Systematic Review

Hip Arthroplasty After Hip Arthroscopy: Are Short-term Outcomes Affected? A Systematic Review of the Literature

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Purpose: To systematically review the published literature regarding intraoperative measures, patient-reported outcomes, and complications of total hip arthroplasty (THA) in patients with or without a history of prior hip arthroscopy. **Methods:** PubMed and Cochrane Library databases were searched for all publications regarding patients who had undergone a THA after a prior ipsilateral hip arthroscopy. Included studies were comparative in nature and included postoperative outcome measures. Excluded studies were opinion articles, review articles, cadaveric studies, case reports, or technique articles. Patient demographics, surgical outcomes, complications, and patient-reported outcome measures (PROMs) were recorded. This study was performed at the American Hip Institute. **Results:** Eight studies were included in this systematic review. These included 305 hips with a THA following a prior hip arthroscopy, with 502 matched control hips. Mean time for conversion from prior hip arthroscopy was 23 months and mean follow up was 35.9 versus 36.1, for the prior arthroscopy and control groups respectively. No significant differences were found regarding intraoperative measures and PROMs. There was no difference in rate of revisions at latest follow up. However, there was a trend toward higher rates of dislocations and infections in the prior hip arthroscopy group. **Conclusion:** The short-term PROMs of those who underwent total hip arthroplasty with a prior history of an ipsilateral hip arthroscopy are comparable to those of patients undergoing primary THA. Although a conclusion could not be made regarding differences in complication rates between patients with a history of prior arthroscopy and patients undergoing primary THA, it is still imperative to consider the possible implications of a prior hip procedure on postoperative stability and infection rates. In summary, hip arthroplasty following a prior hip arthroscopy is a safe procedure with comparable short-term outcomes to primary arthroplasty. **Level of Evidence:** Level III, systematic review.

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In 2003, Ganz et al.[1] proposed femoroacetabular impingement as a cause of osteoarthritis, which ultimately led to increased interest in the potential applications of hip arthroscopy as a diagnostic and therapeutic tool for hip pathology.[2] The range of pathologies that can be treated by hip arthroscopy and endoscopy have also expanded within recent years to include intra- and extra-articular pathologies with the most common procedures being femoroplasty, acetabuloplasty and labral repairs.[3] Utilization rates of hip arthroscopy have increased consistently over the past decade from 3.6 patients per 100,000 in 2005 to 16.7 patients per 100,000 in 2013.[4]

Greater interest and understanding of surgical indications as well as the application of hip arthroscopy

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Table 1. Inclusion and Exclusion Criteria Used for Identifying Studies for Systematic Review

Inclusion Criteria	Exclusion Criteria
Comparative studies	Opinion articles
English language	Review articles
Evaluated both males and females	Cadaveric studies
Reported outcomes of total hip arthroplasty or resurfacing after a prior hip arthroscopy	Case reports
	Technique articles

has yielded promising results in terms of significant functional improvement and patient satisfaction in the general patient population, and high rates of return to play for athletes.[5-8] A subset of patients will continue to experience hip pain after undergoing hip arthroscopy, however, causing significant limitations in quality of life and activities of daily living.[9] Over time, if left untreated, these patients may also develop osteoarthritis.

Several studies have sought to evaluate this particularly challenging patient population, suffering from failed hip arthroscopy, and describe the rates of conversion to total hip arthroplasty (THA). Population and registry-based studies have reported a conversion rate of 9% to 11.7% at 2 years.[10-13] Studies have shown that the most important risk factor for conversion to THA is advanced arthritis, manifested as either higher Tönnis grade, reduced joint space, or intraoperatively observed high-grade cartilage damage at initial hip arthroscopy.[14-16] Other important risk factors for conversion to THA include initial surgery by less experienced surgeons, female gender, older age, and obesity.[10,11] Patients who are older than age 60 have demonstrated exceptionally high conversion rates of 17% to 35%.[11,17]

Because of the expanding role of hip arthroscopy as a treatment for hip pathologies coupled with the relatively high rate of conversion to THA in the over-50 age group, clinicians will inevitably encounter more cases of failed hip arthroscopy. Prior studies have been inconclusive in determining the immediate- and short-term outcomes of a previous arthroscopy on a subsequent THA. Some studies have shown that patients who undergo conversion to THA are more likely to experience worse outcomes, higher perioperative complication rates, and incur higher costs of care in comparison to patients undergoing hip replacement with no prior history of ipsilateral hip arthroscopy.[18-20] Conversely, other studies have shown comparable outcomes

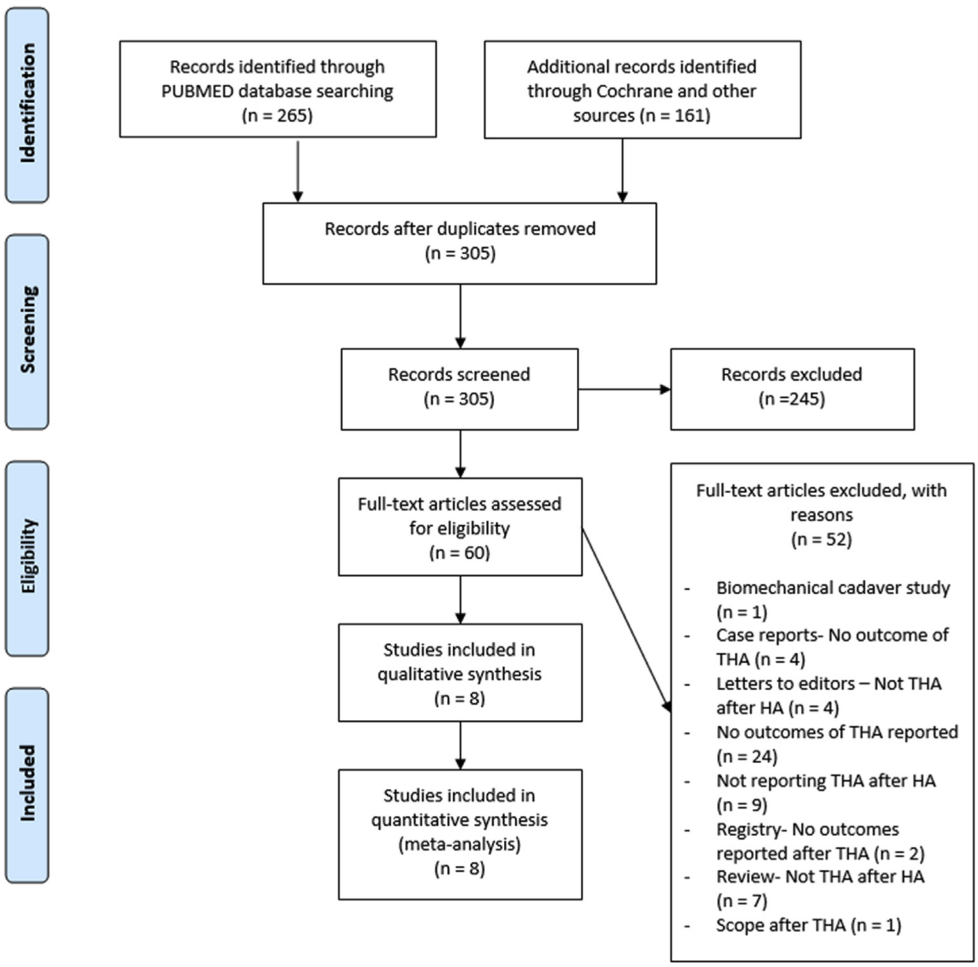

Fig 1. Flow diagram of literature search conducted in September 2018 by the Preferred Reporting Items for Systematic Reviews and Meta-analyses method. (HA, hip arthroplasty; THA, total hip arthroplasty.)

between the 2 groups.[21,22] The controversy within the literature highlights the importance of critically evaluating a patient's surgical history when considering conversion to THA after a prior hip arthroscopy.

The purpose of this study was to systematically review the published literature regarding intraoperative measures, patient-reported outcomes, and complications of THA in patients with or without a history of prior hip arthroscopy. We hypothesized that patients who underwent a THA with a history of prior ipsilateral hip arthroscopy would have inferior outcomes when compared with patients with no history of hip arthroscopy.

Methods

This systematic literature review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines.[23,24] In September 2018, 2 orthopaedic surgeons undergoing a hip preservation fellowship (P.J.R. and J.S.) performed a search of the PubMed/MEDLINE and Cochrane Library databases. The search was completed using the following terms: "hip joint," "hip," "arthroplasty," "hip replacement," "hip reconstruction," "resurfacing," "arthroscopic surgery," "arthroscopic surgical procedure," and "hip arthroscopy." The same reviewers then determined the relevancy of the articles found through the search by reviewing the title and abstract of each article. Eligibility for inclusion was then determined based on a full-text review of the articles. Additionally, references of the included articles were assessed for relevant studies.

Study Eligibility

Studies included in this systematic review were comparative studies that were written in English; evaluated both male and female patients; and reported outcomes of THA or resurfacing after a prior hip arthroscopy. Studies were excluded if they were opinion articles, review articles, cadaveric studies, case reports, or technique articles (Table 1). The overall selection process is summarized in Figure 1. If there were any discrepancies regarding the inclusion of an article, the article was reviewed together so that a final decision could be made. If a collective decision could still not be made, a third, more senior, author (B.G.D.) was included so a consensus could be reached.

Quality Assessment

Two orthopaedic surgeons undergoing a hip preservation fellowship (P.J.R. and J.S.) assessed each of the included articles for quality using the Methodological Index for Non-Randomized Studies (MINORS).[25] Any differences in scores were discussed among the reviewers, and a consensus was reached for final scoring. The level of evidence for the individual articles was designated based on the standard criteria.[26]

Table 2. Demographics of Included Studies

Study	Year	Journal	Level of Evidence	THA or HRA	Enrollment Patients (Hips)		Sex (M:F)		Age, y (SD or Range)		BMI, kg/m^2 (SD or range)		Mean Follow-up, Mo		Mean Time for Conversion (SD or Range)	Minors
					Arthroscopy	Control	Arthroscopy	Control	Arthroscopy	Control	Arthroscopy	Control	Arthroscopy	Control		
Charles et al.[22]	2017	*IO*	III	THA	39 (39)	39 (39)	14:25	14:25	42.4 ± 8.7	43.8 ± 9.1	31.6 ± 6.4	31.3 ± 6.1	52.4	50	—	21
Haughom et al.[28]	2016	*JA*	III	THA	42 (42)	84 (84)	18:24	36:48	51.2 ± 1.04	52.9 ± 11.1	27.5 ± 5.5	28.9 ± 4.2	39.6	36	21.6 ± 15.6	17
Konopka et al.[19]	2018	*JA*	III	THA and HRA	64 (69)	128 (128)	25:39	50:78	51.8 ± 9.7	54.0 ± 9.4	26.0 ± 4.3	26.2 ± 4.0	24	24	27.6 ± 24	19
Nam et al.[29]	2014	*AJO*	III	HRA	43 (43)	86 (86)	32:11	64:22	45.6 ± 7.5	46.2 ± 7.1	25.6 ± 3.3	25.6 ± 3.5	24 ± 12	25.2 ± 13.2	30	20
Parker et al.[21]	2017	*JA*	III	THA and HRA	35 (35)	70 (70)	8:27	23:47	46.7 (27-66)	49.3 (16-66)	—	—	54 (0-96)	72 (12-132)	22.8	19
Perets et al.[18]	2017	*JA*	III	THA	35 (35)	35 (35)	15:20	15:20	53.4 ± 7.1	53.7 ± 7.5	29.0 ± 3.8	28.4 ± 3.7	40.8 ± 16.9	39.4 ± 15.3	18.6	20
Spencer-Gardner et al.[30]	2016	*JA*	III	THA	23 (24)	24 (24)	12:11	13:11	42.6 (20-68)	45.7 (25-68)	30.2 (22.5-28.8)	30.3 (23.9-45.4)	33 (24-70)	33 (24-70)	12 (3-25)	22
Zingg et al.[31]	2012	*AOTS*	III	THA	18 (18)	36 (36)	5:13	10:26	46 (36-74)	50.4	23.9	24.7	24.4 ± 15.1	18.7 ± 13.2	16 (8-21)	19
Sum or average					305	502	129:170	225:277	48.2	50.4	27.6	27.3	35.9	36.1	23	19.6

AJO, The American Journal of Orthopedics; AOTS, Archives of Orthopaedic and Trauma Surgery; BMI, body mass index; F, female; *IO, International Orthopaedics; JA, Journal of Arthroplasty;* HRA, hip resurfacing arthroplasty; M, male; SD, standard deviation; THA, total hip arthroplasty.

Table 3. The Newcastle-Ottawa Scale for Nonrandomized Studies

Quality Assessment Criteria	Acceptable	Charles et al., 2016	Haughom et al., 2016	Konopka et al., 2018	Nam et al., 2014	Parker et al., 2017	Perets et al., 2017	Spencer-Gardner et al., 2016	Zingg et al., 2011
Selection									
Representativeness of exposed cohort?	Truly or somewhat representative of average adult in community (age/sex/being at risk of disease)	*	*	*	*	*	*	*	*
Selection of the nonexposed cohort?	Drawn from same community as exposed cohort	*	*	*	*	*	*	*	*
Ascertainment of exposure?	Secured records, Structured interview	*	*	*	*	*	*	*	*
Demonstration that outcome of interest was not present at start of study?	Yes	*	*	*	*	*	*	*	*
Comparability									
Study controls for age/sex?	Yes	*	*	*	*	*	*	*	-
Study controls for at least 3 additional risk factors?	Yes	— (BMI)	— (BMI)	— (ASA score and BMI)	* (Femoral head size [mm]; preoperative HHS and WOMAC, and BMI)	— (Prosthesis type)	* (BMI, approach, and use of MAKOplasty)	— (Surgical approach and implant used)	— (BMI and Charnley categories)
Outcome									
Assessment of outcome?	Independent blind assessment, record linkage	*	—	—	—	*	—	—	*
Was follow up long enough for outcome to occur?	Follow up >1 y	*	*	*	—	*	*	*	*
Adequacy of follow up of cohorts?	Complete follow up, or subjects lost to follow up unlikely to introduce bias	*	*	*	*	—	*	*	*
Overall assessment of bias; number of stars (maximum = 9)	8	7	7	7	7	8	7	7	

NOTE. *Acceptable.
ASA, American Society of Anaesthesiologists; BMI, body mass index; HHS, Harris Hip Score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

Table 4. Intraoperative Measures

Study	Operative Time, Min		Blood Loss, mL	
	Arthroscopy	Control	Arthroscopy	Control
Charles et al.[22]	133 ± 31	136 ± 39	616 ± 227	554 ± 275
Spencer-Gardener et al.[30]	—	88.0 ± 24.2	296 ± 143	304 ± 139
Zingg et al.[31]	**118 ± 31**	**166 ± 39**	625 ± 372	693 ± 287
Average	128 ± 31	135 ± 36	523 ± 248	543 ± 254

NOTE. Significant results are displayed in bold.

Additionally, the Newcastle-Ottawa Scale (NOS) was used to assess potential biases associated with the studies.[27] This assessment comprised 8 questions that were separated into 3 categories. The first category focused on how representative the cohorts were of the adult community. The second portion of the scale determined if the studies controlled for additional confounding variables. The third category assessed any bias that may have been associated with the way the outcomes were measured.

Data Extraction

The data from all the included studies were organized into Microsoft Excel (Microsoft, Redmond, WA). Data included the title, author, journal and date of publication, study design, number of patients and hips, demographic information, mean follow-up times, intraoperative findings, complication and revision rates, and preoperative and postoperative outcomes scores (Table 2).

Statistical Analysis

Aggregate data were weighted for individual study size and evaluated via Review Manager (RevMan), version 5.3. (Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014). The denominators for each of the studies were adjusted to appropriately reflect the number of hips rather than patients. Weighted means or overall rates were used to compare the prior arthroscopy and control groups. Weighted means were also calculated for demographic variables such as age, BMI, follow-up duration, and time until conversion to THA or hip resurfacing arthroplasty (HRA).

Results

Study Selection

Our initial search of the PubMed and Cochrane libraries yielded 426 studies (Fig 1). However, after removing duplicates, we were left with 305 articles. An additional 245 studies were excluded after abstract and title review. The remaining 60 articles underwent a full-text review; after applying the inclusion and exclusion criteria, 8 studies were included in the analysis. These final articles identified 801 participants with a total of 807 hips (305 prior arthroscopy hips vs 502 control hips). Of these studies, 5 focused solely on THA after a prior hip arthroscopy,[18,22,28,30,31] 1 study reported on conversion to HRA,[29] and the remaining 2 articles discussed both HRA and THA.[19,21]

Quality Assessment

All 8 comparative studies were retrospective case-control studies of prospectively collected data and were assigned a level of evidence III. The quality of each of these studies was evaluated by 2 independent reviewers (P.J.R., J.S.) using the MINORS criteria. On average, the studies yielded a score of 19.6 of 24 (range, 19-21) (Table 2). Regarding the NOS, the included studies demonstrated comparable results and had an average score of 7.25 ± 0.46. Table 3 summarizes the NOS final scores for the individual articles.

Demographic Data and Study Characteristics

Demographic information regarding sex, age, body mass index (BMI), follow-up duration, and time to conversion to THA or HRA for each study is reported in Table 2 in addition to their respective weighted averages. Overall, the prior hip arthroscopy and control groups included 305 hips (129 females vs 170 males) and 502 hips (225 females vs 277 males), respectively. The groups were well matched regarding age (48 vs 50 years), BMI (27.6 vs 27.3 kg/m^2), and follow-up duration (35.9 vs 36 months).

Intraoperative Measures

Of the 8 articles, Zingg et al.,[31] Spencer-Gardner et al.,[30] and Charles et al.[22] reported intraoperative data, and the 2 most common measures evaluated were average operative time and blood loss. Collectively, the 3 studies included a total of 180 cases (81 prior hip arthroscopy vs 99 control). When compared, the prior arthroscopy and control groups had comparable weighted average operative times of 128 ± 31 minutes and 135 ± 36 minutes, respectively. Spencer-Gardner et al.[30] did not report complete data for average operative time and subsequently could not be accounted for in the weighted average operative time for the prior arthroscopy group. Within the individual studies, Zingg et al.[31] was the only study to find a significant difference between the 2 groups, in which the control group had a substantially longer operative time than the prior arthroscopy group (166 ± 39 vs 118 ± 31 minutes [$P < .0001$]). Although this was statistically significant, the clinical relevance of this finding is unclear because it favors prior arthroscopy. Regarding blood loss, all 3 studies reported complete data, and the weighted averages for the prior arthroscopy and control groups were 523 ± 248 mL versus 543 ± 254 mL, respectively. A summary of the intraoperative data from all 3 studies can be found in Table 4.

Patient-Reported Outcomes

Collectively, the 8 studies reported on a large range of postoperative outcome measures; however, the most common patient-reported outcome measure was the Harris Hip Score (HHS). Altogether, HHS was used in 4 studies[18,21,28,29] that included a total of 430 hips (155 prior arthroscopy vs 275 control) with a mean follow up of 38.8 and 42.2 months, respectively. At latest follow up, both groups demonstrated an increase in mean weighted HHS scores with an improvement of 37.9 points (from 55.2 [range, 50.5-51.7] to 93.1 [range, 82.6-99.5]) for the prior arthroscopy group and 40.2 points (from 53.8 [range, 44.9-62.4] to 94.0 [range, 90.0-94.5]) for the control group. Within the individual studies, Perets et al.[18] surveyed a total of 70 patients (35 prior arthroscopy vs 35 control); this was the only study that found a significant difference in HHS scores between the prior arthroscopy and control group at latest follow up (82.6 ± 18.6 vs 90.0 ± 12.4 [P = .029]).

The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) measurement was used by Nam et al.[29] and Konopka et al.[19] and was the second most common patient-reported outcome overall. The 2 studies composed a total of 241 hips (112 prior arthroscopy vs 129 control) with a mean follow up of 24.0 and 24.5 months, respectively. Of these 2 studies, only Nam et al.[29] collected and reported preoperative WOMAC scores (56.4 ± 18.8 prior arthroscopy vs 53.6 ± 17.8 control [P = .4]). In comparison, the calculated weighted average WOMAC scores at latest follow up from the 2 studies demonstrated an increase of 30.6 and 37.6 points for each group at latest follow up with final scores of 87.0 ± 16.1 and 91.2 ± 14.6. Based on the Patient Acceptable Symptomatic State (PASS) threshold for WOMAC set by Naal et al.[32] (score of 85.6 at latest follow up), both the prior arthroscopy and control groups met PASS in Nam et al.'s[29] study and no significant differences were found at latest follow up. Regarding, Konopka et al.'s[19] study, only the control group met PASS. However, there was no significant difference in WOMAC scores at latest follow up. A summary of preoperative to latest follow-up PROs can be found in Table 5.

Complications, Future Operations, and Revision Hip Replacements

Complications were reported in all 8 studies with dislocation as the most frequently stated complication. Overall, dislocations were discussed in a total of 6 studies.[19,21,22,28,30,31] Collectively, dislocations occurred in 6 prior arthroscopy patients (2.45%) and 4 control patients (1.05%). The second most commonly noted complication was postoperative infection. In total, infection rates were reported on in 5 of the 8 studies.[18,22,28,29,31] In total, infections occurred in 5

Table 5. Patient-Reported Outcome Scores

Study	PROM	Preoperative (SD or Range)		PROM	1-Y Follow Up (SD or Range)		PROM	Latest Follow Up >1 Y (SD)	
		Arthroscopy	Control		Arthroscopy	Control		Arthroscopy	Control
Haughom et al.[28]	HHS	**51.7 ± 15.2***	**44.9 ± 8.5***	—	—	—	HHS	92.1 ± 10.9	90.1 ± 6.5
Konopka et al.[19]	—	—	—	—	—	—	WOMAC	83 ± 18.5	90.5 ± 16
Nam et al.[29]	HHS	62.6 ± 10.7	62.4 ± 9.3	HHS	97.7 ± 3.5	98.5 ± 1.6	HHS	99.5 ± 1.3	99.2 ± 9.7
	WOMAC	56.4 ± 18.8	53.6 ± 17.8	WOMAC	95.2 ± 9.9	95.0 ± 8.7	WOMAC	93.5 ± 11.3	92.4 ± 12.2
Parker et al.[21,†]	HHS	50.5 (30-71)	53.9 (24-87)	HHS	96.8 (93-100)	94.5 (50-100)	—	—	—
Perets et al.[18]	—	—	—	—	—	—	HHS	**82.6 ± 18.6***	**90.0 ± 12.4***
Spencer-Gardner et al.[30]	mHHS	56.2 ± 13.5	60 ± 22.6	—	—	—	mHHS	93.3 ± 9.1	95.2 ± 6.6
Average	HHS	55.2 ± 11.0	53.8 ± 7.5	HHS	97.3 ± 3.5	96.7 ± 1.6	HHS	92.0 ± 12.0	94.0 ± 9.1

HHS, Harris Hip Score; mHHS, modified Harris Hip Score; PROM, patient-reported outcome measure; SD, standard deviation; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

*Significant results are displayed in bold type.

†Parker et al. did not report SD.

patients (2.82%) in the prior arthroscopy group and 1 patient (0.35%) in the control group.

Complications aside from dislocation and infection were also accounted for by being grouped into an "other complications" category. This group included complications such as fracture, implant failure, leg length discrepancy, loosening. Of the 8 studies, 5 articles[21,22,28,29,31] reported on at least 1 or more of these complications. Incidences of other complications for the prior arthroscopy group and control group were 2.82% (n = 5) and 3.17% (n = 10), respectively. A full summary of all complications from the individual studies can be found in Table 6.

Clinically significant heterotopic ossification was also a commonly reported complication that was discussed in a total of 4 studies.[21,22,30,31] Overall, these 4 studies surveyed a total of 285 hips (116 prior arthroscopy vs 169 control). In total, there were 8 (6.90%) and 19 (11.24%) cases of heterotopic ossification in the prior arthroscopy and control groups, respectively. Overall and individual rates of reported heterotopic ossification are summarized in Table 7.

The rate of future ipsilateral hip surgeries of any kind was also reported in 3 studies. For this review, future operations were separated into 2 categories: implant revisions or other surgeries such as irrigation and debridement or arthroscopy.

Revision hip replacements were reported in 7 of 8 articles. Collectively, there were 10 (3.70%) patients in the prior arthroscopy group and 14 (3.0%) patients in the control group who required a revision surgery by latest follow up (Table 8).

Regarding future arthroscopies or irrigation and debridement, 3 studies[18,22,29] reported on patients who received either operation. In total, Perets et al.[18] reported on 4 prior arthroscopy patients (3.42% of total), and Charles et al. reported on 3 control patients (1.88% of total) that underwent revision arthroscopy or debridement (Table 8). Nam et al.[29] was the third article to report on other surgeries but stated that no patients from either group required a future arthroscopy or debridement.

Discussion

In this systematic review of 8 studies comparing 305 hips undergoing THA following prior hip arthroscopy with 502 control cases, no significant differences were found regarding intraoperative measures (blood loss

Table 6. Complications

Study	Complications		
	Prior Arthroscopy	Primary Arthroplasty	Risk Factors and Remarks
Charles et al.[22]	- 2 dislocations	- 1 hematoma requiring operative debridement - 2 iliopsoas impingement	No discussion of risk factors
Haughom et al.[28]	- 1 dislocation - 1 acute deep infection - 1 symptomatic LLD	- 1 periprosthetic infection with subsequent dislocation - 1 adverse local tissue reaction - 1 aseptic femoral component loosening - 1 periprosthetic fracture	No discussion of risk factors
Konopka et al.[19]	- 1 dislocation - 1 increased metal ions	- 1 dislocation - 1 aseptic osteolysis	No discussion of risk factors
Nam et al.[29]	- 1 DVT - 1 self-resolving postoperative drainage	- None	No discussion of risk factors
Parker et al.[21]	- 1 LLD - 1 dislocation - 3 ARMD - 1 trochanteric bursitis	- 1 LLD - 1 dislocation - 7 ARMD	Hip resurfacing with metal-on-metal implant was the cause of all ARMDs in both groups with no statistical difference in rates between the prior arthroscopy and primary arthroplasty groups
Perets et al.[18]	- 1 UTI - 1 incision numbness - 2 superficial wound infections - 1 allergic reaction to sutures	- None	No discussion of risk factors
Spencer-Gardner et al.[30]	- 1 dislocation	- None	No discussion of risk factors
Zingg et al.[31]	- 1 superficial wound infection - 1 Screw penetration requiring removal	- 1 intraoperative acetabular protrusion - intraoperative greater trochanter fracture - 1 dislocation	No discussion of risk factors

ARMD, adverse reaction to metal debris; DVT, deep vein thrombosis; LLD, leg length discrepancy, UTI, urinary tract infection.

Table 7. Clinically Significant HO

Study	Brooker Classification	Number of Hips With HO (%)	
		Arthroscopy	Control
Charles et al.[22]	2-4	2 (5.1)	4 (10.3)
Parker et al.[21,*]	—	1 (2.9)	1 (1.4)
Spencer-Gardner et al.[30]	0-1	3 (12.5)	5 (20.8)
	2-4	1 (4.2)	1 (4.2)
Zingg et al.[31]	0-1	1 (5.6)	8 (22.2)
Total		8 (6.9)	19 (11.2)

HO, heterotopic ossification.

*Parker 2017 did not separate patients who received hip arthroscopy from those who had surgical hip dislocation when reporting rates of HO.

and operative time), patient-reported outcomes at latest follow up or complications. While the risk of infections and dislocations seem to trend toward a higher risk in the prior arthroscopy group, the paucity of data reported within the literature limits this finding (Table 9).

Prior hip arthroscopy has multiple theoretical effects on a subsequent THA, from both a technical and prognostic point of view (Table 10). Scarring and inflammation can pose technical difficulties during a future surgery, as well as increase the risk of infection.[18,31] Additionally, capsular and ligamentous deficiency resulting from previous capsulotomy can potentially lead to an elevated risk for joint instability. Also, over-resection of the acetabulum from a prior acetabuloplasty can lead to decreased bone stock and anatomical distortion as in hip dysplasia, thus impairing component placement during THA.[33] Unfortunately, the studies included in this review did not discuss in depth procedures performed during the initial arthroscopy, and none discussed the capsular management.

Although results of this systematic review do not show significant differences in patient-reported outcomes, and only demonstrate a trend toward a higher rate of complications, it is still imperative to account for a potential subsequent THA when performing a hip arthroscopy. Factors that must be considered are respect of the soft tissue including capsular management and preservation of acetabular bone stock. In addition, surgical planning of hip arthroplasty must account for the previous arthroscopy because procedures such as iliopsoas lengthening, capsular release, or gluteus medius repair can potentially dictate surgical approach as well as implant choice.

Regarding outcomes, the most common patient-reported outcome measure used in the reviewed studies, and 1 of the most commonly used measures in the arthroplasty literature, is the HHS. Although the HHS has a long history and is well validated,[34] studies have shown that a major drawback of the measurement is its tendency to show a significant ceiling effect[35]; therefore, studies using HHS may show misleading results that report equal scores despite 1 group having better functional outcomes. The Forgotten Joint Score was introduced in 2012, and it has shown to be a more sensitive measure that has a significantly lower ceiling effect[36]; however, the FJS was only used in 1 study within our review.[36] Using HHS as the primary outcome measure for the majority of the studies limits the ability to differentiate between "good" or "better" results. Future studies should attempt to use outcome measures that can discern between higher levels of functional outcome and satisfaction, with little to no ceiling.

Previously, several studies have been published regarding the deleterious effects of knee arthroscopy before knee arthroplasty. One study compared 160 patients who underwent total knee arthroplasty to a matched control group and found no statistical

Table 8. Revisions and Future Operations

Study	Revisions			Future Arthroscopies or Irrigation and Debridements	
	Arthroscopy	Control		Arthroscopy	Control
Charles et al.[22]	2 (5.13)	0		0	3 (7.69)
Haughom et al.[28]	3 (7.14)	4 (4.76)		-	-
Konopka et al.[19]	1 (1.45)	3 (2.34)		-	-
Nam et al.[29]	0	0		0	0
Parker et al.[21,*]	3 (8.57)	7 (10.0)		-	-
Perets et al.[18]	-	-		4 (11.43)	0
Spencer-Gardner et al.[30]	0	0		-	-
Zingg et al.[31]	1 (5.56)	0		-	-
Total	10 (3.70)	14 (3.0)	$P = .46$	4 (3.42)	3 (1.88)

NOTE. Data are number (%).

*Parker et al. reported 1 additional revision; however, they did not state whether the patient was in the arthroscopy or control group.

Table 9. Key Points of Article

- 305 articles were reviewed based on a PubMed and Cochrane Library search.
- 8 comparative studies met the inclusion criteria; 5 focused solely on THA after a prior hip arthroscopy, 1 reported on conversion to HRA, and 2 articles discussed both HRA and THA.
- A total of 807 hips in 801 patients were included in this systematic review; a total of 305 hips underwent a prior hip arthroscopy before a THA or HRA, whereas 502 hips underwent a primary THA or HRA.
- No significant differences were found regarding intraoperative measures, PROMs (HHS), or rate of revisions at latest follow up.
- There was a trend toward higher rates of dislocations and infections.
- Based on available data, functional outcomes of THA in patients with a history of ipsilateral hip arthroscopy are comparable to patients who receive a primary THA.
- Data on this topic are limited, so future studies should report on larger patient cohorts and should include a further analysis regarding the impact of specific procedures performed during index hip arthroscopy.

HRA, hip resurfacing arthroplasty; HHS, Harris Hip Score; PROMs, patient-reported outcome measures; THA, total hip arthroplasty.

differences regarding Knee Society Score, range of motion and survivorship at 5 and 10 years.[37] In contrast, Barton et al.[38] showed a time-dependent factor in which patients who underwent knee arthroscopy 6 months before a knee replacement reported significantly lower patient-reported outcomes and increased complication rates. Werner et al.[39] reported similar results in their registry-based study that also surveyed patients who underwent a knee replacement within 6 months of a knee arthroscopy. Overall, they found that this cohort of patients was significantly more likely to incur complications such as infection, stiffness, and venous thromboembolism. None of the studies reviewed in this systematic review analyzed patient outcomes based on time from hip arthroscopy to THA, although the mean time to conversion was reported in 7 of the 8 studies.[18,19,21,28-31] It is possible that the time between hip arthroscopy and THA may have an effect on overall patient-reported outcomes; it is therefore advisable that future studies examine this variable.

The strengths of this systematic review include its focus on postoperative outcomes and its comprehensive review of the available results. Additionally, each of the evaluated studies included prospectively collected data with matching methodology and were adequately powered to detect differences in the primary outcome measure of HHS. Last, although no randomized controlled studies were included because of the nature of the study, the articles used in this systematic review achieved a high score based on the MINORS criteria and exhibited low risk of bias based on the NOS. Even though pooling nonrandomized studies increases risk of bias, the studies in this systematic review were strong methodologically and had low risk of bias, allowing for pooling to occur.

Table 10. Potential Deleterious Effects of a Hip Arthroscopy on Subsequent THA

Potential Technical Effects	Potential Effect on Outcomes
Tissue scarring	Infections
Tissue inflammation	Instability due to capsular deficiency
Previous incisions	Heterotopic ossification
Acetabular morphology	Acetabular loosening

THA, total hip arthroplasty.

Limitations

Limitations of this systematic review include the limited number of studies within the literature. This can be attributed to the fact that hip arthroscopy is a relatively new field and therefore the rate of conversions to THA has not been extensively studied yet. Second, outcomes and complications of hip arthroplasty are important not only in the short term, but even more so in the long term. The studies included in this systematic review all report follow-up data within the short term; as such, longer term studies are needed to examine postoperative outcomes as well as potential complications such as component loosening after subsequent THA. Third, because of the retrospective nature of these studies, and despite conducting a matching process, certain factors effecting outcomes of THA were not controlled for, including medical comorbidities, diabetic control, and surgical volume. Last, because of the low incidence of complications, the studies were not adequately powered to detect differences in this regard, thereby limiting the ability to reach conclusions regarding a possible higher risk in the prior arthroscopy group.

Conclusions

The short-term patient-reported outcomes of patients who underwent total hip arthroplasty with a prior history of an ipsilateral hip arthroscopy are comparable to those of patients undergoing primary THA. Although a conclusion could not be made regarding differences in complication rates between patients with a history of prior arthroscopy and patients undergoing primary THA, it is still imperative to consider the possible implications of a prior hip procedure on postoperative stability and infection rates. In summary, hip arthroplasty following a prior hip arthroscopy is a safe procedure with comparable short-term outcomes to primary arthroplasty.

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