Research Article

Mid-term Patient-reported Outcomes of Hip Arthroplasty After Previous Hip Arthroscopy: A Matched Case-control Study With a Minimum 5-year Follow-up

Philip J. Rosinsky, MD
Jeffrey W. Chen, BA
Jacob Shapira, MD
David R. Maldonado, MD
Ajay C. Lall, MD, MS
Benjamin G. Domb, MD

Abstract

Background: Previous hip arthroscopy may affect the outcomes of subsequent hip arthroplasty. The purpose is to compare mid-term patient-reported outcomes (PROs) and complication rates in patients who had previous ipsilateral hip arthroscopy (PA) with those without a previous surgery.

Methods: A minimum 5-year PROs, complications, and revision surgery rates were compared between total hip arthroplasty (THA) recipients who received PA and those without. Available intraoperative findings, procedures, and conversion time of arthroscopies were reported. The relative risk (RR) of complications and revision THAs were reported. A Kaplan-Meier analysis assessed survivorship of revision THA.

Results: There were 34 cases (33 patients) of PA that were matched to 89 control cases (87 patients). Both cohorts reported similar scores for Harris hip score, Forgotten Joint Score, pain, and patient satisfaction. No differences in the outcomes were found based on the arthroplasty approach. A higher postoperative complication rate {RR, 2.617 (95% confidence interval [CI], 0.808 to 8.476)} and revision THA rate (RR, 13.088 [95% CI, 1.59 to 107.99]) were found in the PA group.

Conclusion: Patients with PA demonstrated similar levels of PROs as those without previous ipsilateral hip arthroscopy. There may, however, be a higher rate of complications and revision surgery in the PA group.

Level of Evidence: III

From the American Hip Institute, Des Plaines, IL.

Correspondence to Dr. Domb: DrDomb@americanhipinstitute.org

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Hip arthroscopy for the treatment of the nonarthritic adult hip is one of the most rapidly growing surgical procedures in the field of orthopaedic sports medicine. One study found a 500% increase in cases performed between 2005 and 2013.[1] Two recent randomized controlled trials comparing hip arthroscopy with the best available conservative treatment in the management of femoroacetabular (FAI) found superior outcomes for surgical intervention.[2,3] Critical evaluation of the literature has shown that the success of hip arthroscopy is heavily dependent on proper patient indications.[4]

Multiple high-volume hip preservation institutions have identified preoperative variables, such as advanced age, increased body mass index, and revision procedures as negative

Table 1

Clavien-Dindo Classification

Classification	Grade
Grade I	Deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions. Treated by therapeutic regimens: drugs as antiemetics, antipyretics, analgesics, diuretics, and electrolytes and physiotherapy.
Grade II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications.
Grade III	Requiring surgical, endoscopic, or radiological intervention
IIIa	Intervention not under general anesthesia
IIIb	Intervention under general anesthesia
Grade IV	Life-threatening complication
IVa	Single organ dysfunction
IVb	Multiorgan dysfunction
Grade V	Death of a patient

predictors of postoperative patient-reported outcomes (PROs) after hip arthroscopy.[5-9] Similarly, prolonged duration of symptoms, decreased preoperative joint space, increased Tönnis grade, and advanced articular cartilage damage have all been shown to portend worse outcomes.[10-12] However, even with appropriate indications, a percentage of patients will continue to experience advancing articular cartilage disease, necessitating further surgical interventions such as hip arthroplasty.

Total hip arthroplasty (THA) is the most common revision surgery after THA, with rates of up to 10% by 2 years and up to 34% by 10 years.[8,13-16] The risk for conversion to THA markedly increases with increased age and in the presence of preexisting cartilage damage.[15,17-19] Although multiple studies have reported on the conversion rate to THA, there is a paucity of literature evaluating the outcomes of these conversions regarding PROs and their postoperative complications. Short-term (minimum 2 years) studies have been published with conflicting findings, and a systematic review of these found that although PROs are equivalent to patients without a history of arthroscopy, there may be a higher risk of dislocations and infections.[20-28] To our knowledge, no previous mid-term (minimum 5 years) studies have examined this cohort of patients.

The aim of this study was to compare the 5-year PROs and complication rates for patients who underwent hip arthroplasty with histories of ipsilateral hip arthroscopy with those of a matched cohort of primary THA patients. Our null hypothesis was that the outcome scores and complication rates would be similar.

Methods

Participation in the American Hip Institute Hip Replacement Registry

Although the present study represents novel findings, data on some

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Table 2

Demographics of Matched Cohorts of Study

Measurement	Matched Control	Previous Arthroscope	*P*
No. of hips (patients)	89 (87)	34 (33)	
Sex—n (%)			
Female	54 (61)	21 (62)	0.924
Male	35 (39)	13 (38)	
Side—n (%)			
Left	39 (44)	18 (53)	0.481
Right	50 (56)	16 (47)	
Approach—n (%)			
Anterior	26 (29)	10 (29)	0.842
Posterior	63 (71)	24 (71)	
Age at surgery (yr)	53.55 ± 6.79 (50.96-56.13)	55.69 ± 8.16 (53.96-57.42)	0.304
Body mass index (kg/m^2)	28.99 ± 3.84 (27.53-30.45)	29.26 ± 5.46 (28.10-30.42)	0.768
Follow-up time (mo)	72.57 ± 11.14 (68.25-76.89)	71.74 ± 13.58 (68.84-74.63)	0.637

patients may have been reported in previous studies by our institution. All data collection received Institutional Review Board approval.

Study Cohort

Patients who received THA from senior surgeons (BGD) during the period of May 2008 to December 2013 were considered for this study. Based on chart reviews, patients with histories of previous ipsilateral hip arthroscopy were included in the study group. Workers' compensation and unwilling patients were excluded. Patients who were deceased or received revision THAs were noted.

Outcome Measures

Patients who received bilateral treatments were evaluated independently with separate sets of questionnaires. Patient-reported outcomes, postoperative complications, and revision surgery rates were collected at clinic visits by encrypted electronic questionnaires or by telephone. Patients who received revision THAs before the recorded 5-year follow-up were excluded from analysis of PROs. Complications were graded by the Clavien-Dindo classification,[29] which has been validated for patients undergoing hip surgery[30] (Table 1).

Matching and Statistical Analysis

The previous arthroscopy (PA) group was matched in 1:3 manner on the logit of the propensity score of patients without histories of ipsilateral hip arthroscopies, taking into consideration the covariates: age at surgery, sex, body mass index, laterality, and surgical approach. A nearest-neighbor algorithm was used to match patients, with a caliper set to 0.5.[31] Observations beyond the region of common support were not included in the analyses. For hypothesis testing, the Shapiro-Wilk test assessed normality, followed by either an F-test or Bartlett test to check equality of variances. A Student *t*-test or its nonparametric equivalent was used to compare two samples. The chi-squared test was used for categorical variables. Continuous variables are reported as means and SDs with 95% confidence intervals (CIs).

An a priori power analysis indicated that to detect an effect size of 10 points at an alpha of 0.05, power of 0.80, and SD of 15, 24 and 72 patients were needed in the two groups.

Survivorship Analysis

Survivorship was assessed with Kaplan-Meier analysis. Two more curves were created for revision THA for both the PA and matched control (MC) cohorts. The log-rank test was used to compare the survival distributions of the two samples. Kaplan-Meier curves are accompanied by 95% exponential Greenwood CIs.

Surgical Technique

Patients who experienced advanced osteoarthritis and notable pain that hindered daily activity were selected for THAs. All THAs were performed by the senior author (BGD). TraumaCad software (TraumaCAD, Voyant Health) assisted in calculating offset, measuring leg-length discrepancies, and templating implants. During this study period, the senior author transitioned from a posterolateral to an anterior approach as the preferred surgical approach for THA. All THAs were performed using a noncemented cup with polyethylene liner (Trinity; Corin), noncemented stem (MetaFix;

Table 3

Intraoperative Findings and Procedures in Previous Arthroscopy Group

Findings	n (%)
Seldes tear type	
I	10 (34.5)
I&II combined	12 (41.4)
II	7 (24.1)
Acetabular labral articular damage	
1	2 (6.9)
2	5 (17.2)
3	9 (31)
4	13 (44.8)
Acetabular outerbridge	
0	0 (0)
1	2 (6.9)
2	4 (13.8)
3	10 (34.5)
4	13 (44.8)
Femoral head outerbridge	
0	9 (31)
1	1 (3.4)
2	7 (24.1)
3	9 (31)
4	8 (27.6)
Procedures	
Capsular repair	4 (27.6)
Capsule release	25 (86.2)
Greater trochanteric pain treatment	5 (17.2)
Iliopsoas fractional lengthening	2 (6.9)
Acetabuloplasty	11 (37.9)
Microfracture	8 (27.6)

CorinK), and a ceramic head (BIOLOX delta; CeramTec).

Rehabilitation Protocol

Patients were recommended home physical therapy and nursing care recovery for two weeks after their respective procedures. Hip precautions were provided for all patients depending on the surgical approach. These were advised for at least 6 weeks postoperatively. In addition, for patients undergoing a posterior THA, an abduction pillow was recommended for 6 weeks postoperatively. Outpatient physical therapy lasted an additional 6 weeks.

Results

Demographics and Outcome Comparisons

During the study period, 258 THAs were performed, 43 of which had previous ipsilateral hip arthroscopy. There were 14 workers' compensation cases excluded, none of which were cases with previous ipsilateral arthroscopies. Thirty-six of 43 (83.7%) patients with previous ipsilateral hip arthroscopy had a minimum 5-year follow-up, whereas 165 (82.1%) of 201 THAs without PA had follow-up. One patient who had PA was deceased, and five patients without PA were deceased. Matching was successfully applied to 34 hips in the PA group and 89 hips in the PA group. The patients who were not matched were outside of the region of common support and excluded from the study (Figure 1).

The follow-up times for the PA and MC groups were not significantly different (72.57 ± 11.14 versus 71.74 ± 13.58 months, $P = 0.637$). Demographic data were presented in Table 2.

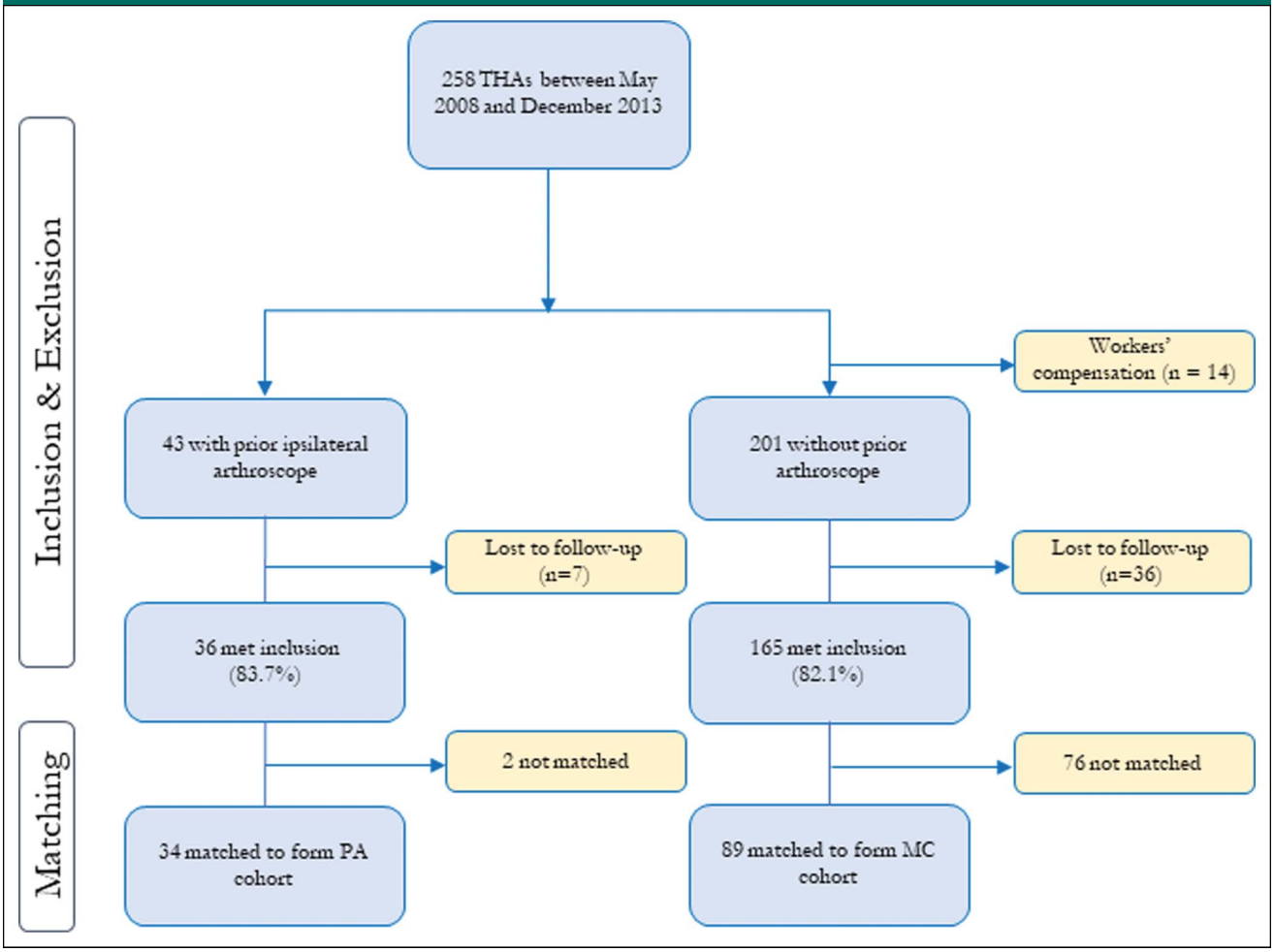
Previous Arthroscopy

Twenty-eight patients underwent PA by the senior author (BGD), a surgeon with extensive experience in hip preservation surgery, and six patients at outside facilities. Previous arthroscopy surgical reports were available for 29 PA patients (85.3%). The indications for arthroscopy were FAI and labral tears in all patients, and in five patients, concomitant greater trochanteric pain syndrome. For these patients, intraoperative findings and procedures performed during arthroscopy are reported. The age at time of arthroscopy of these patients was 51.17 ± 7.22 years. The reported prearthroscopy modified Harris Hip Score (mHHS) was 55.8 ± 14.83. Intraoperative procedures performed during arthroscopy were presented in Table 3. Eight patients received microfracture treatment of cartilage defects of the acetabular or femoral head. Four patients received capsular repairs, whereas 25 had capsular releases. Five patients were treated for greater trochanteric pain and two required iliopsoas lengthening. The median conversion time from arthroscopy to arthroplasty was 17.61 ± 12.86 months.

Outcomes After Hip Arthroplasty

The two groups revealed comparable PROs for all measures (Figure 2 and Table 4). Both groups reported

Figure 1



Flow chart showing patient inclusion and exclusion in the study.

similar HHS, visual analog score for pain, satisfaction, Veterans Rand 12-item, and Short Form 12-item scores.

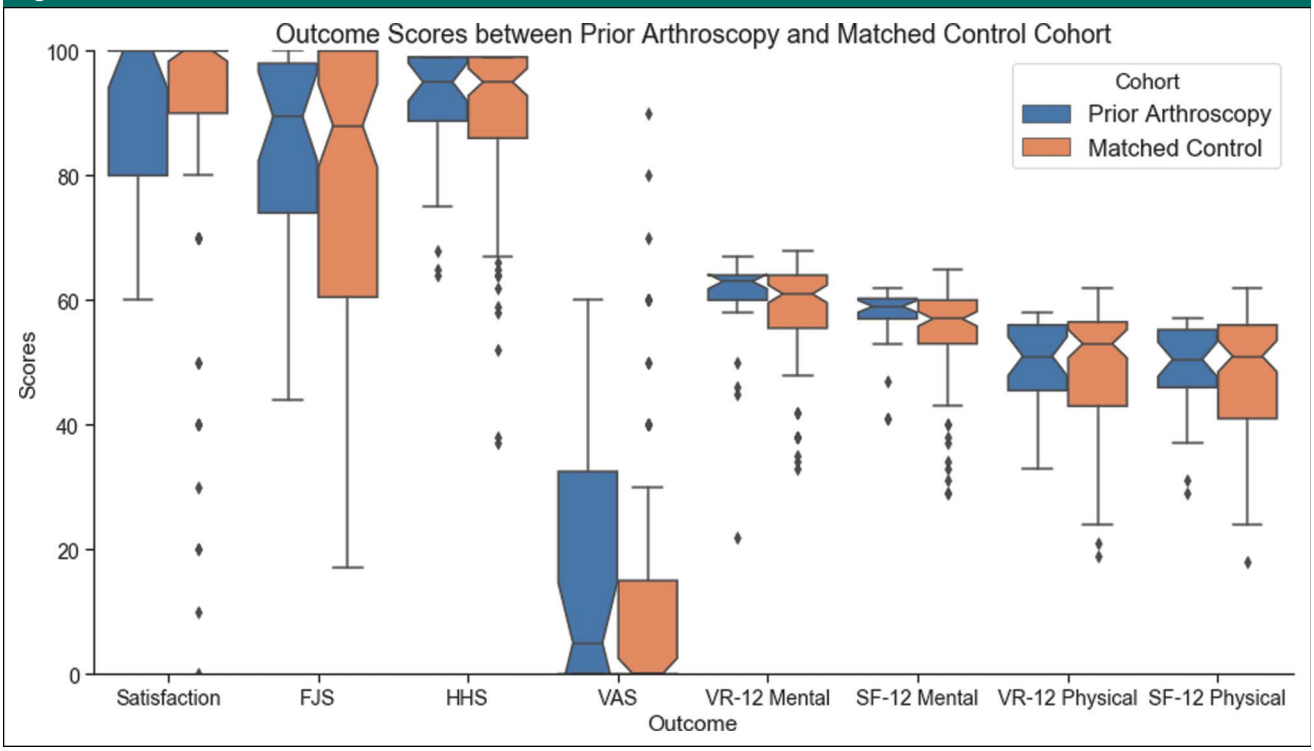
In the MC group, one hip required revision surgery due to infection. In the PA group, five hips required revision surgery due to infection (1), instability (2), leg-length discrepancy (1), and possible femoral implant loosening (1). The relative risk (RR) for revision THA in the PA group was 13.088 (95% CI, 1.59 to 107.99). Figure 3 shows the Kaplan-Meier curves for the two cohorts. The log-rank test indicated a significant difference between the curves (P = 0.0019). The time to revision in the PA cohort was 35.54 ± 19.47 months.

Complications were graded by the Clavien-Dindo classification. Besides the abovementioned complications leading to revisions, there were five additional complications in the MC group (grade I [mild] = 5) and five in the PA group (grade I [mild] = 5). The complications in the PA group consisted of thigh numbness (3), bladder infection (1), and leg-length discrepancy (1). In the MC group, the complications included intraoperative greater trochanter fracture treated with fixation (1), thigh numbness (2), iliopsoas impingement (1), and leg-length discrepancy (1). The RR for complications in the PA group was comparable with RR = 2.617 (95% CI, 0.808 to 8.476).

Analysis of Arthroplasty Approach

Both PA and MC patients were grouped by surgical approach, either direct anterior or posterior, and compared. The HHS, Forgotten Joint Score, visual analog score for pain, and satisfaction are shown in Figure 4, A–C. Notable differences were not found between the groups. Among the six revision THAs performed, only two from the PA group were anterior approach. The rest were posterior approaches.

Figure 2



Box-and-whisker plots of outcome scores at the minimum 5-year follow-up. The horizontal line within the box indicates the mean. Boundaries of the box indicate the first and third quartiles, and the whiskers are set to 1.5 time the inter-quartile range. The notch indicates the 95% confidence interval around the mean.[38] FJS = Forgotten Joint Score, HHS = Harris hip score, SF-12 = short form 12-item health survey, VAS = visual analog pain score, VR-12 = Veterans rand 12-item health survey

Table 4

Patient-reported Outcomes of PA Group Versus MC Group at Minimum 5-year Postoperative

Variable	PA	MC	*P*
HHS	90.79 ± 10.80 (86.60-94.97)	88.44 ± 14.20 (85.41-91.46)	0.559
FJS	83.32 ± 17.47 (76.55-90.09)	76.91 ± 26.38 (71.28-82.53)	0.145
VAS	15.36 ± 19.15 (7.93-22.78)	11.72 ± 21.31 (7.18-16.27)	0.155
Satisfaction	91.43 ± 13.25 (86.29-96.57)	87.47 ± 23.04 (82.56-92.38)	0.264
VR-12 mental	59.93 ± 9.28 (56.33-63.53)	58.66 ± 8.34 (56.88-60.43)	0.301
VR-12 physical	49.43 ± 6.87 (46.76-52.09)	49.02 ± 9.73 (46.95-51.10)	0.808
SF-12 mental	57.25 ± 5.49 (55.12-59.38)	54.67 ± 8.20 (52.92-56.41)	0.062
SF-12 physical	48.75 ± 7.39 (45.88-51.62)	47.51 ± 10.25 (45.32-49.69)	0.487

FJS = Forgotten Joint Score, HHS = Harris hip score, MC = matched control, PA = previous arthroscopy, SF-12 = Short Form 12-item Health Survey, VAS = visual analog score for pain, VR-12 = Veterans Rand 12-item Health Survey
All values are presented as means and SDs with 95% confidence intervals in brackets.

Discussion

To our knowledge, this study presents the first published series of PROs in patients with a minimum of 5-year follow-up after arthroplasty after previous ipsilateral hip arthroscopy. This study found comparable PROs between the PA and MC groups. Although complication rates were not markedly different, the revision THA rates were markedly higher in the PA group.

Previous short-term follow-up studies have examined the influence of previous hip arthroscopy on the outcomes of

subsequent THA and have reported conflicting results. Zingg et al[25] published the first series of 18 matched patients and found no difference in 1-year WOMAC scores or complication rates. Spencer-Gardner et al[24] conducted a matched study of 24 PA hips and found no notable differences in the HHS scores at 2 years. Parker et al[21] compared a cohort of 35 PA to a matched group and also found no differences in PROs at two years in addition to range of motion, complications, or survivorship. Charles et al[22] also found no differences in intraoperative and immediate postoperative measures. Finally, Haughom et al[26] performed a matched study on 42 hips and found no significant difference in absolute postoperative HHS. However, their control group did have a markedly larger improvement compared with preoperative HHS.

On the other hand, other authors have found inferior results in the short-term. Konopka et al[20] published 2-year outcomes in 64 patients, which is the largest series of patients to date. They reported lower outcome scores and lower satisfaction in the PA cohort. Perets et al[23] reported similar findings in a matched study with 35 PA patients. The authors reported lower postoperative HHS and Forgotten Joint Score relative to that of the matched group and higher complication and revision rates. Aside from PROs, Ryan et al[32] showed higher costs for patients undergoing conversion from arthroscopy to THA as opposed to patients undergoing primary THA. The possibility for higher complication rates, lower functional outcome scores, and added financial cost should all be taken into consideration in preoperative evaluation of a middle-aged patient before hip arthroscopy.

The most important finding of our study was the markedly higher revision rates in patients with a history of hip arthroscopy. Of the five patients undergoing revision THA, two patients underwent a revision because of instability, one patient because of residual pain and possible femoral implant loosening, one patient due to leg-length discrepancy, and one patient because of infection. Although the short-term studies did not find higher revision THA rates, in this study, all but one of the revisions occurred after the 2-year timeframe. Possible reasons for the higher rate of revision could be due to joint instability after compromise of the capsule and soft-tissue scarring, which may lead to persistent pain. In addition, overresection of the acetabulum in the treatment of pincer lesions may cause relative bony insufficiency, thereby compromising cup fixation. Finally, we must entertain the possibility of increased infection risk in someone with previous surgery.

Arthroscopy surgical reports and data were available for 29 patients in the PA group. Of this group, 25 patients had undergone capsular releases compared with four who had undergone repairs. Previous studies have shown higher rates of joint instability after capsular release.[33-35] This fact may contribute to the higher rate of revisions in the PA group because two of the revisions occurred due to instability and one for aseptic loosening, which may have occurred due to weakening of the stabilizing structures around the joint.

Werner et al[36] in a national registry study found higher infection rates in patients undergoing knee arthroplasty within 6 months of arthroscopy. In the present study, one revision THA was due to infection. This patient underwent the primary THA 21 months following hip arthroscopy.

To determine whether the THA approach could lead to divergent outcomes, patients were grouped by approach and compared within and between groups. In theory, each

Figure 3

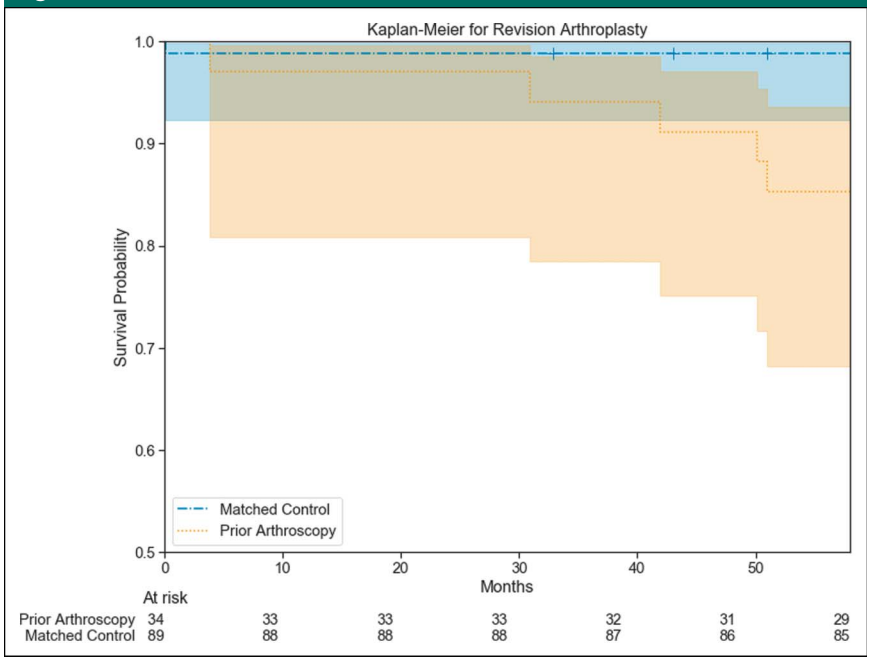
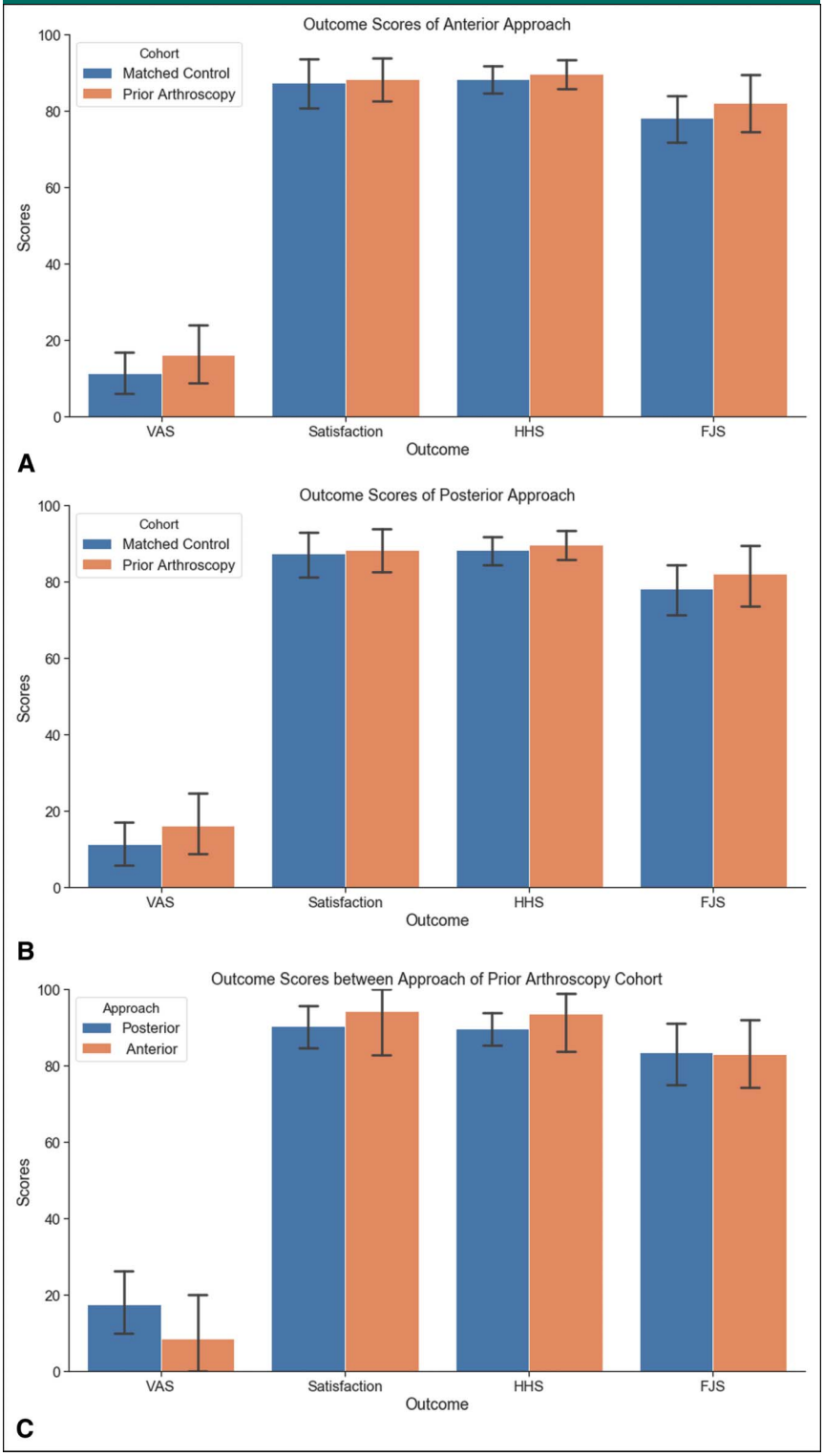


Chart showing the Kaplan-Meier curves of revision arthroplasties within the previous arthroscopy and matched control groups. The curve is accompanied by 95% confidence intervals.

Figure 4



Boxplots of outcome scores by surgical approach and study group. **A**, Outcome scores between approaches of previous arthroscopy patients, (**B**) outcome scores between the groups of posterior approach patients, and (**C**) outcome scores between the groups of anterior approach patients. FJS = Forgotten Joint Score, HHS = Harris hip score, VAS, visual analog pain score

approach has advantages and disadvantages in cases of previous ipsilateral surgeries. An anterior approach enters the joint through previously scarred soft tissue, which may lead to higher rates of infection and nerve damage. On the other hand, a posterior approach may damage the posterior capsule, rendering the joint susceptible to instability, both anteriorly and posteriorly. This is especially pertinent in cases in which the anterior capsule was released and not repaired during the initial surgery. Despite these potential concerns, we found no differences in the outcomes or rates of complications between the two groups.

It is important to note that this study was designed to primarily compare PROs. As such, a larger study may produce more conclusive findings regarding complication and revisions rates. In general, it is crucial to perform hip arthroscopy in a manner that will not cause tissue damage or incur tissue loss that complicates future surgical procedures. Recent improvements in hip arthroscopy have been made to minimize these risks. Some of the most important evolutions have been in preoperative evaluation with the introduction of imaging modalities such as delayed gadolinium-enhanced magnetic resonance imaging of cartilage, which provided for more accurate patient selection and reduced the need for early conversions to THA. On the side of surgical management, FAI treatment has shifted to emphasize more femoral side treatment. Specifically, the development of the spherical femoroplasty techniques[37] has sought to reduce the need for acetabular resection. Soft-tissue preservation, including labral reconstructions, and more importantly for this study, capsular preservation, and repair have improved outcomes and joint stability. The cases included in this study underwent hip arthroscopy during years when the development of these principals was taking place, which is reflected in the capsular management

in this cohort where nearly 90% of patients underwent releases.

The strengths of this study include the high mid-term follow-up rates at five years. In addition, this was a single-center study in which the senior author performed all the arthroplasties and many of the arthroscopies, thereby reducing performance bias. The completeness of data including surgical reports from both procedures and multiple PROs contribute to the ability to reach notable conclusions.

There are limitations to this study. First, an a priori power analysis was performed to assess the differences in PROs, but not for complication and revision rates. The size of the cohort limits the strength of the conclusions regarding complications and revisions and warrants larger studies including registry-based studies. Furthermore, the size of the PA cohort precludes the undertaking of a regression analysis to evaluate the effect of specific procedures performed during the index arthroscopy on the risk of THA complications and revisions. Second, a study centered on PROs is susceptible to subject recall bias. Third, although propensity score matching does control for confounding factors, it is inherently limited by the data recorded in the registry. Fourth, although we attempted to perform a subgroup analysis by surgical approach, dividing the groups into smaller subsets may leave the results underpowered. Finally, a single-center study limits generalizability of the conclusions.

Conclusion

This study reports on the 5-year outcomes of hip arthroplasty after previous ipsilateral hip arthroscopy. The results of this study show PROs at a minimum 5-year follow-up after THA for patients with a history of hip arthroscopy who are comparable with a MC group. There is, however, a concern for higher rates of complications and revision surgery in the PA group.

References

Levels of evidence are described in the table of contents. In this article, reference 5 and 6 are level I studies. Reference 24 is a level II study. References 1, 8, 9, 14-23, 31, and 32 are level III studies. Reference 2, 3, 4, 7, 10-13, and 27 are level IV studies.

References printed in **bold type** are those published within the past 5 years.

1. **Maradit Kremers H, Schilz SR, Van Houten HK, et al: Trends in utilization and outcomes of hip arthroscopy in the United States between 2005 and 2013. *J Arthroplasty* 2017;32:750-755.**
2. **Griffin DR, Dickenson EJ, Wall PDH, et al: Hip arthroscopy versus best conservative care for the treatment of femoroacetabular impingement syndrome (UK FASHIoN): A multicentre randomised controlled trial. *Lancet* 2018;391:2225-2235.**
3. **Palmer AJR, Gupta VA, Fernquest S, et al: Arthroscopic hip surgery compared with physiotherapy and activity modification for the treatment of symptomatic femoroacetabular impingement: Multicentre randomised controlled trial. *BMJ* 2019;364:l185.**
4. Saadat E, Martin SD, Thornhill TS, Brownlee SA, Losina E, Katz JN: Factors associated with the failure of surgical treatment for femoroacetabular impingement: Review of the literature. *Am J Sports Med* 2014;42:1487-1495.
5. **Mygind-Klavsen B, Lund B, Nielsen TG, et al: Danish hip arthroscopy registry: Predictors of outcome in patients with femoroacetabular impingement (FAI). *Knee Surg Sports Traumatol Arthrosc* 2019;27:3110-3120.**
6. **Domb BG, Martin TJ, Gui C, Chandrasekaran S, Suarez-Ahedo C, Lodhia P: Predictors of clinical outcomes after hip arthroscopy: A prospective analysis of 1038 patients with 2-year follow-up. *Am J Sports Med* 2018;46:1324-1330.**
7. **Stephan P, Röling MA, Mathijssen NMC, Hannink G, Bloem RM: Developing a risk prediction model for the functional outcome after hip arthroscopy. *BMC Musculoskelet Disord* 2018;19:122.**
8. **Degen RM, Pan TJ, Chang B, et al: Risk of failure of primary hip arthroscopy-a population-based study. *J Hip Preserv Surg* 2017;4:214-223.**
9. **Menge TJ, Briggs KK, Philippon MJ: Predictors of length of career after hip arthroscopy for femoroacetabular impingement in professional hockey players. *Am J Sports Med* 2016;44:2286-2291.**
10. Domb BG, Gui C, Lodhia P, et al: How much arthritis is too much for hip arthroscopy: A systematic review. *Arthroscopy* 2015;31:520-529.
11. Kemp JL, Makdissi M, Schache AG, Pritchard MG, Pollard TCB, Crossley KM: Hip chondropathy at arthroscopy: Prevalence and relationship to labral pathology, femoroacetabular impingement and patient-reported outcomes. *Br J Sports Med* 2014;48:1102-1107.
12. Egerton T, Hinman RS, Takla A, Bennell KL, O'Donnell J: Intraoperative cartilage degeneration predicts outcome 12 months after hip arthroscopy. *Clin Orthop* 2013;471:593-599.
13. Byrd JWT, Jones KS: Prospective analysis of hip arthroscopy with 10-year followup. *Clin Orthop* 2010;468:741-746.
14. Harris JD, McCormick FM, Abrams GD, et al: Complications and reoperations during and after hip arthroscopy: A systematic review of 92 studies and more than 6,000 patients. *Arthroscopy* 2013;29:589-595.
15. **Kester JW, Capogna B, Mahure SA, Ryan MK, Mollon B, Youm T: Independent risk factors for revision surgery or conversion to total hip arthroplasty after hip arthroscopy: A review of a large statewide database from 2011 to 2012. *Clin Orthop Relat Res* 2018;34:464-466.**
16. **Menge TJ, Briggs KK, Dornan GJ, McNamara SC, Philippon MJ: Survivorship and outcomes 10 years following hip arthroscopy for femoroacetabular impingement: Labral debridement compared with labral repair. *J Bone Joint Surg Am* 2017;99:997-1004.**
17. **Horner NS, Ekhtiari S, Simunovic N, Safran MR, Philippon MJ, Ayeni OR: Hip arthroscopy in patients age 40 or older: A systematic review. *Arthroscopy* 2017;33:464-475.e3.**
18. **Lei P, Conaway WK, Martin SD: Outcome of surgical treatment of hip femoroacetabular impingement patients with radiographic osteoarthritis: A meta-analysis of prospective studies. *J Am Acad Orthop Surg* 2019;27:e70-e76.**
19. Larson CM, Giveans MR, Taylor M: Does arthroscopic FAI correction improve function with radiographic arthritis? *Clin Orthop* 2011;469:1667-1676.
20. **Konopka JF, Buly RL, Kelly BT, Su EP, McLawhorn AS: The effect of prior hip arthroscopy on patient-reported outcomes**

after total hip arthroplasty: An institutional registry-based, matched cohort study. *J Arthroplasty* 2018;33:1806-1812.

21. Parker SJM, Grammatopoulos G, Davies OLI, Lynch K, Pollard TCB, Andrade AJ: Outcomes of hip arthroplasty after failed hip arthroscopy: A case-control study. *J Arthroplasty* 2017;32:3082-3087.e2.

22. Charles R, LaTulip S, Goulet JA, Pour AE: Previous arthroscopic repair of femoro-acetabular impingement does not affect outcomes of total hip arthroplasty. *Int Orthop* 2017;41:1125-1129.

23. Perets I, Mansor Y, Mu BH, Walsh JP, Ortiz-Declet V, Domb BG: Prior arthroscopy leads to inferior outcomes in total hip arthroplasty: A match-controlled study. *J Arthroplasty* 2017;32:3665-3668.

24. Spencer-Gardner LS, Camp CL, Martin JR, Sierra RJ, Trousdale RT, Krych AJ: Does prior surgery for femoroacetabular impingement compromise hip arthroplasty outcomes? *J Arthroplasty* 2016;31: 1899-1903.

25. Zingg PO, Schallberger A, Rüdiger HA, Poutawera V, Dora C: Does previous hip arthroscopy negatively influence the short term clinical result of total hip replacement? *Arch Orthop Trauma Surg* 2012;132: 299-303.

26. Haughom BD, Plummer DR, Hellman MD, Nho SJ, Rosenberg AG, Della Valle CJ: Does hip arthroscopy affect the outcomes of a subsequent total hip arthroplasty? *J Arthroplasty* 2016;31:1516-1518.

27. Nam D, Maher P, Nath T, Su EP: Does a prior hip arthroscopy affect clinical outcomes in metal-on-metal hip resurfacing arthroplasty? *Am J Orthop Belle Mead NJ* 2014;43:E255-E260.

28. Rosinsky PJ, Kyin C, Shapira J, Maldonado DR, Lall AC, Domb BG: Hip arthroplasty after hip arthroscopy: Are short-term outcomes affected? A systematic review of the literature. *Arthroscopy* 2019;35: 2736-2746.

29. Dindo D, Demartines N, Clavien PA: Classification of surgical complications: A new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 2004;240:205-213.

30. Sink EL, Leunig M, Zaltz I, Gilbert JC, Clohisy J: Reliability of a complication classification system for orthopaedic surgery. *Clin Orthop* 2012;470: 2220-2226.

31. Austin PC: Optimal caliper widths for propensity-score matching when estimating differences in means and differences in proportions in observational studies. *Pharm Stat* 2011;10:150-161.

32. Ryan SP, DiLallo M, Attarian DE, Jiranek WA, Seyler TM: Conversion vs primary total hip arthroplasty: Increased cost of care and perioperative complications. *J Arthroplasty* 2018;33:2405-2411.

33. Bayne CO, Stanley R, Simon P, et al: Effect of capsulotomy on hip stability-a consideration during hip arthroscopy. *Am J Orthop Belle Mead NJ* 2014;43:160-165.

34. Philippon MJ, Trindade CAC, Goldsmith MT, et al: Biomechanical assessment of hip capsular repair and reconstruction procedures using a 6 degrees of freedom robotic system. *Am J Sports Med* 2017;45: 1745-1754.

35. Wuerz TH, Song SH, Grzybowski JS, et al: Capsulotomy size affects hip joint kinematic stability. *Am J Orthop* 2016;32: 1571-1575.

36. Werner BC, Burrus MT, Novicoff WM, Browne JA: Total knee arthroplasty within six months after knee arthroscopy is associated with increased postoperative complications. *J Arthroplasty* 2015;30: 1313-1316.

37. Mansor Y, Perets I, Close MR, Mu BH, Domb BG: In search of the spherical femoroplasty: Cam overresection leads to inferior functional scores before and after revision hip arthroscopic surgery. *Am J Sports Med* 2018;46:2061-2071.

38. Chambers JM, Cleveland WS, Kleiner B, Tukey PA: *Comparing Data Distributions*, Belmont, CA, Wadsworth International Group, 1983.