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Review Article

Does Surgical Approach Affect Outcomes in Total Hip Arthroplasty Through 90 Days of Follow-Up? A Systematic Review With Meta-Analysis

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ABSTRACT

Background: The choice between anterior approach (AA) and posterior approach (PA) in primary total hip arthroplasty (THA) is controversial. Previous reviews have predominantly relied on data from retrospective studies.

Methods: This systematic review included prospective studies comparing postoperative outcomes through 90 days of AA vs PA in primary THA. Outcomes were pain severity, narcotic usage, hip function using Harris Hip Score, and complications. Random effects meta-analysis was performed for all outcomes. Efficacy data were reported as standardized mean difference (SMD) where values of 0.2, 0.5, 0.8, and 1.0 were defined as small, medium, large, and very large effect sizes, respectively. Complications were reported as the absolute risk difference (RD) where a positive value implied higher risk with AA and a lower value implied lower risk with AA.

Results: A total of 13 prospective comparative studies (7 randomized) with patients treated with AA (n = 524) or PA (n = 520) were included. The AA was associated with lower pain severity (SMD = −0.37, $P < .001$), lower narcotic usage (SMD = −0.36, $P = .002$), and improved hip function (SMD = 0.31, $P = .002$) compared to PA. No differences between surgical approaches were observed for dislocation (RD = 0.2%, $P = .87$), fracture (RD = 0.2%, $P = .87$), hematoma (RD = 0%, $P = .99$), infection (RD = 0.2%, $P = .85$), thromboembolic event (RD = −0.9%, $P = .42$), or reoperation (RD = 1.3%, $P = .26$). Conclusions of this study were unchanged when subjected to sensitivity analyses.

Conclusion: In this systematic review and meta-analysis of prospective studies comparing postoperative outcomes through 90 days of AA vs PA in primary THA, patients treated with AA reported less pain, consumed fewer narcotics, and reported better hip function. No statistical differences in complication rates were detected between AA and PA. Ultimately, the choice of surgical approach in primary THA should consider preference and experience of the surgeon as well as preference and anatomy of the patient.

Total hip arthroplasty (THA) is a highly cost-effective surgery with an incremental cost effectiveness ratio of $10,000 per quality-adjusted life year vs no surgery [1]. Although most THA patients realize clinically meaningful improvements in pain severity and joint function [2], there remains opportunity to further improve outcomes by hastening recovery, shortening the length of hospital stay, and decreasing the risk of dislocation, fracture, and infection. A posterior approach (PA) is the most

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commonly used THA technique worldwide [3]. The anterior approach (AA) has generated increased interest recently. Proponents of the AA report advantages of shorter hospital stay, less perioperative pain, faster functional recovery, and lower dislocation risk [4–6]. Others have reported a protracted learning curve and higher early revision rates with AA [7,8]. Candidates for THA report that their choice of surgical approach is based, in part, on their desire for a technique that allows quicker functional recovery [9]. Therefore, rigorous comparative evaluation of surgical approach methods in primary THA is warranted.

With the shift toward value-based care in the US healthcare system, hospitals are highly incentivized to reduce complication rates, both in-hospital and perioperatively [10]. Hospitals participating in the Comprehensive Care for Joint Replacement (CJR) model receive a bundled payment for in-hospital claims as well as all episodes of care through 90 days postdischarge. Of the total 90-day cost of care associated with Medicare Severity-Diagnosis Related Group 469 and 470 (major joint replacement or reattachment, with or without major complication or comorbidity), postdischarge episodes of care comprise nearly 50% of these costs [11]. To the extent that choice of surgical approach may influence perioperative recovery, complication risk, and associated healthcare costs, evaluation of THA outcomes through 90 days postdischarge is a useful metric.

Several systematic reviews [12,13] have reported comparative outcomes with AA vs PA for primary THA, yet none have focused on perioperative outcomes. In addition, more than half of the studies in each review were retrospective in nature. The purpose of this systematic review and meta-analysis is to compare postoperative outcomes through 90 days of AA vs PA THA among prospective comparative studies. To the extent possible, the design of this meta-analysis attempted to address each component of the CJR model, which includes complication rate, patient satisfaction, and pain management.

Methods

Literature Search

This review followed the guidelines set forth in the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) [14]. This systematic review was not registered, and a public protocol does not exist. We searched MEDLINE and EMBASE for prospective comparative studies of AA vs PA that reported efficacy and complications of primary THA. Therapeutic search terms consisting of "THA" and "total hip arthroplasty" were combined with the following surgical approach-specific search terms: anterior, direct, posterior, posterolateral, and Smith-Petersen. Additionally, manual searches were conducted using the Directory of Open Access Journals, Google Scholar, and the reference lists of included papers and relevant meta-analyses. No language or date restrictions were applied to the searches. The final search was conducted on June 30, 2017.

Study Selection and Data Extraction

Two researchers independently identified studies for eligibility. Disagreements were resolved by discussion. Main inclusion criteria included prospective study of primary THA with comparison of AA vs PA, predominant diagnosis of osteoarthritis, and at least one extractable perioperative outcome. Titles and abstracts were initially screened to exclude review articles, commentaries, letters, case reports, and obvious irrelevant studies. Full texts of the remaining articles were retrieved and reviewed. Studies were excluded if the design was retrospective, if all patients received bilateral THA, or if prespecified outcomes were not reported or not calculable. When multiple studies included overlapping series of patients, only the study with the largest sample size was included. Data were independently extracted from eligible peer-reviewed articles by 2 researchers and data discrepancies were resolved by discussion.

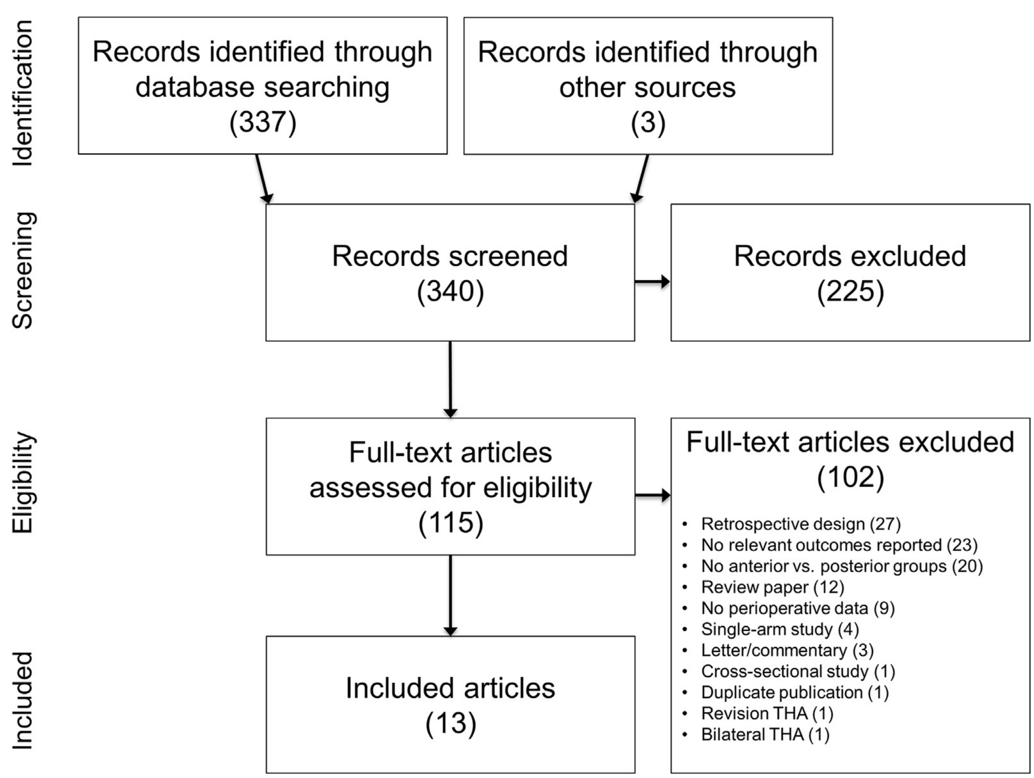

Fig. 1. Study flow diagram.

Table 1
Study and Patient Characteristics of Anterior vs Posterior Approach in Primary Total Hip Arthroplasty.

Study	Study Design	Treatment Period	Follow-Up Duration (d)[a]	Learning Cases Included	N[b] (AA:PA)	Age (AA:PA)	Female (%) (AA:PA)	BMI (kg/m^2) (AA:PA)
Barrett (2013) [5]	RCT	2010-2011	90	No	43:44	61:63	33:57	31:29
Bergin (2011) [20]	PN	–	28	No	29:28	69:65	68:50	26:28
Cheng (2017) [21]	RCT	2014-2015	84	No	35:37	59:63	57:53	28:28
Christensen (2015) [6]	RCT	–	42	No	28:23	64:65	54:52	31:30
Engdal (2017) [22]	PN	2011-2013	8	Not specified	20:19	56:56	75:42	26:27
Hananouchi (2009) [23]	PN	2005-2006	0[c]	No	20:20	55:57	90:90	22:21
Luo (2016) [24]	RCT	2014	30	No	52:52	62:64	67:58	23:24
Petis (2016) [25,26]	PN	–	90	No	40:40	67:67	63:65	28:28
Poehling-Monaghan (2017) [27]	PN	2013-2014	63	No	50:50	63:63	48:56	31:30
Rodriguez (2014) [28]	PN	2010	84	No	60:60	60:59	53:57	27:28
Taunton (2014) [29]	RCT	2012	42	No	27:27	62:66	56:52	28:29
Zhang (2006) [30]	RCT	2002-2004	90	Not specified	60:60	61:63	58:53	–[d]
Zhao (2017) [31]	RCT	2015-2016	90	No	60:60	65:62	60:56	24:26

BMI, body mass index; PN, prospective nonrandomized.
[a] Data represent maximum follow-up duration of data extraction in the meta-analysis.
[b] Reported as number of patients or hips.
[c] Operative data only reported.
[d] All patients with BMI $\leq$27 kg/m^2.

Outcomes

This review included postoperative outcomes reported through 90 days following primary THA. Main efficacy outcomes of this study included pain severity, need for opioid analgesia, and hip function using the Harris Hip Score (HHS). Postoperative pain severity was preferentially extracted from a visual analogue pain scale or, secondarily, from the HHS or Western Ontario and McMaster Universities Osteoarthritis Index pain subscale [15]. Narcotic use was preferentially extracted as morphine equivalents consumed during follow-up or, secondarily, alternative opioid consumption metrics. HHS was reported as the score at final follow-up in the perioperative period or the change in HHS during this period. When efficacy data were reported at multiple intervals within 90 days of follow-up, the final value was extracted for analysis. Complications included dislocation, fracture, hematoma, infection, thromboembolic event, and reoperation reported through 90 days of follow-up. Complication frequencies included in-hospital and events through 90 days of follow-up because complications in each period were rarely reported. The Cochrane Collaboration tool was used for assessing risk of bias in each study [16]. The risk of bias tool assesses sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting, and other sources of bias.

Data Synthesis

A random effects meta-analysis model was applied for all outcomes given the a priori assumption of heterogeneous treatment effects among studies. Denominators were adjusted to include the number of patients or hips, as appropriate. For continuous data reported on the same scale, the mean difference between groups

Table 2
Cochrane Risk of Bias Assessment in Comparative Studies of Anterior vs Posterior Approach in Primary Total Hip Arthroplasty.

Study	Random Sequence Generation	Allocation Concealment	Blinding of Participants	Blinding of Personnel	Blinding of Outcome Assessment	Incomplete Outcome Data	Selective Outcome Reporting
Barrett (2013) [5]	🟨	🟨	🟨	🟨	🟨	🟩	🟩
Bergin (2011) [20]	🟥	🟥	🟥	🟥	🟥	🟩	🟩
Cheng (2017) [21]	🟩	🟩	🟨	🟨	🟨	🟨	🟩
Christensen (2015) [6]	🟨	🟨	🟨	🟨	🟨	🟨	🟥
Engdal (2017) [22]	🟥	🟥	🟥	🟥	🟥	🟨	🟩
Hananouchi (2009) [23]	🟥	🟥	🟥	🟥	🟥	🟥	🟨
Luo (2016) [24]	🟨	🟨	🟨	🟨	🟨	🟥	🟨
Petis (2016) [25,26]	🟥	🟥	🟥	🟥	🟥	🟩	🟩
Poehling-Monaghan (2017) [27]	🟥	🟥	🟥	🟥	🟥	🟩	🟩
Rodriguez (2014) [28]	🟥	🟥	🟥	🟥	🟥	🟨	🟩
Taunton (2014) [29]	🟩	🟩	🟨	🟨	🟨	🟩	🟥
Zhang (2006) [30]	🟥	🟨	🟨	🟨	🟨	🟥	🟨
Zhao (2017) [31]	🟨	🟩	🟨	🟨	🟨	🟨	🟩

🟩, low bias risk; 🟨, uncertain bias risk; 🟥, high bias risk.

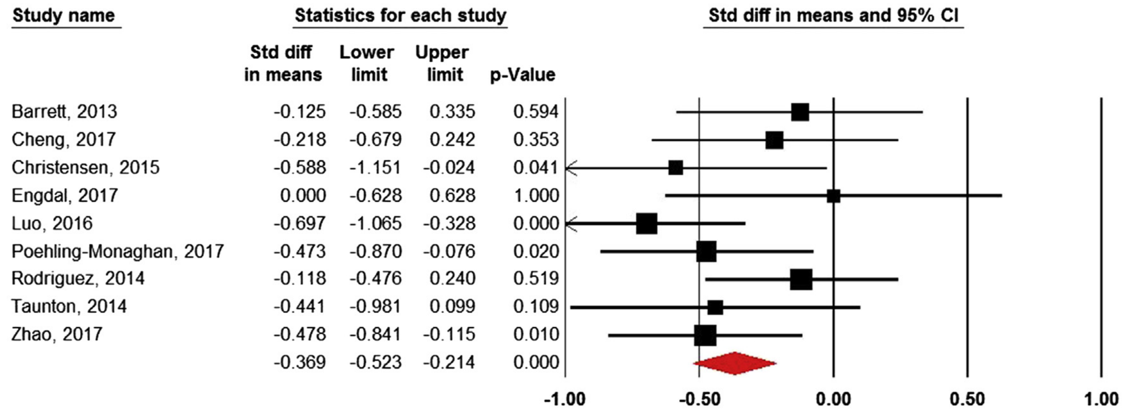

Fig. 2. Pain severity in recovery of anterior vs posterior approach in primary total hip arthroplasty. Negative SMD indicates less pain severity with anterior approach. Heterogeneity: $I^2 = 11\%$, $P = .34$. Publication bias: Egger's *P*-value = .53.

was the reported statistic. The standardized mean difference (SMD) was used for continuous data reported on different scales. For reference, SMD values of 0.2, 0.5, 0.8, and 1.0 are defined as small, medium, large, and very large effect sizes, respectively [17]. For binary outcomes, the absolute risk difference between groups was the reported statistic given the inclusion of zero total event trials [18]. For each outcome, the effect size and 95% confidence intervals (CIs) were calculated in each study and visually displayed using forest plots. Heterogeneity of outcomes among studies was estimated with the I^2 statistic where values of $\leq$25%, 50%, and $\geq$75% represent low, moderate, and high inconsistency, respectively [19]. Publication bias was visually assessed with funnel plots (not shown) and quantitatively assessed using Egger's regression test. Sensitivity analyses included a one-study removed analysis where the meta-analysis for each outcome was recalculated after removing one study at a time to explore the impact of single studies on treatment effects, and an analysis that included randomized controlled trials (RCTs) only. *P*-values were 2-sided with a significance level <.05. All analyses were performed using Comprehensive Meta-analysis (version 3.3; BioStat, Englewood, NJ).

Results

Study Selection

After screening 340 records for eligibility, 13 prospective comparative studies (14 manuscripts) [5,6,20–31] with 1044 patients treated with AA (n = 524) or PA (n = 520) were included in the meta-analysis. The most common reasons for exclusion were retrospective study design (27), no relevant outcomes reported (23), and no comparison of AA vs PA (20). A flow diagram of study identification and selection is shown in Figure 1.

Patient and Study Characteristics

Among 13 included studies, 7 were RCTs and 6 were prospective nonrandomized studies. Comparing patients treated with AA vs PA, pooled baseline patient characteristics were well-matched, including age (62 vs 63 year), female gender (60% vs 58%), and body mass index (27 kg/m^2 in each group) (Table 1). Learning cases were not explicitly included in any study although this information was not reported in 2 studies. Risk of bias assessment for each study is described in Table 2. The primary risks of bias were attributable to inclusion of nonrandomized studies.

Short-Term Efficacy Outcomes

In follow-up through 90 days post-treatment, AA was associated with lower pain severity, lower narcotic usage, and improved hip function compared to PA. In 9 studies reporting these data, pain severity was lower with AA (SMD = −0.37, 95% CI −0.52 to −0.21, $P < .001$) with minimal heterogeneity among studies ($I^2 = 11\%$, $P = .34$) (Fig. 2). Pain severity was reported on a 0-10 visual analogue scale in 3 studies, on the HHS pain subscore in 1 study, and on the Western Ontario and McMaster Universities Osteoarthritis Index pain subscore in 1 study. In 5 studies reporting these data, narcotic usage was also lower with AA (SMD = −0.36, 95% CI −0.60 to −0.13, $P = .002$) with low heterogeneity among studies

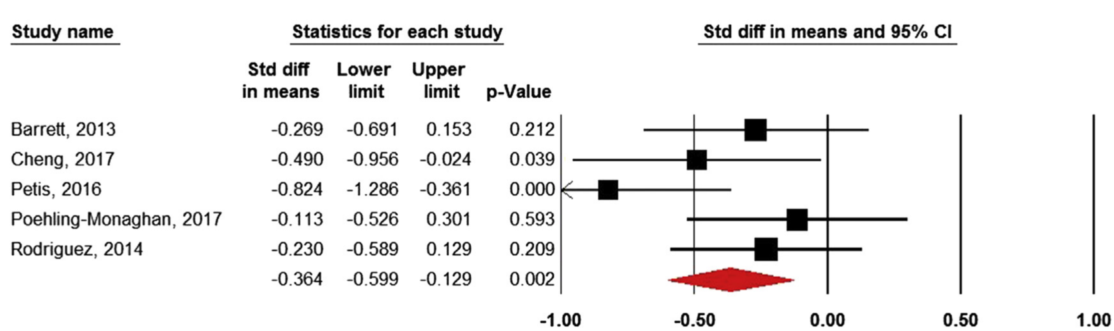

Fig. 3. Narcotic use in recovery of anterior vs posterior approach in primary total hip arthroplasty. Negative SMD indicates lower narcotic use with anterior approach. Heterogeneity: $I^2 = 36\%$, $P = .19$. Publication bias: Egger's *P*-value = .20.

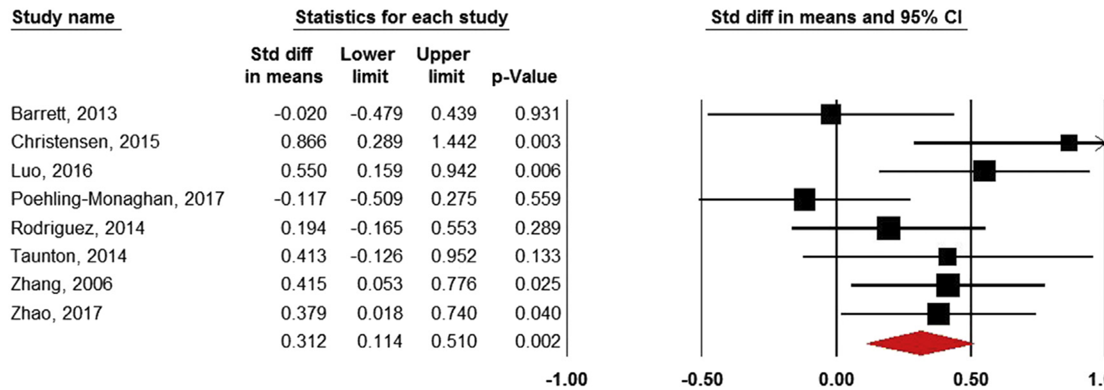

Fig. 4. Harris Hip Score in recovery of anterior vs posterior approach in primary total hip arthroplasty. Positive SMD indicates better hip function with anterior approach. Heterogeneity: $I^2 = 44\%$, $P = .08$. Publication bias: Egger's P-value = .47.

($I^2 = 36\%$, $P = .19$) (Fig. 3). Narcotic usage was reported as morphine equivalents in 3 studies, number of narcotic pills consumed in 1 study, and days using narcotics in 1 study. In 8 studies reporting these data, HHSs were higher in follow-up with AA (SMD = 0.31, 95% CI 0.11-0.51, $P = .002$) with low to moderate heterogeneity among studies ($I^2 = 44\%$, $P = .08$) (Fig. 4). The HHS values used in the analysis included the total scores at final follow-up through 90 days in 7 studies and the change in HHS total score in 1 study. Significant publication bias was not observed for any short-term efficacy outcome.

Short-Term Complications

Over 90 days of follow-up, no differences between surgical approaches were observed for dislocation, fracture, hematoma, infection, thromboembolic event, or reoperation (Table 3). In studies reporting these data, the pooled frequency of individual events ranged from 1% to 4% in each group. For each complication, heterogeneity was low and publication bias was not evident, apart from significant publication bias identified for reoperation rates (Egger's P-value<.01). When adjusting for publication bias using a trim and fill technique, the risk difference for reoperation decreased from 1.3% to 0.8% and remained not statistically different.

Sensitivity Analyses

We performed 2 types of sensitivity analyses to assess the robustness of the meta-analysis conclusions, including a one-study removed analysis and an analysis of RCTs only (Table 4). Overall, the main results of this meta-analysis were unchanged when assessing only RCTs or when removing one study at a time. In all analyses, the AA remained associated with lower pain severity, lower narcotic use, and higher HHSs relative to PA, with no differences between approaches for any complication. When isolated to RCTs only, the SMD for AA improved from −0.37 to −0.44 for pain severity, −0.36 to −0.37 for narcotic usage, and 0.31 to 0.41 for HHS.

Discussion

In this systematic review and meta-analysis of 13 prospective studies with more than 1000 patients comparing postoperative outcomes through 90 days with AA vs PA in primary THA, patients treated with AA reported less pain, consumed fewer narcotics, and reported better hip function. No statistical differences in complication rates were detected between AA and PA. These conclusions were unchanged among various sensitivity analysis assumptions.

The reason for less pain, lower narcotic usage, and greater hip function with the AA remains speculative. One possible rationale for these results is the avoidance of muscle splitting and reduced soft tissue damage with the AA. In contrast, the PA involves detachment of the tensor fascia lata, which may impair dynamic stabilization and require activity restrictions until soft tissues have adequately healed. In support of this hypothesis, 2 RCTs have reported lower C-reactive protein levels with AA vs PA [31,32]. Furthermore, magnetic resonance imaging [33] and cadaver [34] studies have revealed less soft tissue damage to gluteal and external rotator muscles with AA vs PA. On balance, each of these effects favoring the AA is small-to-medium in magnitude. Thus, whether these early differences are large enough to be detectable by patients remains unknown.

Table 3
Summary of Short-Term Complications of Anterior vs Posterior Approach in Primary Total Hip Arthroplasty.

Outcome	No. of Studies[a]	Event Frequency		Difference Between Approaches			Heterogeneity		Publication Bias
		Anterior	Posterior	RD[b]	95% CI	P-Value	I^2	P-Value	Egger's P-Value
Dislocation	5	2.5%	2.0%	0.2%	−2.3 to 2.7	.87	0%	.97	.25
Fracture	5	3.9%	2.4%	0.2%	−2.7 to 3.2	.87	0%	.67	.81
Hematoma	4	1.9%	1.9%	0.0%	−2.5 to 2.5	.99	0%	.77	.97
Infection	5	1.4%	1.1%	0.2%	−1.6 to 2.0	.85	0%	.97	.21
Thromboembolic event	5	1.1%	1.9%	−0.9%	−3.1 to 1.3	.42	0%	.92	.20
Reoperation	6	2.6%	1.3%	1.3%	−0.9 to 3.5	.26	0%	.92	<.01[c]

RD, risk difference.
[a] Represents number of studies reporting comparative data.
[b] Positive risk difference infers higher complication risk with anterior approach; negative risk difference infers lower complication risk with anterior approach.
[c] The RD decreases from 1.3% to 0.8% when adjusting for publication bias.

Table 4
Sensitivity Analyses of Anterior vs Posterior Approach in Primary Total Hip Arthroplasty.[a]

Statistic	Outcome	Main Analysis		One Study Removed				RCTs Only	
		Estimate	Significance[b]	Minimum Estimate	Significance[b]	Maximum Estimate	Significance[b]	Estimate	Significance[b]
Standardized mean difference	Pain severity	−0.37	‡	−0.42	‡	−0.35	‡	−0.44	‡
	Narcotic use	−0.36	‡	−0.43	†	−0.34	*	−0.37	*
	Harris Hip Score	0.31	‡	0.27	*	0.37	‡	0.41	‡
Risk difference	Dislocation	0.2%		0.0%		0.6%		0.0%	
	Fracture	0.2%		−0.8%		1.0%		0.9%	
	Hematoma	0.0%		−0.3%		0.3%		−0.3%	
	Infection	0.2%		0.0%		0.3%		0.0%	
	Thromboembolic event	−0.9%		−1.7%		−0.7%		−0.8%	
	Reoperation	1.3%		1.1%		2.4%		0.8%	

[a] Positive numbers indicate higher values with anterior approach. Negative numbers indicate lower values with anterior approach.
[b] Significance indicators: *$P < .05$, †$P < .01$, ‡$P < .001$.

We found no statistically significant differences in complication rates between surgical approaches. Prior studies reporting complication rates between the 2 approaches are conflicting [4,21,35,36]. Complications were uncommon and this meta-analysis may have been underpowered to detect clinically meaningful differences between surgical approaches. Furthermore, the sample size within any AA or PA group ranged from 19 to 60 patients among studies. Therefore, it is plausible that rare events were undetected in some studies due to the small study size. Nonetheless, differences in complication rates between surgical approaches were small and were further reduced for most individual complications when evaluating RCTs only. Importantly, because no study in this meta-analysis included learning cases, it is plausible that complication risks could be higher with inexperienced surgeons using either approach. Additionally, given the mean body mass index of 27 kg/m^2 in each group, it is also possible that complication rates in each group were underestimated [37–39].

The CJR model requires mandatory participation among 791 hospitals in 6 geographical areas. Participating hospitals are accountable for all Medicare fee-for-service Part A and B costs during the hospital stay as well as for 90 days following hospital discharge. As part of the CJR, 3 hospital-level quality of care measures are used to derive a composite quality score. The risk-standardized complication rate comprises 50% of the score, a patient satisfaction survey comprises 40% of the score, and a patient-reported outcome measure focused on pain management comprises 10% of the score. Hospitals with higher composite quality scores are eligible to receive reconciliation payments and lower effective discount percentages on reconciliation payments and repayments [40]. To the extent possible based on data typically reported in the THA literature, the design of this meta-analysis attempted to address each component of the composite quality score. Comparable complication rates and lower pain severity findings from this review may relate to the complication and pain elements of the composite quality score. While patient satisfaction was not reported in any study, it is plausible that lower narcotic usage and better hip function might translate to higher patient satisfaction scores. Therefore, while the results of this meta-analysis do not directly translate to quality composite scores specified in the CJR model, these data may be viewed as hypothesis-generating for future studies that evaluate hospital reimbursements with AA vs PA.

We report the first known meta-analysis of prospective comparative studies evaluating AA or PA for primary THA. The systematic reviews of Higgins et al [12] and Meermans et al [13] compared AA vs PA, albeit over longer follow-up periods. Still, common data derived from these reviews can be compared. In Higgins et al study, AA was associated with less pain and better hip function in early follow-up, lower dislocation risk over longer term follow-up, and no difference in intraoperative fracture risk. Meermans et al reported improved early hip function with AA, but no difference between surgical approaches in longer term follow-up; complication risk was not evaluated in this review. Synthesis of these results in light of outcomes from this study suggest modest reductions in pain severity and better hip function with AA vs PA during early follow-up, with no detectable difference in short-term complication risk. Although Higgins et al reported lower dislocation risk with AA, we found no difference in dislocation risk between surgical approaches. A plausible explanation is that our review included data through 90 days of follow-up, whereas the Higgins meta-analysis reported dislocation risk over longer term follow-up. Despite these early modest advantages of the AA, the comparative safety and effectiveness of these surgical approaches over long term follow-up is unclear.

Strengths of this meta-analysis are inclusion of only prospective comparative studies, comprehensive evaluation of efficacy and complications, low heterogeneity in outcomes among studies, and results that were robust to sensitivity analyses. This study also had several limitations. First, generalizability of these findings to less experienced centers is unknown because the studies did not explicitly exclude learning curve cases. Second, given the focus on the 90-day postoperative period, long-term comparative outcomes between AA and PA cannot be inferred from these results. Third, despite greater efficacy and comparative complication risk with AA during the 90-day postoperative period, no conclusions regarding cost utility with either approach can be derived from this research. Finally, complication reporting was inconsistent among studies, with several studies excluding this information altogether. Therefore, complication outcomes reported here should be interpreted cautiously.

Conclusion

In this systematic review and meta-analysis of prospective studies comparing postoperative outcomes through 90 days of AA vs PA in primary THA, patients treated with AA reported less pain, consumed fewer narcotics, and reported better hip function. No statistical differences in complication rates were detected between AA and PA. Ultimately, the choice of surgical approach in primary THA should consider preference and experience of the surgeon as well as preference and anatomy of the patient.

Acknowledgments

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