<.001**
Patient satisfaction	—	8.1 ± 2.4 (7.9-8.4)	—

[a]Data are shown as mean ± SD (95% CI). Bold values indicate statistical significance ($P < .05$). HOS-SSS, Hip Outcome Score–Sport-Specific Subscale; iHOT-12, International Hip Outcome Tool; mHHS, modified Harris Hip Score; NAHS, Nonarthritic Hip Score; SF-12, Short Form–12; VAS, visual analog scale; VR-12, Veterans RAND 12-Item Health Survey.

Patient-Reported Outcomes

With respect to the mHHS, NAHS, HOS-SSS, and VAS, the mean improvement from before to after surgery achieved statistical significance ($P < .001$ for all) (Table 5 and Figure 5). On average, patients demonstrated a favorable mHHS score postoperatively (86.9 ± 16.2). The NAHS score improved from 63.1 ± 16.7 to 86.1 ± 16.7, and the HOS-SSS score improved from 39.8 ± 22.0 to 74.2 ± 27.3. In addition, patients exhibited significant improvement in iHOT-12, SF-12 mental, SF-12 physical, VR-12 mental, and VR-12 physical scores ($P < .001$ for all). The mean patient satisfaction with surgery was 8.1 of 10.

Table 6 shows the proportion of patients who achieved the MCID and PASS for the mHHS, HOS-SSS, and iHOT-12 according to the literature.[10,40,46] There were 243 (78.6%) patients who achieved the MCID and 254

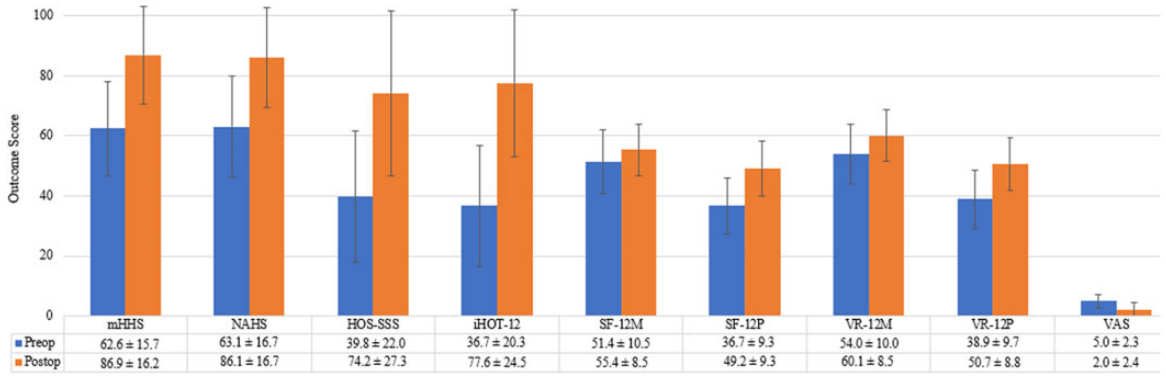

Figure 5. Patient-reported outcomes at baseline and minimum 2-year follow-up. $P < .001$ for all postoperative scores (Postop) with respect to baseline values (Preop). HOS-SSS, Hip Outcome Score–Sport-Specific Subscale; iHOT-12, International Hip Outcome Tool; mHHS, modified Harris Hip Score; NAHS, Nonarthritic Hip Score; SF-12 M, Short Form–12 mental; SF-12 P, Short Form–12 physical; VAS, visual analog scale; VR-12 M, Veterans RAND 12-Item Health Survey mental; VR-12 P, Veterans RAND 12-Item Health Survey physical.

TABLE 6
MCID and PASS[a]

	n (%)
mHHS	
MCID (8 points)	243 (78.6)
PASS (score of 74)	254 (82.2)
HOS-SSS	
MCID (6 points)	188 (60.8)
PASS (score of 75)	216 (69.9)
iHOT-12	
MCID (13 points)	239 (77.3)

[a]HOS-SSS, Hip Outcome Score–Sport-Specific Subscale; iHOT-12, International Hip Outcome Tool; MCID, minimal clinically important difference; mHHS, modified Harris Hip Score; PASS, patient acceptable symptomatic state.

(82.2%) patients who achieved the PASS for the mHHS. Further, there were 188 (60.8%) who achieved the MCID and 216 (69.9%) who achieved the PASS for the HOS-SSS. In addition, there were 239 (77.3%) patients who met the MCID for the iHOT-12 at latest follow-up.

Secondary Surgery and Conversion to Total Hip Arthroplasty

There were 21 (6.8%) patients who required subsequent revision arthroscopic surgery and 8 (2.6%) patients who converted to total hip arthroplasty at latest follow-up.

DISCUSSION

This study demonstrates that at minimum 2-year follow-up, labral repair using the knotless controlled-tension anatomic technique is a safe and viable option when addressing labral tears in the setting of FAIS. On average, the postoperative mHHS, NAHS, HOS-SSS, and iHOT-12 scores exhibited improvement from their preoperative values ($P < .001$ for all). The MCID and PASS were more likely achieved for the mHHS (78.6% and 82.2%, respectively) than for the HOS-SSS (60.8% and 69.9%, respectively) and iHOT-12 (77.3% for MCID only). Favorable VR-12 and SF-12 scores were also achieved postoperatively and were significantly superior to preoperative scores ($P < .001$ for all). Patients also experienced less pain postoperatively (2.0 ± 2.4 vs 5.0 ± 2.3 preoperatively) and were overall very satisfied, with a mean satisfaction of 8.1 of 10. With the development of novel arthroscopic hip techniques came a shift in the rationale for restoration over debridement of the acetabular labrum.[18,34,43] Clinical outcomes have since supported this change over the past decade, as PROs for debridement have been shown to be inferior to those for repair.[7,35,37,49,62]

Aside from knot-tying versus knotless labral repair, historically there have been several options on how labral repair can be performed arthroscopically. Both the simple looped stitch and labral base repair, with single or vertical mattress stitches, strive to restore anatomy and function and are dependent on the fit of the labrum on the femoral head (sealing mechanism).[23,24] Nevertheless, pitfalls can occur with these labral repair configurations, such as labral overcompression (looped), triangular cross-sectional anatomy distortion, labral eversion, or intrasubstance labral tearing (labral base) (Figure 6).[18] Furthermore, insufficient labral tissue in small or hypotrophic labra may not sustain a base repair configuration.[24] To overcome these situations, the controlled-tension labral anatomic concept with the use of knotless technology emerged as a solution.[18,71] The ability to control the amount of force or tension applied to the repair construct allows the surgeon to restore the anatomic position of the labrum in a circumferential or labral base configuration (Figure 7).[71] The findings of the ongoing study demonstrated the reproducibility and consistency of this principle.

To date, there are few studies that report PROs after solely using knotless technology for the management of labral tears in the hip.[2] Instead, many studies have focused

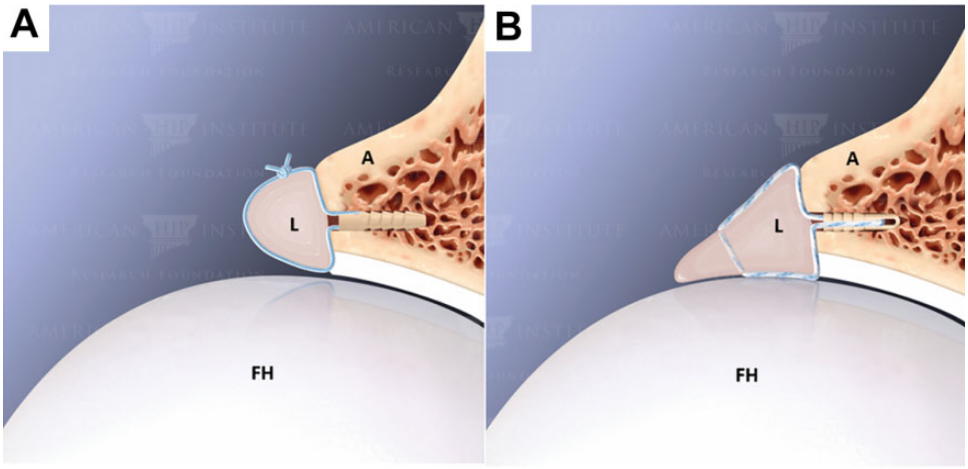

Figure 6. The anatomic labral base repair technique. (A) A simple circumferential stitch around the labrum (L) may cause unwanted bunching of the labrum and disruption of the suction seal. (B) Labral base refixation involves passing the suture through the labrum, which may eliminate bunching while securing the suction seal. A, acetabulum; FH, femoral head.

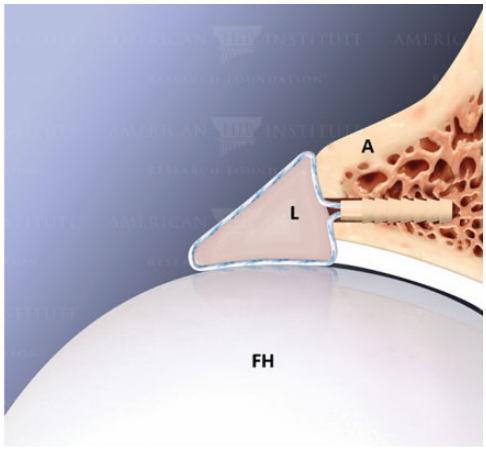

Figure 7. The knotless controlled-tension anatomic technique. The knotless suture anchor is placed in the acetabular rim. After applying appropriate tension, the cross-sectional anatomy of the labrum (L) is preserved. A, acetabulum; FH, femoral head.

on arthroscopic knot-tying and knotless suture anchor techniques in the upper extremity.[22,25,73] These techniques are used for Bankart and superior labrum from anterior to posterior (SLAP) tear repair in shoulder arthroscopic surgery, in which knotless anchor technology has shown favorable results.[52,61] However, Safran et al[66] recently reported their results after comparing the biomechanics of different knotless anchor models. The exact physiological loads on hip labral repair are unknown, making it difficult to evaluate the superiority of one anchor over another in a clinical setting.[66] Most of the available data regarding suture anchor technology in the acetabular labral tear scenario are either purely theoretical, such as the principle that we describe in Figure 7, or are based on cadaveric or polyurethane foam test blocks.[21,64,66] Nonetheless, Rhee et al[62] published a prospective study in which they examined 37 hips (33 patients; 7 bilateral procedures; 3 lost to follow-up) that were randomized into 2 groups to undergo either a knot-tying (19 hips) or knotless (18 hips) suture technique to repair the labrum. The mean follow-up time was 32.3 months for the knotless group and 31.8 months for the knot-tying group. The authors reported no additional surgery or progression of arthritic changes, with the survival rate being 100% (defined as no reoperation or progression to arthritis). When comparing PROs between the knot-tying and knotless suture anchor groups, Rhee et al found no significant differences; further, the scores at final evaluation all improved compared with preoperatively.

The knot-tying suture technique for labral repair is noted to be much more difficult and requires a steeper learning curve than the knotless suture anchor technique.[38] Sutures can be bulky and difficult to handle with arthroscopic instruments, even for the well-seasoned arthroscopic surgeon.[29] Using knotless anchors removes this difficulty from the procedure.[2] The use of knotless suture anchors is a safe alternative to other labral repair techniques and makes a difficult procedure more reproducible while also resulting in equivalent PROs.[48] Nonetheless, more studies are required to determine whether knotless technology should become the gold standard in arthroscopic hip labral repair.

Strengths

There are several strengths to this study. To our knowledge, the current study is one of the few to report outcomes at minimum 2-year follow-up in a large case series using exclusively knotless technology with the controlled-tension anatomic technique for arthroscopic primary hip labral repair. In addition, prospective data collection limited selection and recall bias. The validity and generalizability of the results were increased by using multiple validated functional hip outcome tools specific to nonarthritic hips

and to overcome ceiling effects.[31,33] By excluding hip dysplasia, the potential confounding effect of this important variable was eliminated.[3,44] Furthermore, stepping forward from statistical to clinical significance, the proportion of patients who achieved the PASS and MCID for the mHHS, HOS-SSS, and iHOT-12 were also calculated.[30]

Limitations

This ongoing study has limitations that must be disclosed. First, this was a nonrandomized study; as such, confounding variables may have influenced the results. Second, with no control (knot-tying) group, we cannot conclude that this technology is superior to knot-tying or other knotless alternatives. Labral repair using knot-tying anchors has never been a part of the senior author's practice in the past. Third, this study included data from a single high-volume hip preservation surgeon's practice, and results may be not reproducible in low-volume hands.[48] Fourth, the labral treatment decision was based on the senior author's expertise and experience, which may introduce bias.[18] Fifth, although this was a minimum 2-year follow-up study, a longer follow-up is still required to determine the durability of the findings. Sixth, because revision surgery and conversion to total hip arthroplasty were considered endpoint outcomes, the postoperative scores for these patients were not included in the PRO analysis. Seventh, the patient cohort included in the present study was relatively heterogeneous from a demographic standpoint and also in terms of intraoperative procedures performed, which may have introduced confounding variables to the results. Eighth, a further limitation is that generalized ligamentous laxity was not considered in this analysis.[65]

CONCLUSION

In the setting of FAIS and labral tears, patients who underwent hip arthroscopic surgery for labral repair using the knotless controlled-tension anatomic technique demonstrated significant improvement in several validated PRO measures, the VAS, and patient satisfaction at a minimum 2-year follow-up. Based on this evidence, labral repair using the knotless controlled-tension anatomic technique seems to be a safe option.

A Video Supplement for this article is available at http://journals.sagepub.com/doi/suppl/10.1177/2325967120935079.

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