Review Article

Posterior Approach versus Lateral Approach for Primary Total Hip Arthroplasty: An Updated Systematic Review and Meta-Analysis

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Abstract

Total hip arthroplasty (THA) has become one of the most therapeutic and cost-effective procedures that are frequently carried out in orthopedic surgery. This review aimed to systematically compare postoperative outcomes between the two most commonly performed surgical approaches for THA posterior approach (PA) and lateral approach (LA) for abductor strength, operative time, perioperative blood loss, and limb length discrepancy. We searched Medline, Ovid, Europe PMC, Web of Science, and CENTRAL to identify eligible studies comparing PA and LA for patients who underwent primary THA for any indication. No restrictions on date or language were applied. Out of 15,764 records identified, 16 studies were deemed eligible, including five randomized controlled trials, five prospective cohort studies, and six retrospective cohort studies, providing data for 16,964 patients. PA was associated with a significant recovery in abductor strength (standardized mean difference (SMD) = 0.39, 95% confidence interval [CI] 0.14–0.63) postoperatively. No significant difference between PA and LA was found in terms of operative time (SMD = 0.05, 95% CI − 0.40–0.50), perioperative blood loss (SMD = −0.29, 95% CI − 0.62–0.03), or mean radiographic limb length discrepancy (LLD) (SMD = 0.02, 95% CI − 0.21–0.25). After removing the heterogeneity source, the sensitivity analysis showed consistent results except for operative time, which was significantly lower in the PA group (SMD= −0.72, 95% CI − 0.81–0.62). This review found PA to be associated with a significant enhancement in abductor strength recovery following THA. No significant difference was found between the two surgical approaches in operative time, perioperative blood loss, and LLD. However, after removing the source of heterogeneity, the sensitivity analysis showed a significantly lower mean operative time in favor of the PA group. Further studies are warranted to delineate the surgical approach's influence on abductor strength recovery in the long term.

Keywords: Hip osteoarthritis, lateral approach, meta-analysis, posterior approach, surgical approach, systematic review, total hip arthroplasty

Introduction

Since its commencement in the middle of the 20th century, total hip arthroplasty (THA) heralded a new era in arthroplasty and became one of the most therapeutic and cost-effective procedures that are frequently carried out in orthopedic surgery.[1,2] It is expected that the quality of life will be considerably improved following THA.[3] Determining the surgical approach that confers the most favorable postoperative clinical outcomes following THA has recently become an area of interest in the literature.[4] The two most commonly performed surgical approaches for THA worldwide are the posterior approach (PA) and lateral approach (LA). Globally, PA is more commonly used for THA (45%) compared to LA (42%).[5] Studies comparing the two surgical approaches have shown conflicting results, leaving uncertainty about the surgical approach choice for THA.[4,6-11]

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A recent systematic review and meta-analysis concluded that PA was associated with a reduction in Trendelenburg gait, dislocation rate, heterotopic ossification, and stem malposition. However, the review was limited by a relatively small sample size due to the paucity of studies.[12] Since the most recent meta-analysis, nine further studies that compare PA to LA representing 16,319 patients were introduced to the literature since the most recent meta-analysis.[13-19]

Given the addition of 16,319 patients, we sought to conduct an updated systematic review and meta-analysis comparing PA and LA with specific regard to abductor strength at different time points, operative time, perioperative blood loss, and radiographic limb length discrepancy (LLD).

Materials and Methods

This systematic review was conducted according to a protocol established at inception and registered at PROSPERO (CRD42020176864). This systematic review's reporting follows the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) checklist.[20]

Eligibility criteria

This systematic review included all available randomized controlled trials (RCTs), prospective cohort studies (PCSs), and retrospective cohort studies (RCSs) that involved a direct comparison between PA and LA and reported at least one of the following outcomes: abductor strength, operative time, perioperative blood loss, or radiographic LLD for patients who underwent primary THA for any indication. Abductor strength should be measured objectively using a dynamometer or manually, according to the Medical Research Council.[21]

Although systematic reviews of RCTs are considered to provide the highest level of evidence, a discrepancy has been found to exist between the effect sizes obtained from RCTs and the effect sizes obtained from observational studies for the same treatment arms.[22-25] Moreover, the incorporation of well-designed observational studies along with high-quality RCTs provides an insight into various clinical settings, a broader set of patients, and longer periods of treatment effects, enabling the assessment of small treatment effects and rare outcome measures.[26,27] Therefore, we sought to include well-designed PCSs and RCSs along with RCTs.

For the purpose of this review, LA was defined as the dissection of one-third of the gluteus medius without trochanteric osteotomy. The descriptions of Hardinge as well as Mulliken *et al*., and Frndak *et al*. modification of the Hardinge approach were accepted as LA.[28-30] The descriptions of Kocher and Langenbeck and the modifications by Gibson and Moore of that approach were accepted as PA.[31-33] Studies reporting revision THA results, bipolar hemiarthroplasty, and hip resurfacing were excluded.

Search strategy

We searched the electronic databases Medline/PubMed, Ovid, Europe PMC, and Web of Science. Medical Subject Headings for each electronic database was extensively explored to retrieve the different keywords assigned for the same concept. No restrictions on date or language were applied. The search strategy is shown in the supplementary material. All identified articles were exported to EndNote X9 (Clarivate, Philadelphia, Pennsylvania, USA) to manage references and remove duplicates. We also searched the following trial registries: Cochrane Central Register for Controlled Trials (CENTRAL), ISRCTN registry, Australian New Zealand Clinical Trials Registry, and UMIN Clinical Trials Registry. We screened abstracts provided by the Orthopedic Proceedings Journal. The last search was done on the May 2, 2020. We searched bibliographic references of the included studies thoroughly to recognize articles that might not appear during the systematic search of the electronic databases. We contacted the authors of the eligible studies in case of missing data to obtain further information.

Study selection and data extraction

Two independent review authors (ASA and MSA) screened titles and abstracts of the identified articles by applying the eligibility criteria of this systematic review, and any disagreement regarding the eligibility of a particular study was resolved by discussion. If consensus could not be achieved with discussion, a third reviewer (AAG) decision was considered. The two independent review authors (ASA and MSA) then read the full texts of the eligible articles and retrieved data using a predefined data collection file. The following data were extracted from included studies: name of the first author, year of publication, mean follow-up, study design, surgical approaches used, the number of patients assigned for each surgical approach, year(s) data collected, final diagnoses, and demographic data (i.e., gender, mean age, and mean body mass index [BMI]). The desired outcomes, including mean postoperative abductor strength (±standard deviation [SD]) at different time points, mean operative time in minutes (±SD), mean peri-operative blood loss (±SD), and mean postoperative LLD (±SD), were extracted. For studies with multiple publications, data were extracted from the original study and only the data related to abductor strength (if applicable) were extracted from follow-up publications.

Meta-analysis

Meta-analyses were conducted using Comprehensive Meta-Analysis version 3 (Biostat, Inc. Eaglewood, New Jersey, USA) using the random-effects model. The measure of effect used to express the desired outcomes was the standardized mean differences (SMD). Between-study statistical heterogeneity was assessed using I^2 and the P of the χ^2 test for heterogeneity. A confidence level of 95% was used, and $P < 0.05$ was considered to be significant to reject the null hypothesis. We performed a subgroup analysis for the primary outcome, abductor strength, according to the following follow-up periods: 3 months, 6 months, and ≥12 months. If the statistical heterogeneity was significant ($I^2 > 50\%$), a sensitivity analysis was performed by removing each individual study at a time to identify the potential source of heterogeneity.

Risk of bias assessment

Two independent review authors (ASA and MSA) assessed the quality of eligible RCTs using the Revised Cochrane Bias Risk Assessment tool.[34] The quality of nonrandomized studies (i.e., PCSs and RCSs) was assessed using The Newcastle Ottawa Quality Assessment Scale (NOS).[35] Any disagreement was resolved by discussion and decision of the third review author (AAG) if it was not settled by discussion. The potential publication bias was investigated through visual inspection of the funnel plot of the primary outcome (i.e., abductor strength) along with Egger's test assessing the funnel plot asymmetry.[36]

Results

The literature search yielded 15764 potentially related articles. After removing duplicates, screening abstracts, and reading 42 full-text articles, 16 accessible studies (18 publications) were found to be eligible.[13-18,37-46] Five studies were RCTs (6 publications),[13,16,37,42-44] five were PCSs (6 publications),[14,17,38,39,41,45] and six were RCSs.[15,18,19,40,46,47] The review progress in this study is shown in the PRISMA flow chart [Figure 1].

Trial characteristics

The included studies were published between 1996 and 2019. The overall number of patients was 16,964 (4,252 (25.1%) and 12,712 (74.9%) allocated to LA and PA, respectively). The mean age of the patients ranged between 42 and 72 years. The detailed characteristics of the included studies are shown in Table 1.

Risk of bias assessment

All of the included RCTs were found to have an overall low risk of bias according to the Revised Cochrane Bias Risk Assessment tool [Table 2]. Of the 11 observational studies, seven were found to have an overall good quality, one had fair quality, and three had poor quality according to NOS [Table 3]. The funnel plot for the primary outcome was asymmetrical and Egger's test showed a statistical significance ($P < 0.01$), suggesting evidence of publication bias [Supplementary Figure 1].

Abductor strength

Six studies (7 publications), including a total of 556 participants (PA, n = 288; LA, n = 268), reported mean abductor strength.[13,14,17,38-40,45] All of the studies measured abductor strength objectively using a dynamometer except for Barber *et al*.,[38] who manually measured the abductor strength according to the Medical Research Council.[21] Overall, there was a significant enhancement in abductor strength recovery following THA in favor of PA (SMD = 0.39, 95% confidence interval [CI] 0.14–0.63, $P = 0.002$; $I^2 = 50\%$) [Figure 2]. The subgroup analysis revealed that the recovery in abductor strength conferred by PA reached statistical significance at 6 months (SMD = 0.85, 95% CI 0.21–1.50, $P = 0.009$; $I^2 = 0\%$) and ≥12 months postoperatively (SMD = 0.34, 95%

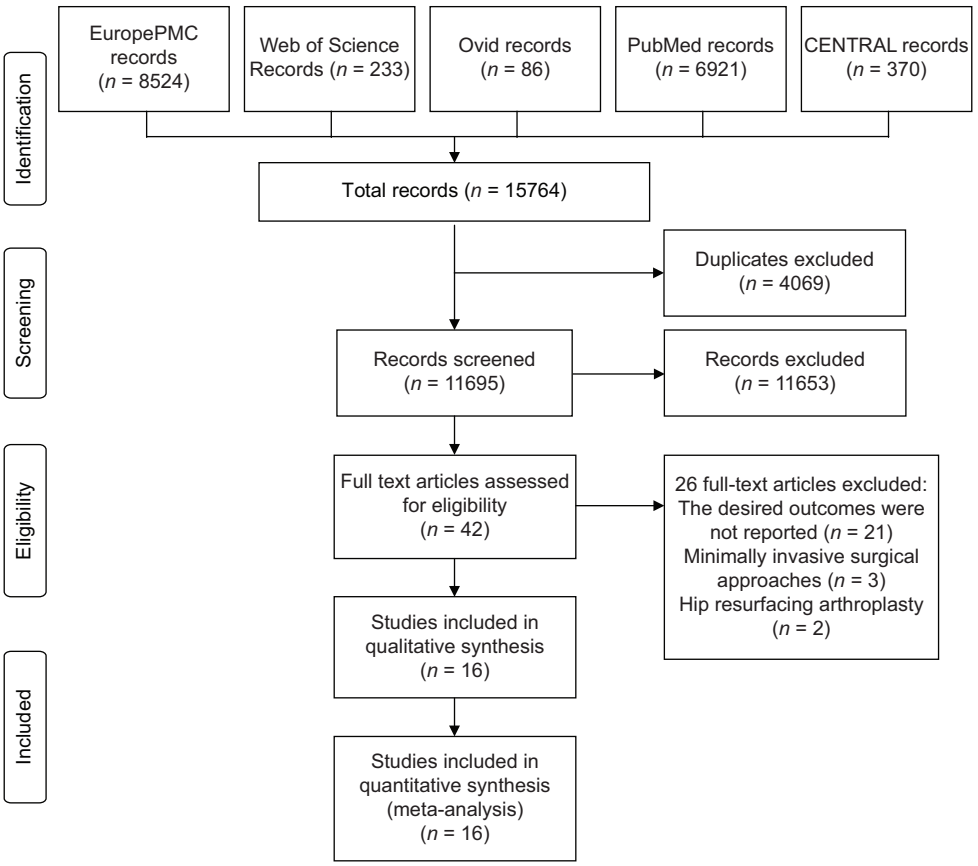

Figure 1: Study flow diagram

Table 1: Characteristics of the included studies

Study	Study Design	Follow up	Final diagnoses	Demographic data (i.e., gender, mean age, BMI)	Approaches used	Number of patients	Year(s) data collected
Aggarwal *et al*., 2019[46]	RCS	3.72 years	NR	Gender (male, *n* = 928; female, *n* = 1122), age (LA, 61; PA, 62.5) BMI (LA, 29.9; PA, 30.1)	LA described by Hardinge,[28] PA**	LA (*n* = 393), PA (*n* = 1657)	2011-2016
Barber *et al*., 1996[38]	PCS	2 years	Primary osteoarthritis of the hip (*n* = 49)	Gender (LA male, *n* = 22; female *n* = 27), age (LA, 72; PA, 70), BMI; NR	LA described by Hardinge[28], PA**	LA (*n* = 21), PA (*n* = 28)	NR
Downing *et al*., 2001[39]	PCS	1 year	Primary osteoarthritis of the hip (*n* = 100)	Gender (male, *n* = 45; female, *n* = 55), age (LA, 65; PA, 67), BMI; NR	LA described by Hardinge[28], PA**	LA (*n* = 51), PA (*n* = 49)	1995-1997
Gharanizade *et al*., 2016[19]	RCS	1 year	Hip joint dysplasia, primary osteoarthritis of the hip, avascular necrosis*	Gender (male, *n* = 70; female, *n* = 64), age (LA, 43; PA, 42) BMI; NR	LA described by Hardinge[28], PA described by Moore[24]	LA (*n* = 79), PA (*n* = 55)	2011-2014
Goosen *et al*., 2010[44]	RCT	1 year	Primary osteoarthritis of the hip (*n* = 59), developmental dysplasia of the hip (*n* = 1)	Gender (male, *n* = 29; female, *n* = 31), age (ALA, 62 [±6.9]; PLA, 62 [±6.3]), BMI (ALA, 26.1 [±2.8]; PLA, 26.8 [±2.7])	LA described by Frndak *et al*. modification on Harding approach,[30] PA described by Gibson[32]	LA (*n* = 60), PA (*n* = 60)	2005-2007
Hart *et al*., 2019[18]	RCS	NR	Primary osteoarthritis of the hip (*n* = 1482), posttraumatic (*n* = 80), osteonecrosis (*n* = 78), other (*n* = 34)	Gender (male, *n* = 791; female, *n* = 883), age (LA, 62.4 [±14]; PA, 67.9 [±12.2]), BMI (LA, 30.7 [±6.8], PA, 30.6 [±7.4])	LA**, PA**	LA (*n* = 565), PA (*n* = 1109)	2009-2017
Ji *et al*., 2012[37]	RCT	Follow-up (LA, 38.3 [±9.2]; PA, 37.5 [±10.0])	Primary osteoarthritis of the hip (*n* = 73), inflammatory osteoarthritis (*n* = 8), osteonecrosis (*n* = 105), septic hip sequelae (*n* = 6), femoral neck fracture (*n* = 4)	Gender (male, *n* = 112; female, *n* = 84), age (LA, 52 [±15.1]; PA, 51 [±14.5]), BMI (LA, 24.3 [±3.0]; PA, 24.3 [±3.3])	LA described by Mulliken *et al*.,[29] PA described by Kocher and Langenbeck[31]	LA (*n* = 97), PA (*n* = 99)	2004-2005
Kiyama *et al*., 2010[40]	RCS	3.5 years	Primary osteoarthritis of the hip (*n* = 71), osteonecrosis (*n* = 7)	Gender (male, *n* = 7; female, *n* = 71); age (LA, 60.4 [range 47-72]; PA, 62.5 [range 47-74]); BMI (LA, 26.4; PA, 26.8)	LA described by Frndak *et al*. modification on Hardinge approach,[30] PA described by Gibson[32]	LA (*n* = 38), PA (*n* = 40)	1997-2004
Kruse *et al*., 2018[16]	RCT	NR	Primary osteoarthritis of the hip (*n* = 80)	Gender (male, *n* = 52; female, *n* = 24), age (LA, 60.2 [range 45-69]; PA, 61.5 [range 47-69]), BMI (LA, 26.9 [range 20-35]; PA, 27.6 [range 20-35])	LA described by Mulliken,[29] PA described by Moore[33]	LA (*n* = 38), PA (*n* = 38)	2012-2014
Pongcharoen and Chaichubut, 2019[15]	RCS	65.04 months	Osteonecrosis of the femoral head, osteoarthritis of the hip, inflammatory joint disease, femoral neck fracture*	Gender (male, *n* = 59; female, *n* = 59), age (LA, 50.67 [±8.26]; PA, 49.96 [±11.12]), BMI (LA, 27.24 [±4.31]; PA, 25.91 [±3.68])	LA described by Hardinge,[28] PA described by Gibson[32]	LA (*n* = 53), PA (*n* = 43)	2005-2016
Rosenlund *et al*., 2016/2017[13,43]	RCT	12 months	Osteoarthritis of the hip secondary to mild hip dysplasia (*n* = 77)	Gender (male, *n* = 52; female, n = 25), age (LA, 60 [±7]; PA, 60 [±6]), BMI (LA, 27 [±3]; PA, 28 [±4])	LA described by Mulliken,[29] PA described by Moore[33]	LA (*n* = 38), PA (*n* = 39)	2012-2014

Contd...

Table 1: Contd...

Study	Study Design	Follow up	Final diagnoses	Demographic data (i.e., gender, mean age, BMI)	Approaches used	Number of patients	Year(s) data collected
Weale *et al*., 1996[41]	PCS	NR	NR	Gender (male, *n* = 18; female, *n* = 24), age (LA, 68.5; PA, 69.4), BMI; NR	LA described by Hardinge,[28] PA described by Moore[33]	LA (*n* = 20), PA (*n* = 22)	NR
Winther *et al*., 2016/2019[17,45]	PCS	12 months	Primary osteoarthritis of the hip (*n* = 40)	Gender (male, *n* = 19; female, *n* = 21), age (LA, 57 [range 45-68], PA, 56 [range 44-67]), BMI (LA, 26 [±2.6], PA, 27 [±3.7])	LA described by Hardinge,[28] PA described by Gibson[32]	LA (*n* = 21), PA (*n* = 19)	2011-2013
Witzleb *et al*., 2009[42]	RCT	3 months	Primary osteoarthritis of the hip (*n* = 60)	Gender (male, *n* = 29; female, *n* = 31), age (LA, 55 [range 47-64], PA, 58 [range 46-64]), BMI (LA, 26.6 [range 20-38]; PA, 28.9 [range 21-39])	LA described by Hardinge,[28] PA described by Moore[33]	LA (*n* = 30), PA (*n* = 30)	2003-2006
Zeni *et al*., 2016[14]	PCS	1 year	Primary osteoarthritis of the hip (*n* = 63)	Gender (male, *n* = 32; female, *n* = 31), age (LA, 59 [±6]; PA, 68 [±7]), BMI (LA, 29 [±5]; PA, 28.8 [±6])	LA described by Hardinge,[28] PA described Gibson[32]	LA (*n* = 21), PA (*n* = 42)	NR
Zhang *et al*., 2019[47]	RCS	2.83 years	Osteoarthritis, rheumatoid arthritis, other inflammatory, avascular necrosis*	BMI 30-39: Gender (male, *n* = 5429; female, *n* = 5307), age (LA, 65.1 [range 19-91]; PA, 65.0 [range 18-97]), BMI ≥ 40: Gender (male, *n* = 518; female, *n* = 855), age (LA, 60.3 [range 25-90); PA, 61.0 [range 19-86])	LA described by Hardinge,[28] PA described Gibson[32]	BMI 30-39: LA (*n* = 2407), PA (*n* = 8329), BMI ≥ 40: LA (*n* = 320), PA (*n* = 1053)	2010-2017

*Numbers could not be extracted, **Not specified. RCT: Randomized controlled trial, PCS: Prospective cohort study, RCS: Retrospective cohort study, LA: Lateral approach, PA: Posterior approach, NR: Not reported, BMI: Body mass index

Table 2: Risk of bias assessment of randomized controlled trials

Study	Randomization	Deviations from the intended intervention	Missing outcomes data	Measurement of the outcome	Selection of the reported results	Overall risk of bias
Goosen *et al*., 2010[44]	⊖	⊖	⊖	⊖	⊖	⊖
Ji *et al*., 2012[37]	⊖	⊖	⊖	⊖	⊖	⊖
Kruse *et al*., 2018[16]	⊖	⊖	⊖	⊖	⊖	⊖
Rosenlund *et al*., 2016/2017[13,43]	⊖	⊖	⊖	⊖	⊖	⊖
Witzleb *et al*., 2009[42]	⊖	⊖	⊖	⊖	⊖	⊖

⊕: High risk, ⊖: Low risk, ?: Some concerns

CI 0.05–0.64, $P = 0.02$; $I^2 = 50\%$). After sensitivity analysis, there was still a statistical significance in abductor strength recovery in favor of PA (SMD = 0.51, 95% CI 0.28–0.75, $P < 0.001$; $I^2 = 8\%$) [Table 4].

Operative time

The mean operative time was reported by seven studies, including a total of 12,949 participants (PA, *n* = 9,715; LA, *n* = 3,234).[15,18,37,41,43,47] Operative time ranged from 76.1 to 109.8 min for PA and from 60 to 132 min for LA. No significant difference was found between PA and LA (SMD = 0.05, 95% CI − 0.40–0.50, $P = 0.82$; $I^2 = 98\%$) [Figure 3]. Zhang *et al*. provided mean operative time for two BMI classes: the obese class (BMI 30–39) and morbidly obese class (BMI ≥40). Therefore, we decided to include the mean operative time for the obese class (BMI 30–39) in the analysis and to

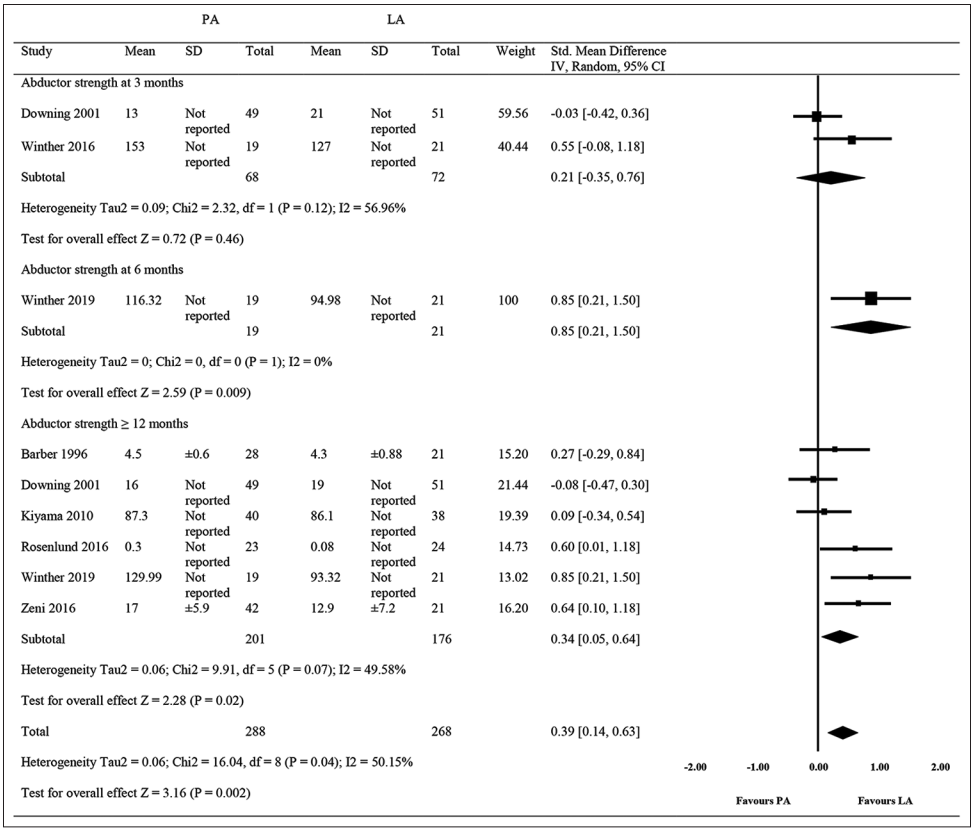

Figure 2: Mean abductor strength (posterior approach versus lateral approach)

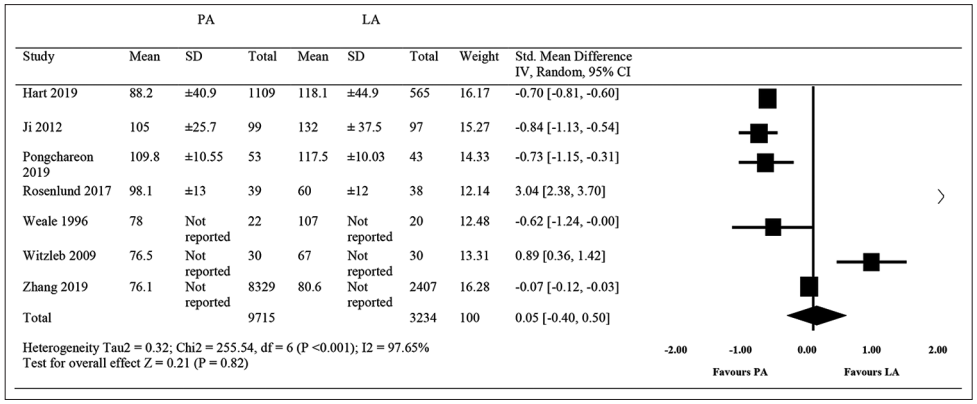

Figure 3: Mean operative time (posterior approach versus lateral approach)

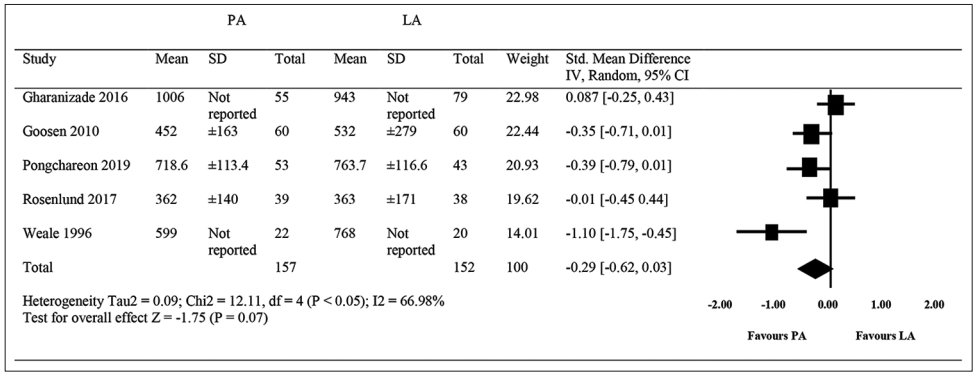

Figure 4: Peri-operative blood loss (posterior approach versus lateral approach)

Table 3: NewcastleOttawa quality assessment scale for cohort studies

Study	Selection				Comparability	Outcome			Total (9/9)	Quality assessment based on AHRQ
	Representativeness of the exposed cohort (maximum: ❋)	Selection of nonexposed cohort (maximum: ❋)	Ascertainment of the exposure (maximum: ❋)	Demonstration that outcome of interest was not present at start of study (maximum: ❋)	Comparability of cohorts of the basis of the design or analysis (maximum: ❋)	Assessment of outcome (maximum: ❋)	Sufficient follow-up time	Adequacy of follow-up		
Barber *et al*., 1996[38]	❋	❋	❋	❋	❋	❋	❋	-	7/9	Good
Downing *et al*., 2001[39]	❋	❋	❋	❋	❋	❋	❋	❋	8/9	Good
Zeni *et al*., 2016[14]	❋	❋	❋	❋	-	❋	❋	-	6/9	Poor
Winther *et al*., 2016/2019[17,45]	❋	❋	❋	❋	❋	❋	❋	❋	8/9	Good
Kiyama *et al*., 2010[40]	❋	❋	❋	❋	❋	❋	❋	-	7/9	Good
Pongcharoen and Chaichubut 2019[15]	❋	❋	❋	❋	❋	❋	❋	❋	8/9	Good
Weale *et al*., 1996[41]	-	-	❋	❋	❋	❋	-	-	4/9	Poor
Hart *et al*., 2019[18]	❋	❋	❋	❋	-	❋	❋	-	6/9	Poor
Aggarwal *et al*., 2019[46]	-	-	❋	❋	❋	❋	❋	-	5/9	Fair
Gharanizade *et al*., 2016[19]	❋	❋	❋	❋	❋	❋	❋	-	7/9	Good
Zhang *et al*., 2019[47]	❋	❋	❋	❋	❋	❋	❋	-	7/9	Good

❋: A star given when the study satisfies the corresponding domain. AHRQ: Agency for Healthcare Research and Quality

Table 4: Sensitivity analysis

Outcomes	Number of studies	Number of patients	Standardized mean difference	95% CI	*P*	I^2 (%)
Abductor strength	5 (6 publications)	357	0.51	0.28-0.75	<0.001	8.26
Operative time	4	2008	−0.72	−0.81-−0.62	<0.001	0
Peri-operative bleeding	4	427	−0.16	−0.40-0.08	0.18	37

CI: Confidence interval

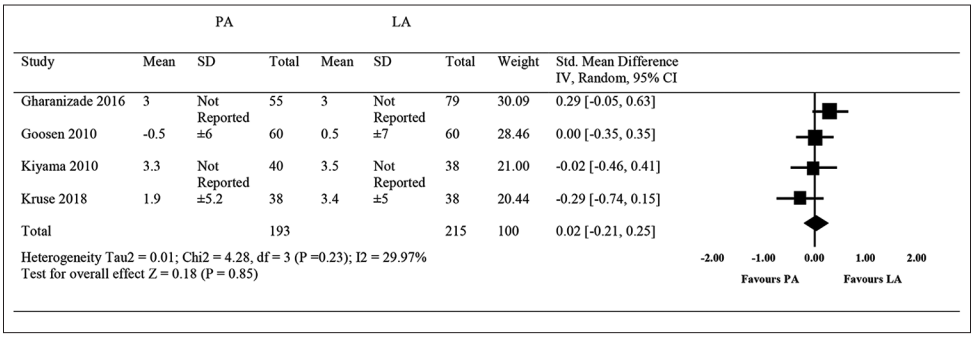

Figure 5: Mean radiographic limb length discrepancy (posterior approach versus lateral approach)

narratively report the mean operative time for the morbidly obese class (BMI ≥ 40), which also showed no significant difference between PA and LA (SMD = −0.01, 95% CI − 0.14–0.10, $P = 0.79$).[47] After removing the source of heterogeneity, operative time ranged from 78 to 109.8 min for PA and from 107 to 132 min for LA. The sensitivity analysis showed a significant reduction in mean operative time in favor of PA (SMD = −0.72, 95% CI − 0.81–0.62, $P < 0.001$; $I^2 = 0\%$) [Table 4].

Perioperative blood loss

Five studies reported mean perioperative blood loss, including a total of 209 participants (PA, $n = 157$; LA, $n = 152$).[15,19,41,43,44] Perioperative bleeding volume ranged from 362 to 1006 ml for PA and from 363 to 943 ml for LA. The amount of bleeding volume was similar between PA and LA (SMD = −0.29, 95% CI − 0.62-0.03, $P = 0.07$; $I^2 = 67\%$) [Figure 4]. Similarly, perioperative bleeding volume ranged from 362 to 1006 ml for PA and from 363 to 943 ml for LA. The sensitivity analysis also did not show any significant difference in mean perioperative blood loss (SMD = −0.16, 95% CI − 0.40–0.08, $P = 0.18$; $I^2 = 37\%$) [Table 4].

Limb length discrepancy

Four studies reported mean radiographic LLD, including a total of 408 participants (PA, $n = 193$; LA, $n = 215$).[16,19,40,44] LLD ranged from − 0.05 to 3.3 cm for PA and from 0.05 to 3.5 cm for LA. The pooled effect showed no significant difference between the two groups (SMD = 0.02, 95% CI − 0.21–0.25, $P = 0.85$; $I^2 = 30\%$) [Figure 5].

Discussion

Our results demonstrated a significant enhancement in the abductor strength recovery associated with PA at 6 months and ≥12 months' postoperatively. We found PA and LA to have comparable results in terms of mean operative time, mean perioperative blood loss, and mean radiographic LLD. After removing the source of heterogeneity, the sensitivity analysis showed consistent results except for operative time, which was significantly lower in the PA group.

Our findings are consistent with some of the previous studies revealing a significantly better abductor muscle strength in patients allocated to PA for up to 2 years' postoperatively.[48-51] A recent systematic review and meta-analysis found that patients allocated to LA have significantly higher Trendelenburg gait at a mean of 15.5 months.[11] High Trendelenburg gait manifestations in patients allocated to LA have been attributed to the intraoperative dissection of the abductor muscle group (i.e., gluteus medius and minimus).[29,52,53] Other studies, however, found that Trendelenburg gait manifestations associated with LA disappeared within 12 months' postoperatively.[6,12,54] The absence of Trendelenburg signs in the LA group at 12 months has been attributed to the over-activation of the gluteus medius muscle in order to compensate for the weakness and support the pelvis during walking.[55] A recent RCT found abductor strength to be significantly better in the LA group at 3 months, 6 months, and 12 months. We believe that this improvement is attributed to their use of a modified antero LA, which does not involve cutting through gluteus medius muscle.[56] Judd *et al*. and Rasch *et al*. found abductor strength to be similar in patients who underwent THA through PA compared to healthy controls at 3 months, 6 months, and 12 months but not as strong as contralateral healthy limb even 2 years' postoperatively.[57,58] A gait analysis study conducted by Madsen *et al*. found 30% of patients in the PA group were restored to their normal gait, while none of the patients in the LA group were restored to

their normal gait at 6 months' postoperatively.[59] Furthermore, Meermans *et al*. reported that postoperative gait analysis results were similar regardless of the surgical approach.[8]

Our findings suggest no statistical difference in operative time between the two surgical approaches with high statistical heterogeneity. However, after removing the source of heterogeneity, the sensitivity analysis showed a significantly lower mean operative time in favor of the PA group. Cantrell *et al*., in a systematic review, stated that the mean operative time was relatively stable and not amenable to be influenced by the surgical approach over the past 20 years.[60] Some studies found LA to be higher in terms of mean operative time,[61-63] whereas Rasch *et al*. found PA to be higher.[58] The discrepancy in mean operative time has been attributed to the impact of many factors, including BMI, surgeon experience, and presence of trainee.[56,60]

Our findings revealed no significant difference in mean bleeding volume between PA and LA. Even after removing the source of heterogeneity, the sensitivity analysis did not show any significant difference in mean perioperative blood loss. However, many studies found that LA is associated with a higher amount of blood loss.[62,63]

Our findings demonstrated no statistical difference between the two surgical approaches in terms of mean radiographic LLD. Previous reviews consistently showed no significant difference.[11,12] Gore *et al*. displayed that mean LLD was significantly lower in female patients allocated to the PA, while it was significantly lower in male patients allocated to the LA.[50]

The present review has some limitations. First, it was limited by the small number of included RCTs, and most of the data was derived from observational studies. However, all of the included RCTs had an overall low risk of bias and most of the observational studies were found to have good quality. Second, although the results of abductor strength displayed by our review were measured objectively and unlikely to be influenced by outcome assessors, our review was not able to determine whether the enhancement in abductor strength recovery associated with PA continue to be significant on the long-term follow up (i.e., >2 years).

Conclusion

This review displayed a significant improvement in abductor strength associated with PA post-THA. No significant difference was found between PA and LA in terms of mean operative time, mean bleeding volume, and mean radiographic LLD. However, after removing the source of heterogeneity, the sensitivity analysis showed a significantly lower mean operative time in favor of the PA group. Further RCTs are warranted to assess the influence of the surgical approach on abductor strength in the long term.

Ethical approval

The authors confirm that this review had been prepared in accordance with COPE roles and regulations. Given the nature of the review, the IRB review was not required.

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Conflicts of interest

There are no conflicts of interest.

Author contributions

AAG contributed to the research idea, design of the study, data extraction, statistical analysis and interpretation, risk of bias assessment, writing, and editing, MSAO contributed the design of the study, data extraction, statistical analysis and interpretation, writing, and editing, ASA, contributed to the data extraction, statistical analysis and interpretation, risk of bias assessment, writing, and editing, MSAS contributed to the statistical analysis and interpretation, and editing. All authors have critically reviewed and approved the final draft and are responsible for the manuscript's content and similarity index.

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