

Meta-Analysis

Comparison of surgical approaches of total hip arthroplasty in Crowe 3/4 dysplastic hips in adults: a systematic review and meta-analysis

Zina Smadi¹, Sereen Halayqeh^{1,2*}, Yazeed E. Alhanbali¹, Arez R. Faraj¹,
Omar M. Ismail¹, Bassem I. Haddad³

¹School of Medicine, The University of Jordan, Amman, Jordan

²Hospital for Special Surgery, New York, United States of America

³Department of Special Surgery, Division of Orthopedics, School of Medicine, The University of Jordan, Amman, Jordan

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*Correspondence:

Dr. Sereen Halayqeh,

E-mail: sereenhalaika99@gamil.com

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ABSTRACT

Developmental dysplasia of the hip (DDH) presents unique challenges for total hip arthroplasty (THA) due to altered anatomy, requiring tailored surgical approaches. Differences in outcomes such as Harris Hip Score (HHS), leg length discrepancy (LLD), operative variables, and postoperative complications between THA approaches remain unclear. This meta-analysis aimed to evaluate variations in functional outcomes, operative data, and postoperative complications among THA approaches in adult patients with DDH, focusing on direct anterior (DAA), posterolateral (PLA), and anterolateral (ALA) approaches, as well as osteotomy versus non-osteotomy techniques. Following preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines, we systematically searched PubMed, Cochrane, and manual sources for retrospective studies published until March 2024. An inverse variance pooling meta-analysis was conducted. Thirty-five studies (1501 hips; 1246 patients; mean age 46.9 years; mean follow-up 7 years) were included. HHS improved by 47.08 points with no significant differences between approaches ($p=0.81$) or osteotomy groups ($p=0.96$). LLD reduced by 3.50 cm overall, with the posterior approach achieving the greatest reduction (-3.67 cm, $p=0.03$). Operative time (148.47 minutes) and blood loss (832.74 ml) did not differ significantly between DAA and PLA ($p=0.59$ and $p=0.08$, respectively). Minor complications, including nerve palsy and non-union, were rare. Dislocation rates were higher with the posterior approach (2%, $p=0.04$), while infection rates were negligible (0%). THA approaches in DDH yield comparable functional and operative outcomes. The posterior approach achieved the greatest LLD reduction but had a higher risk of dislocation, highlighting the need for careful approach selection.

Keywords: DDH, Dysplastic hip, Crowe III, Crowe IV, Total hip arthroplasty

INTRODUCTION

Developmental dysplasia of the hip (DDH) is one of the most common congenital conditions diagnosed in children.^{1,2} If left untreated, DDH can persist into adulthood, leading to abnormal gait patterns, restricted movement, weakened muscles, and an increased risk of joint degeneration.³

In adults with DDH, several surgical treatment options are available. The University of Colorado Periacetabular Osteotomy (CU PAO) is a common procedure used to realign the acetabulum in cases of symptomatic acetabular dysplasia.⁴ This approach allows for early weight-bearing, cosmetic incisions, and favorable short-term outcomes. Another option, the Birmingham Interlocking Pelvic Osteotomy (BIPO), focuses on enhancing the

reproducibility of pelvic osteotomies, leading to quicker recovery.⁵ Lastly, total hip arthroplasty (THA) is the most effective solution for reducing pain, improving joint function, and adjusting differences in leg length for individuals with severe arthritis resulting from DDH.⁶

Among all surgical treatment options for DDH, THA remains the main treatment for patients with end-stage osteoarthritis secondary to DDH.⁷ The primary surgical methods used in hip replacement surgery are the posterior and lateral approaches, only a small number of orthopaedic surgeons opt for the anterior approach.⁸ In the most extensive study to date, cementless THA combined with a subtrochanteric femoral shortening osteotomy in patients with a high-grade hip dislocation secondary to dysplasia showed high rates of successful implant fixation and stable clinical improvement.⁹

Complications may arise following THA, such as leg length discrepancy (LLD), early dislocation, and temporary and permanent nerve injuries.¹⁰ Moreover, other complications may involve wound healing issues, infection, and periprosthetic fractures.¹¹ Additionally, THA for severe DDH poses a challenge for surgeons due to anatomical abnormalities like a small femoral canal, increased anteversion, and a hypoplastic acetabulum.^{12,13}

A review of the literature reveals a significant gap in research comparing the various THA approaches for Crowe type 3/4 DDH in adults. The goal of this study is to address this gap by comparing the outcomes of different THA approaches in managing DDH in adult patients. Specifically, we aim to evaluate differences in Harris hip score (HHS), LLD, operative characteristics, and postoperative complications among the most commonly used approaches.

METHODS

This systematic review was conducted in line with the preferred reporting items for systematic reviews and meta-analyses (PRISMA).¹⁴ It was also registered with PROSPERO with the ID (CRD42024517038).

Eligibility criteria

Studies were considered eligible if they satisfied the following criteria: all retrospective cohorts reporting outcomes of interest post THA in Crowe 3/4 DDH in adults; direct anterior approach, posterolateral approach, anterolateral approach of THA whether they were with osteotomy or without osteotomy; and published in the English language.

Exclusion criteria included: studies including Crowe 1/2 DDH only; studies including other different approaches of THA; studies with incomplete or unextractable data for review; and review articles, preclinical, cadaveric and anatomical studies, and case reports.

Search strategy

We performed computer systematic literature searches of the PubMed and Cochrane databases for published papers from inception till March 2024 with the following keywords and their derivatives “(crowe) OR (iii/iv) OR (DDH) OR (hip dysplasia) AND (total hip arthroplasty in adults)” in all fields (title, keywords, and abstract). A second search was conducted with the terms “hip dysplasia” and “arthroplasty” in all fields. A third search was conducted with the terms “Crowe 3/4” and “arthroplasty”. Searches performed with very broad search terms were used to ensure we did not miss any articles presenting different surgical approaches of THA in adult DDH. Search results were screened against the eligibility criteria by two authors independently based on the title and/or abstract. Conflicts were resolved via a discrepancy meeting with a third senior author, if needed. The abstracts were compiled in a reference management software, Rayyan.ai.

Data extraction

Two independent reviewers used a predesigned data collection sheet in Microsoft excel to extract data. The extracted demographic data included the first authors' surnames, study year, design and country, number of participants and hips, the mean age of patients, approach used, osteotomy type, follow-up duration, the mean of preoperative and postoperative HHS, LLD, operative data including operative time and estimated blood loss, postoperative complications including nerve palsy, non-union, osteolysis, loosening, dislocation rate, infection rate, and fracture rate.

Risk of bias and quality assessment

The methodological quality of the included studies was assessed using the quality assessment tool for before-after (pre-post) studies with no control group developed by the National Heart Lung and Blood Institute website (NHLBI).¹⁵ The publication bias of the primary outcomes was assessed by checking for asymmetry in the funnel plots either visually, or statistically using Egger's test for continuous outcomes or the method suggested by Peters et al.^{16,17}

Outcomes of interest

Our main outcomes of interest were preoperative and postoperative HHS, LLD, operative data including operative time and estimated blood loss, postoperative complications including nerve palsy, non-union, osteolysis, loosening, dislocation rate, infection rate, and fracture rate.

Statistical analysis

The continuous outcomes were presented as mean difference (MD) with its respective 95% confidence

interval (95% CI) while binary outcomes were presented as proportions (%) with their corresponding 95% (95% CI). The data analysis was conducted using the package "meta" in R statistical software (v4.1.2; R Core Team 2021).¹⁸ Random effects model was adopted when significant heterogeneity was detected ($I^2 > 60\%$), while a fixed effects model was used when the data was more homogenous. Results were presented using a forest plot for each outcome.

Subgroup analysis was conducted for each of the primary outcomes to check for differences between different surgical approaches and between doing osteotomies or not.

RESULTS

Study selection

Searching the databases yielded 4459 articles, and after removing 4331, 159 records were screened by title and abstracts, of which 59 were excluded. A total of 46 papers were eligible for a full-text review. As a result, 35 studies met the eligibility criteria and were included in the qualitative and quantitative synthesis. The PRISMA flowchart is displayed in Figure 1.

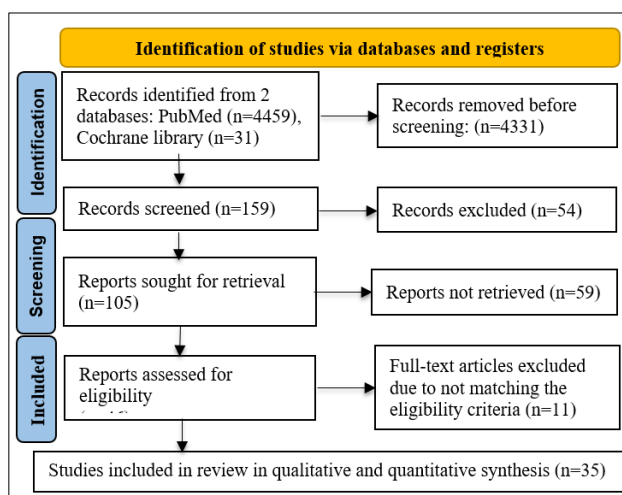


Figure 1: PRISMA flow diagram of record identification, screening and selection in meta-analysis.

Pooled study characteristics

The search yielded 4459 records, of which 35 records were included in the review and analysis, that encompassed 1501 DDH hips of 1246 patients that underwent surgeries, with an average age of 46.9 years. The posterior approach was the most used approach (24 records, 69%), with 30 records reporting doing an osteotomy (86%). The oldest record was published in 2001, and about a third of the records were conducted solely in China (13 records, 37%), followed by Italy (5, 14%), and Turkey (4, 11%). More details regarding the characteristics of the included studies can be found in Table 1.

Harris hip score

The mean change of Harris score between before and after the operation of the 35 included reports were pooled using a random effects model and yielded a mean improvement of 47.08 points on the Harris score (95% CI = [44.37; 49.80]), with significant heterogeneity ($I^2=97\%$). The forest plot of the change in Harris score is seen in Figure 2.

Subgroup analysis showed no significant difference in the Harris score between different approaches nor between doing an osteotomy or not ($p=0.81$ and $p=0.96$, respectively). Studies that reported using multiple approaches or doing an osteotomy for some patients without reporting the result of each group separately were not included in the subgroup analysis.

Limb length discrepancy

The change in LLD between the two limbs was reported in 27 studies including 936 hips, and the mean change between pre-op and post-op was pooled under random effects model and showed a reduction in the LLD of 3.50 cm [-3.80; -3.19], with significant heterogeneity ($I^2=95\%$). The forest plot of the change in LLD is seen in Figure 3.

Subgroup analysis showed no significant association between the change in LLD and doing an osteotomy ($p=0.750$). However, a significant difference between the approaches used was noted ($p=0.050$), where the posterior approach was found to provide the highest reduction in LLD (-3.67, [-4.06; -3.28]) compared to direct anterior approach (-2.84, [-3.39; -2.29]) and anterolateral approach (-3.44, [-4.23; -2.65]).

Operative variables

The operation time and blood loss outcomes were only reported by 9 and 6 studies, respectively with all of them doing an osteotomy. Figures 4 and 5 represent the forest plots of the operation time and blood loss outcomes along with their subgroup analyses.

The operation time had a significant heterogeneity ($I^2=99\%$) with reports ranging from 72 minutes up to 276 minutes. The pooled estimate of the operation time was 148.47 minutes [114.48; 182.46], with no difference between the direct anterior and the posterior approaches ($p=0.59$). Similarly, the reported intraoperative blood loss was highly heterogeneous among the studies ($I^2=96\%$). The pooled estimate was a mean blood loss of 832.74 ml [578.68; 1086.80], with no significant difference between the direct anterior and the posterior approaches ($p=0.08$).

Postoperative complications

The incidence rates of nerve palsy (0.01, [0.00; 0.02]), non-union (0.01, [0.00; 0.01]), osteolysis (0.00, [0.00; 0.01]), and loosening (0.00, [0.00; 0.01]) were very

minimal with no significant heterogeneity. As can be seen in Figure 6, the pooled rate of occurrence of dislocations after the operation was 2% [1%; 3%] with minimal heterogeneity ($I^2=22\%$, fixed effect). Subgroup analysis comparing those with osteotomies and this without showed no significant difference ($p=0.55$), while comparing the different approaches showed that the posterior approach had a significantly higher rate of dislocations ($p=0.04$).

Similarly, presented in Figure 7, the pooled rate of fractures after the operation was 2% [1%; 2%] with some heterogeneity ($I^2=54\%$, fixed effect), with no significant differences noted between different approached or with osteotomies ($p=0.14$ and $p=0.82$, respectively).

On the other hand, the rate of postoperative infections was minimal (0%, [0%; 1%]), with only four studies reporting the occurrence of any infections, as can be found in Figure 8. There was no heterogeneity between the studies ($I^2=0\%$, fixed effect). Subgroup analyses showed no differences between approaches nor between surgeries with

osteotomies and those without ($p=0.94$ and $p=0.95$, respectively).

Quality assessment [risk of bias and level of evidence (LoE)]

The methodological quality of the included studies was assessed using the quality assessment tool for before-after studies with no control group developed by the NHLBI.¹⁵ Results of the assessment can be found in Table 2.

Publication bias

Funnel plots for the major outcomes. The asymmetry of the funnel plots for the Harris score and LLD indicate potential risk of publication bias, however an insignificant Egger's test ($p=0.472$ and $p=0.561$) refute such possibility. On the other hand, funnel plots of dislocation, fracture, and infection rates do not suggest publication bias, however, only fractures rate was not statistically significant ($p=0.223$), while dislocation and infection rates were both significant for publication bias ($p<0.001$ and $p=0.042$, respectively).

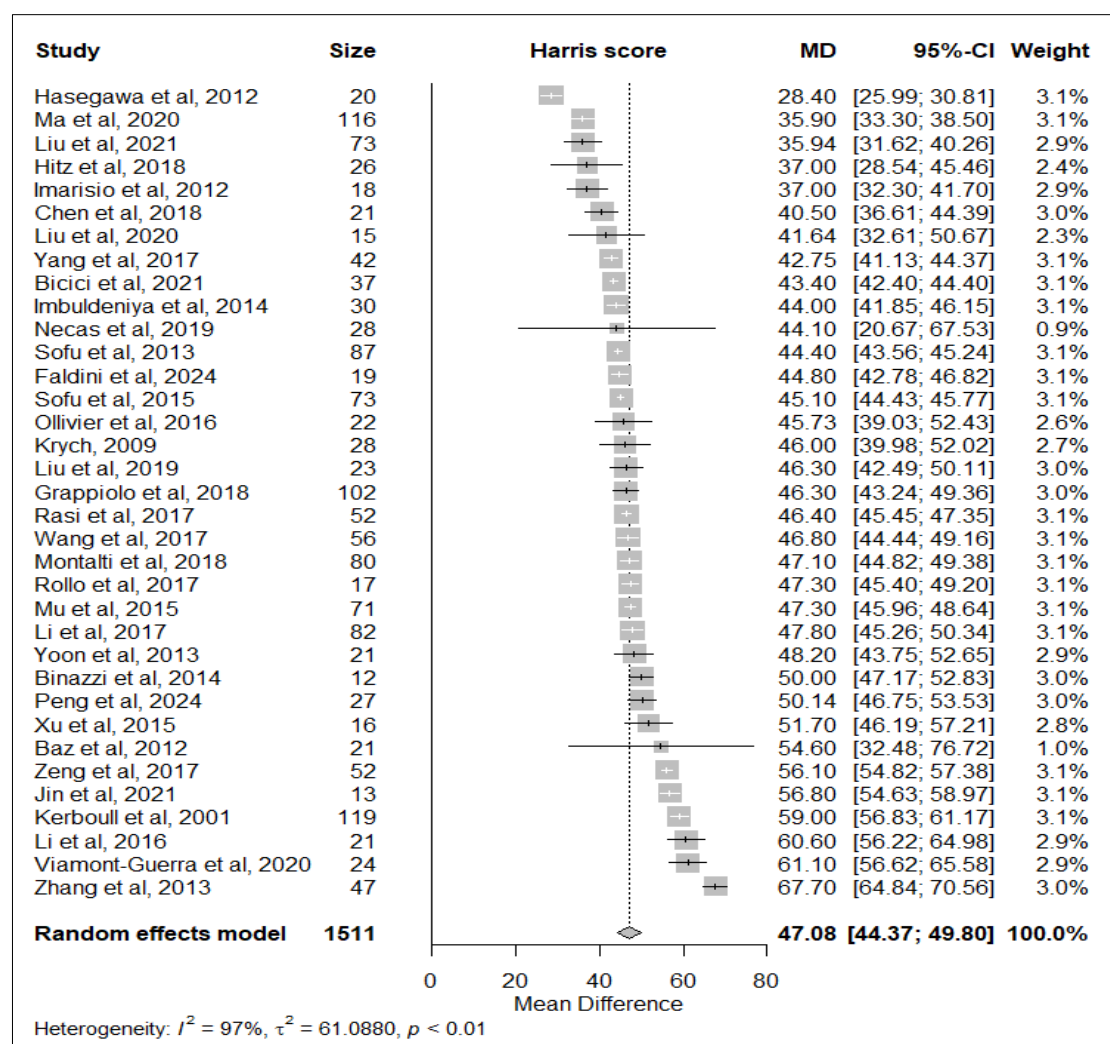


Figure 2: Forest plot of the change in Harris score outcome

Table 1: Characteristics of the included studies.

Study	Country	Number of patients	Number of hips	Age	CRO -WE	Approach	Osteotomy
Necas et al, 2019	Slovak and Czech Republics	23	28	49.9	4	Anterolateral	Transverse
Liu et al, 2020	China	14	15	34.3	3/4	Direct anterior	Subtrochanteric
Liu et al, 2019	China and USA	21	23	46.5	4	Posterior	Subtrochanteric
Rasi et al, 2017	Iran	48	52	41	3/4	Anterolateral	Subtrochanteric
Liu et al, 2021	China and USA	69	73	46	3/4	Direct anterior (23 hips), posterior (50 hips)	Transverse subtrochanteric
Zhang et al, 2013	China	35	47	61		Posterior	Femoral neck
Zeng et al, 2017	China	45	52	40.6	4	Posterior	Transverse subtrochanteric
Baz et al, 2012	Turkey	15	21	41.6	4	Posterior	Transverse subtrochanteric
Binazzi et al, 2014	Italy	11	12	48	4	Anterolateral	None
Yoon et al, 2013	Korea	17	21	52.3	3/4	Anterolateral	Subtrochanteric
Grappiolo et al, 2018	Italy	74	102	53.9	4	Posterior	Transverse subtrochanteric
Hasegawa et al, 2012	Japan	18	20	58.5	4	Posterior	Subtrochanteric step-cut
Hitz et al, 2018	France & Switzerland	23	26	45	3/4	Anterolateral Wattson-Jones approach	Greater trochanteric osteotomy
Li et al, 2016	China	17	21	43.6	4	Posterior	Subtrochanteric transverse/oblique
Imarasio et al, 2012	Italy	17	18	50	4	Posterior	Subtrochanteric
Imbuldeniya et al, 2014	Australia	25	30	47	3/4	Posterior	None
Chen et al, 2018	China	18	21	47	4	Posterior	Subtrochanteric
Jin et al, 2021	Korea	13	13	50	4	Posterior	Modified trochanteric osteotomy
Kerboull et al, 2001	France	89	119	52	4	Anterolateral	Shelf procedure (32 hips), femoral osteotomy (23 hips), Girdlestone (8 hips), arthrodesis (1 hip), and cup or acrylic arthroplasty (9 hips)
Yang et al, 2017	Taiwan	21	21	42.9	3/4	Posterior	Subtrochanteric (10 hips), proximal cup placement (11 hips)
Krych, 2009	USA	24	28	47.6	4	Posterior: 26, anterior: 2	Subtrochanteric
Li et al, 2017	China	74	82	55.8	3/4	Posterior	None
Faldini et al, 2024	Switzerland	19	19	55	4	Direct anterior	None
Montalti et al, 2018	Italy	80	80	54.6	3/4	Anterolateral	None
Mu et al, 2015	China	58	71	35.8	3/4	Posterior	Subtrochanteric (61 hips)
Xu et al, 2015	China	14	16	52	4	Posterior	Subtrochanteric (4 patients)
Ollivier et al, 2016	USA	24	28	48	4	Posterior/antero lateral	Subtrochanteric

Continued.

Study	Country	Number of patients	Number of hips	Age	CRO -WE	Approach	Osteotomy
Ma et al, 2020	China	58	116	37.3	4	Posterior	Subtrochanteric (86 hips)
Rollo et al, 2017	Italy	15	17	38.6	4	Anterolateral	Subtrochanteric
Wang et al, 2017	China	49	56	36.9	3/4	Posterior	Subtrochanteric
Peng et al, 2024	China	24	27	43.3	4	Posterior	Greater trochanteric osteotomy (15 hips), subtrochanteric (12 hips)
Sofu et al, 2013	Turkey	74	87	46.8	4	Posterior/antero lateral	Transverse subtrochanteric
Sofu et al, 2015	Turkey	68	73	47	3/4	Posterior	Transverse subtrochanteric
Viamont-Guerra et al, 2020	France	23	29	49	3/4	Direct anterior	Subtrochanteric
Bicici et al, 2021	Turkey	29	37	43	3/4	Posterior	Subtrochanteric

Table 2: Quality assessment of the included studies.

Criteria	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Necas et al, 2019	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Liu et al, 2020	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y	NA
Liu et al, 2019	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Rasi et al, 2017	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Liu et al, 2021	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Zhang et al, 2013	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Zeng et al, 2017	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Baz et al, 2012	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y	NA
Binazzi et al, 2014	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Yoon et al, 2013	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Grappiolo et al, 2018	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Hasegawa et al, 2012	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Hitz et al, 2018	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Li et al, 2016	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Imarasio et al, 2012	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y	NA
Imbuldeniya et al, 2014	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Chen et al, 2018	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Jin et al, 2021	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y	NA
Kerboull et al, 2021	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Yang et al, 2017	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Krych et al, 2009	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Li et al, 2017	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Faldini et al, 2024	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y	NA
Montalti et al, 2018	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Mu et al, 2015	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Xu et al, 2015	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y	NA
Ollivier et al, 2016	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Ma et al, 2020	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Rollo et al, 2017	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y	NA
Wang et al, 2017	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Peng et al, 2024	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y	NA
Sofu et al, 2013	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Viamont-Guerra et al, 2020	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA
Biçici et al, 2021	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	NA

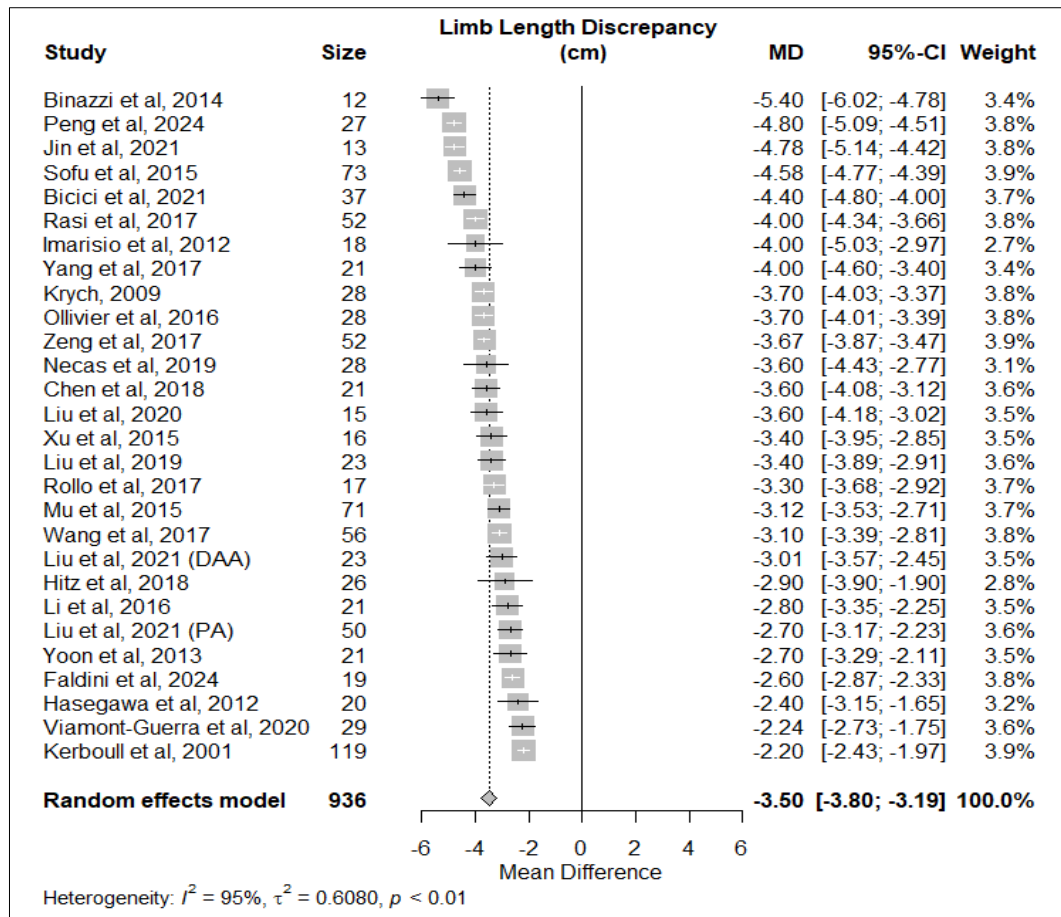


Figure 3: Forest plot of the change in limb length discrepancy.

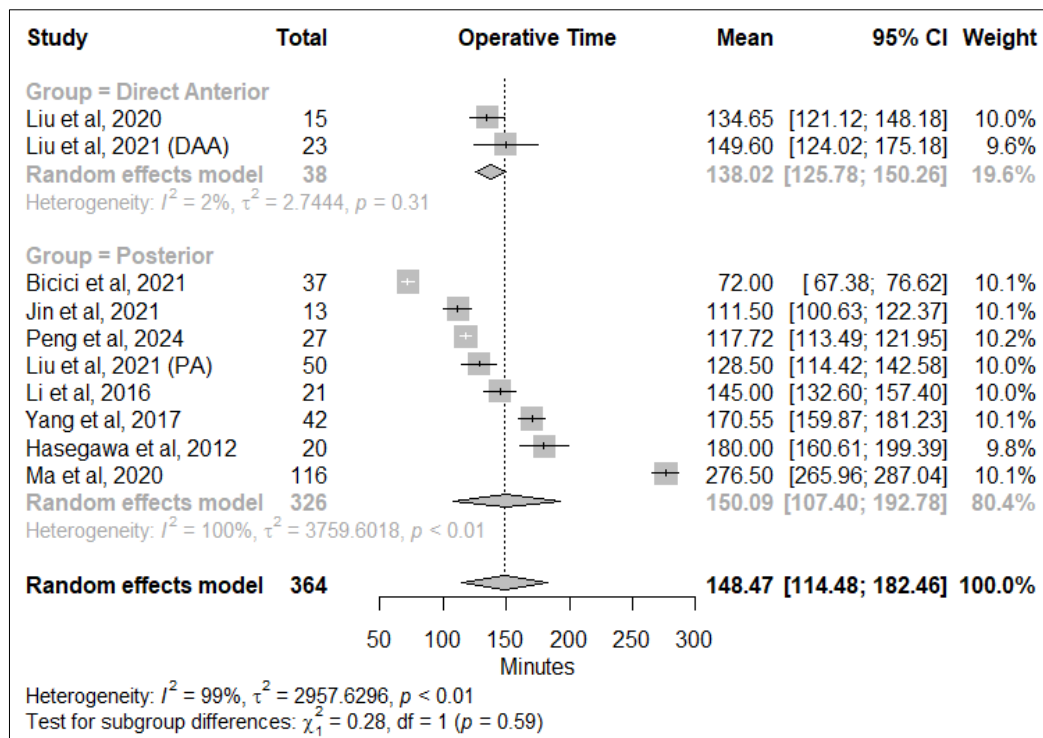


Figure 4: Forest plot of operation time outcome showing the overall pooled estimate and the subgroup analysis according to the surgical approach used.

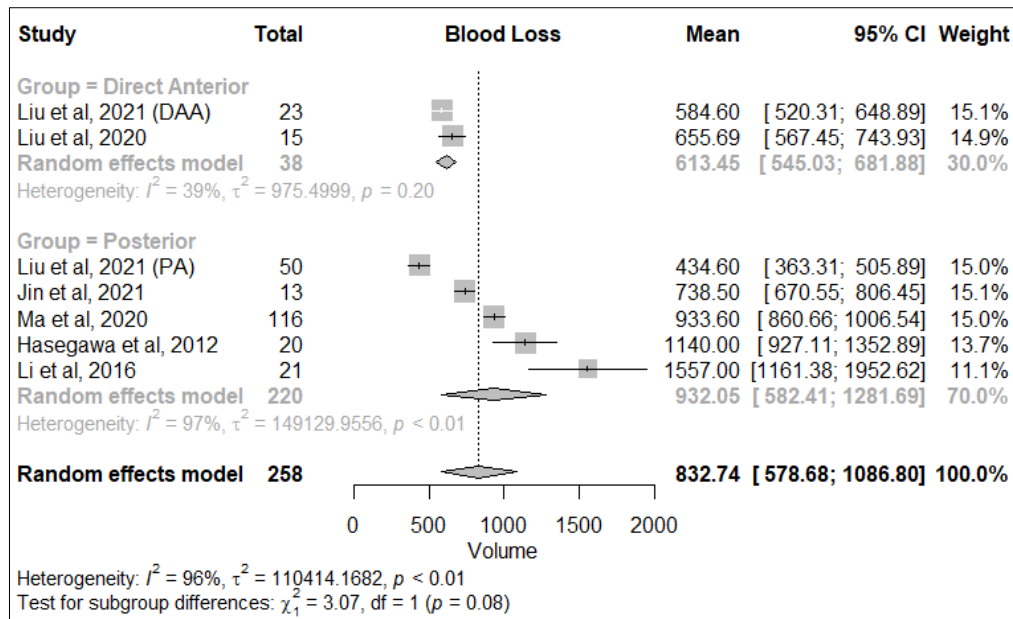


Figure 5: Forest plot of the intraoperative blood loss outcome showing the overall pooled estimate and the subgroup analysis according to the surgical approach used.

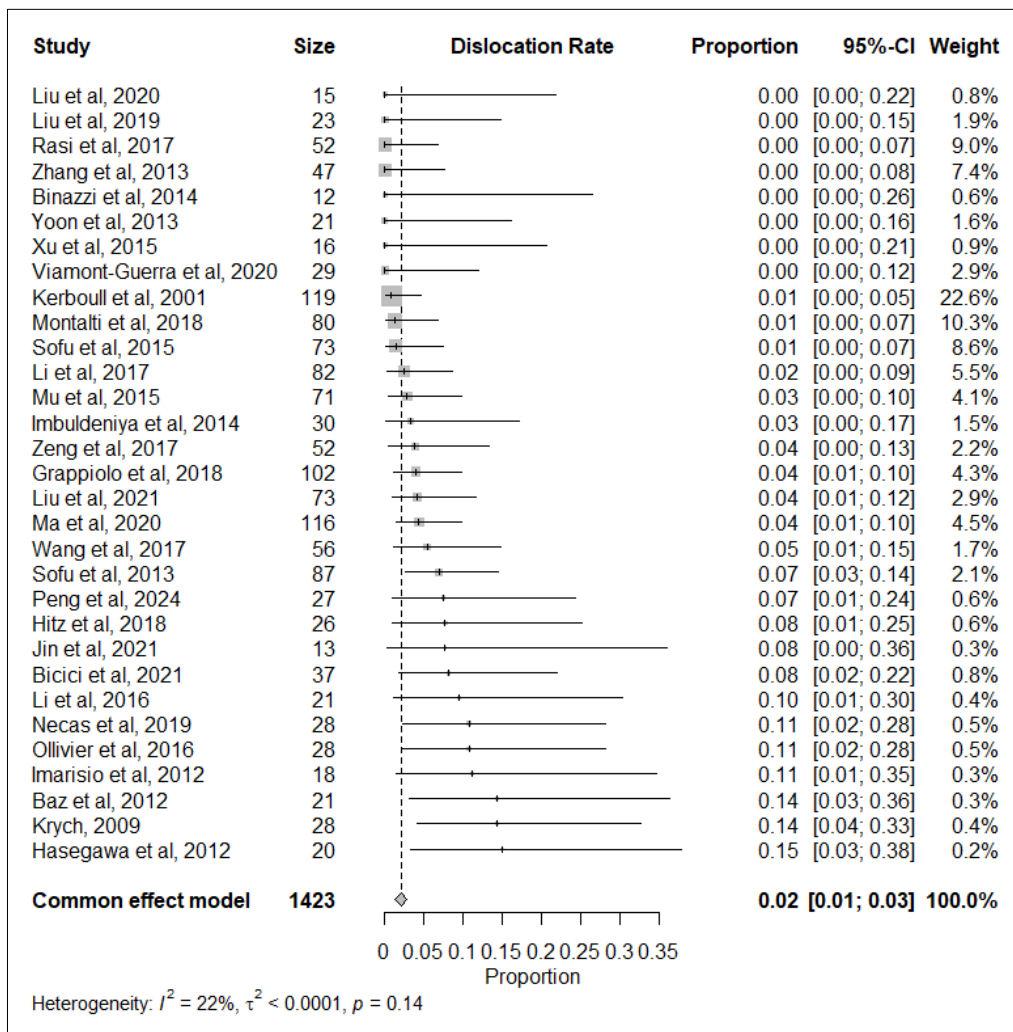


Figure 6: Forest plot of the dislocation rate outcome.

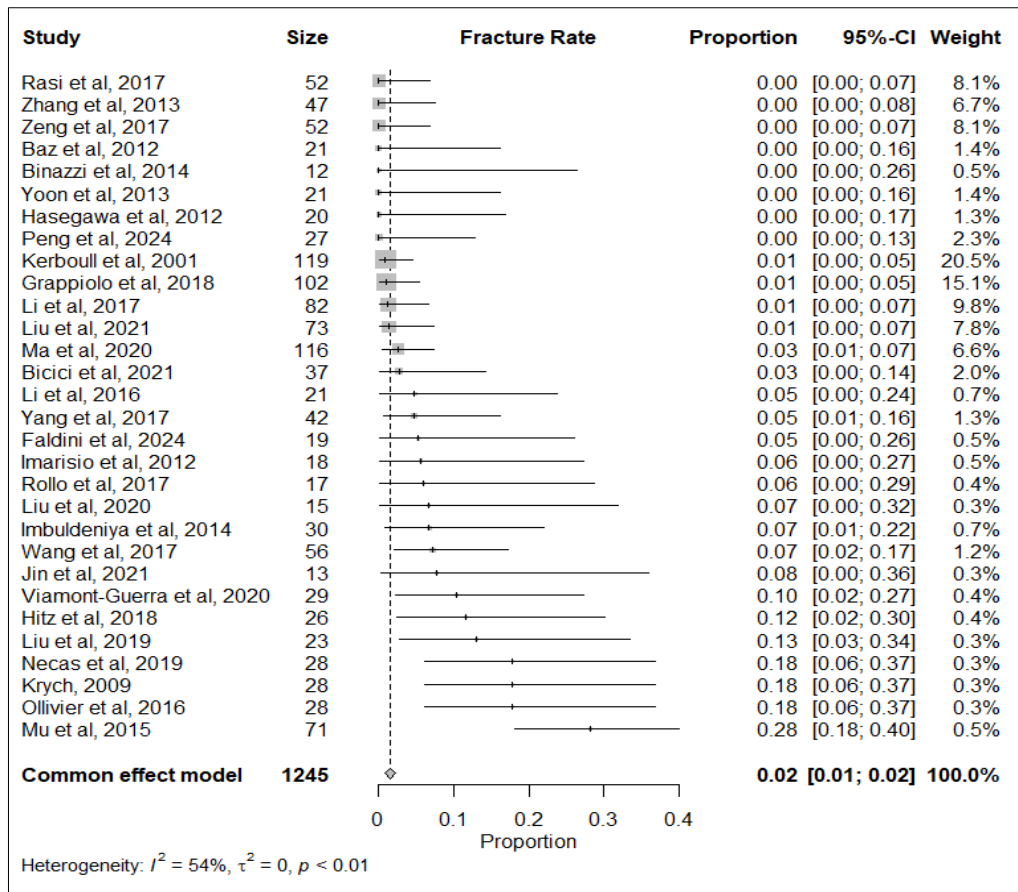


Figure 7: Forest plot of the fracture rate outcome.

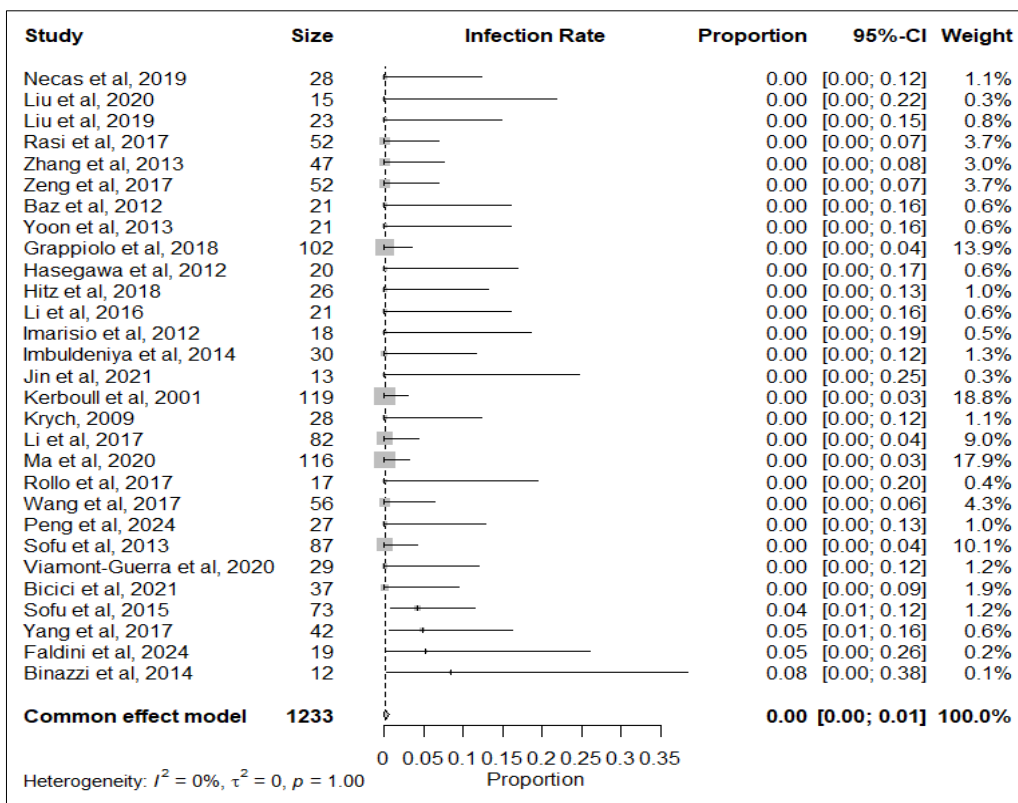


Figure 8: Forest plot of the infection rate outcome.

DISCUSSION

In this study, both Harris scores and LLD showed significant improvements postoperatively in adult patients with DDH undergoing THA. The Harris score is a widely used tool for assessing hip conditions and outcomes of hip surgeries.¹⁹⁻²¹ Despite its limitations—such as a high ceiling effect and inter-observer variability in some components—it remains a reliable method for evaluating postoperative outcomes.²²⁻²⁴ Our analysis found a significant average improvement of 47.08 points in the HHS following THA across all surgical approaches. This is consistent with findings from a systematic review of 3,356 hips in Crowe type IV DDH patients, which also reported significant postoperative improvements in both the Harris score and LLD.²⁵ Additionally, a study of 104 patients with a minimum 13-year follow-up found a significant decline in Harris scores in the Crowe II-IV DDH group.²⁶

In our analysis, we compared outcomes between patients who underwent THA with and without osteotomy. Our findings revealed no significant difference in either the Harris score or LLD between these two groups. Although osteotomy is often considered the “gold standard” for THA in DDH patients, it has some limitations, particularly the potential for residual LLD.²⁷ However, this complication was not observed in our study, as complete limb symmetry was achieved in both groups, regardless of whether osteotomy was performed.

When examining the impact of different surgical approaches, our analysis showed no significant differences in Harris scores between patients undergoing the anterior, posterior, or anterolateral approaches. This supports the findings of Liu et al., who compared the direct anterior approach (DAA) with the conventional posterolateral approach (PLA) in DDH patients and found no difference in Harris scores between the two.²⁸ However, we did observe significant differences in LLD reductions between the approaches, with the posterior approach achieving the greatest reduction in LLD. While many studies comparing the direct anterior and posterior approaches reported no significant differences in LLD, other studies favored the anterior approach for reducing LLD.²⁹⁻³³

Regarding operative characteristics, our study found an average operative time of 148.47 minutes (approximately 2.5 hours), with no significant differences between the different THA approaches. Literature reports on THA operative times vary widely, ranging from 72 to 276.5 minutes.^{34,35} Some studies have suggested that the posterior approach may be associated with shorter operative times compared to the anterior approach.³⁶⁻³⁸ For intraoperative blood loss, we found that the mean estimated blood loss across the 6 studies reporting it was 832.74 ml, with no significant differences between the anterior and posterior approaches. Reported blood loss in the literature ranged from 434.6 ml to 1,557 m.^{28,39} Consistent with our findings on operative time, a

prospective randomized clinical trial has shown that the posterior approach tends to result in less blood loss compared to the anterior approach.³⁶

THA is generally considered a safe procedure with a low complication rate, though complications can still occur.⁴⁰ In this study, postoperative complications such as nerve injuries, non-union, osteolysis, and loosening were reported at low rates across different surgical approaches. However, literature suggests that sciatic nerve injury is more commonly reported with the posterior approach, while femoral nerve injury is more frequently associated with the anterior approach.^{41,42} Non-union has been reported more often in patients undergoing posterior THA combined with osteotomy.⁴³⁻⁴⁵ To mitigate this, some surgeons recommend using a stem with an appropriate length to bridge the osteotomy site and reinforcing the fixation with locking plates or wiring.⁴⁶ Regarding osteolysis, the highest incidence was reported in 17 out of 30 hips (56.7%) in a posterior THA cohort without osteotomy, attributed to polyethylene wear.⁴⁷ Other studies have also linked osteolysis to the posterior approach.^{46,48} For patients undergoing femoral shortening osteotomy, a long-term complication of THA is femoral stem loosening, particularly in cases of severe hip dysplasia.⁴⁸ In our analysis, the highest rate of prosthesis loosening was observed in 5 cases (two cups and three stems) among 23 hips that underwent posterior THA with subtrochanteric osteotomy, where small, deeply seated components were used to achieve cup coverage and avoid loosening.⁴⁹ However, prosthesis loosening is a rare complication, with an incidence of less than 0.4% in most studies, while other studies reported a rate of 1%.^{9,50,51}

Other postoperative complications after THA include dislocations, fractures, and infections.⁴⁰ In our study, complications did not differ significantly between approaches, except for dislocation rates, which were higher in patients undergoing posterior THA. This aligns with findings from several studies that attribute the higher dislocation rate in the posterior approach to lower soft tissue tension, as tendons and muscles are left more intact in the anterior approach.⁵²⁻⁵⁶ However, other studies have found no difference in dislocation rates between different approaches, and most studies included in our analysis did not show significant differences in overall complications between THA approaches.^{36,57-61}

This meta-analysis has several limitations. First, the studies included did not encompass patients from some important regions, such as the Middle East, Eastern Europe, Africa, and Southeast Asia, where healthcare services may differ and could influence outcomes. Second, many of the included studies focused on THA with osteotomy and the posterolateral approach (PLA), resulting in limited representation of other approaches. Finally, some studies did not report full operative data or clarify whether the surgeries were the initial procedures for DDH or subsequent revisions.

CONCLUSION

It can be concluded that there are no significant outcome differences between osteotomy vs no-osteotomy THA for Crowe types 3 and 4 DDH or between the different surgical approaches (DAA, PLA, ALA) in terms of Harris Score and post-op major complications (fracture, infection, dislocation). No difference was noted between the DAA and Posterior approaches among operative variables (blood loss and operative time). However, there has been an increased dislocation rate in the posterior approach in comparison to the other approaches. The incidence of nerve palsy, non-union, osteolysis and loosening were minimal across different approaches.

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Ethical approval: Not required

REFERENCES

- Guille JT, Pizzutillo PD, MacEwen GD. Development dysplasia of the hip from birth to six months. *J Am Acad Orthop Surg.* 2000;8(4):232-42.
- Jacobsen S, Sonne-Holm S. Hip dysplasia: a significant risk factor for the development of hip osteoarthritis. A cross-sectional survey. *Rheumatol (Oxf).* 2005;44(2):211-8.
- Dezateux C, Rosendahl K. Developmental dysplasia of the hip. *Lancet.* 2007;369:1541-52.
- Mei-Dan O, Welton KL, Kraeutler MJ, Young DA, Raju S, Garabekyan T. The CU PAO: A Minimally Invasive, 2-Incision, Interlocking Periacetabular Osteotomy: Technique and Early Results. *J Bone Joint Surg Am.* 2019;101(16):1495-504.
- Mu W, Yang D, Xu B, Mamtimin A, Guo W, Cao L. Midterm Outcome of Cementless Total Hip Arthroplasty in Crowe IV-Hartofilakidis Type III Developmental Dysplasia of the Hip. *J Arthroplasty.* 2016;31(3):668-75.
- Dhaliwal AS, Akhtar M, Razick DI, Afzali A, Wilson E, Nedopil AJ. Current Surgical Techniques in the Treatment of Adult Developmental Dysplasia of the Hip. *J Pers Med.* 2023;13(6):942.
- Sanchez-Sotelo J, Berry DJ, Trousdale RT, Cabanela ME. Surgical treatment of developmental dysplasia of the hip in adults: II. Arthroplasty options. *J Am Acad Orthop Surg.* 2002;10(5):334-44.
- Chechik O, Khashan M, Lador R, Salai M, Amar E. Surgical approach and prosthesis fixation in hip arthroplasty world wide. *Arch Orthop Trauma Surg.* 2013;133(11):1595-600.
- Ollivier M, Abdel MP, Krych AJ, Trousdale RT, Berry DJ. Long-Term Results of Total Hip Arthroplasty With Shortening Subtrochanteric Osteotomy in Crowe IV Developmental Dysplasia. *J Arthroplasty.* 2016;31(8):1756-60.
- Zeng WN, Liu JL, Wang FY, Zhang X, Fan HQ, Chen GX, et al. Total hip arthroplasty for patients with Crowe type IV developmental dysplasia of the hip: Ten years results. *Int J Surg.* 2017;42:17-21.
- Varacallo M, Luo TD, Johanson NA. Total Hip Arthroplasty Techniques. In: StatPearls. Treasure Island (FL): StatPearls Publishing. 2024.
- Argenson JN, Flecher X, Parratte S, Aubaniac JM. Anatomy of the dysplastic hip and consequences for total hip arthroplasty. *Clin Orthop Relat Res.* 2007;465:40-5.
- Crowe JF, Mani VJ, Ranawat CS. Total hip replacement in congenital dislocation and dysplasia of the hip. *J Bone Joint Surg Am.* 1979;61(1):15-23.
- Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *J Clin Epidemiol.* 2009;62(10):1006-12.
- National Heart, Lung, and Blood Institute. Study Quality Assessment Tools. Available at: <https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools>. Accessed on 12 December 2024.
- Egger M, Smith GD, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *Br Med J.* 1997;315:629-34.
- Peters JL, Sutton AJ, Jones DR, Abrams KR, Rushton L. Comparison of two methods to detect publication bias in meta-analysis. *JAMA.* 2006;295(6):676-80.
- Schwarzer G. General Package for Meta-Analysis [R package meta version 8.0-1]. Available at: <https://cran.r-project.org/web/packages/meta/index.html>. Accessed on 12 December 2024.
- Li F, Zhu L, Geng Y, Wang G. Effect of hip replacement surgery on clinical efficacy, VAS score and Harris hip score in patients with femoral head necrosis. *Am J Transl Res.* 2021;13(4):3851-5.
- Cheng K, Zhu H, Peng Y, Yan H, Wen X, Cheng Z, et al. To further incorporate computer-aided designs to improve preoperative planning in total hip arthroplasty: a cohort study. *Front Surg.* 2024;11:1345261.
- Bei M, Xiao Y, Xu Y, Chen Y, Cao Q, Zhao C, et al. Enhanced Outcomes in Femoral Subtrochanteric Fractures Using Long INTERTAN Nails with Titanium Cable Cerclage: A Retrospective Analysis. *Med Sci Monit.* 2024;30:e944383.
- Wamper KE, Sierevelt IN, Poolman RW, Bhandari M, Haverkamp D. The Harris hip score: Do ceiling effects limit its usefulness in orthopedics? *Acta Orthop.* 2010;81(6):703-7.
- Rose-Dulcina K, Gasparutto X, Djebara AE, Gauthier M, Zingg M, Lübbecke A, et al. Reliability of the Harris Hip limping sub-score in patients undergoing total hip arthroplasty. *Int Orthop.* 2024;48(4):991-6.
- Nilsson A, Bremander A. Measures of hip function and symptoms: Harris Hip Score (HHS), Hip Disability and Osteoarthritis Outcome Score (HOOS), Oxford Hip Score (OHS), Lequesne Index of Severity for Osteoarthritis of the Hip (LISOH),

- and American Academy of Orthopedic Surgeons (AAOS) Hip and Knee Questionnaire. *Arthritis Care Res (Hoboken)*. 2011;63(11):S200-7.
25. Esmaeili S, Ghaseminejad-Raeini A, Ghane G, Soleimani M, Mortazavi SMJ, Shafiei SH. Total Hip Arthroplasty in Patients Who Have Crowe Type IV Developmental Dysplasia of the Hip: A Systematic Review. *J Arthroplasty*. 2024;39(10):2645-60.
 26. Galea VP, Laaksonen I, Donahue GS, Fukui K, Kaneuji A, Malchau H, et al. Developmental Dysplasia Treated With Cementless Total Hip Arthroplasty Utilizing High Hip Center Reconstruction: A Minimum 13-Year Follow-up Study. *J Arthroplasty*. 2018;33(9):2899-905.
 27. Binazzi R. Two-Stage Progressive Femoral Lowering Followed by Cementless Total Hip Arthroplasty for Treating Crowe IV-Hartofilakidis Type 3 Developmental Dysplasia of the Hip. *J Arthroplasty*. 2015;30(5):790-6.
 28. Liu Z, Bell CD, Ong AC, Zhang J, Li J, Zhang Y. Clinical evaluation of direct anterior approach total hip arthroplasty for severe developmental dysplasia of the hip. *Sci Rep*. 2021;11(1):8105.
 29. Barrett WP, Turner SE, Leopold JP. Prospective randomized study of direct anterior vs postero-lateral approach for total hip arthroplasty. *J Arthroplasty*. 2013;28(9):1634-8.
 30. Jia F, Guo B, Xu F, Hou Y, Tang X, Huang L. A comparison of clinical, radiographic and surgical outcomes of total hip arthroplasty between direct anterior and posterior approaches: a systematic review and meta-analysis. *Hip Int*. 2019;29(6):584-96.
 31. Pujol O, Soza D, Lara Y, Castellanos S, Hernández A, Barro V. Restoring hip biomechanics during the learning curve of a novice surgeon: Direct anterior approach vs posterior approach. *J Orthop*. 2021;26:72-8.
 32. Tassinari L, Di Martino A, Brunello M, Rossomando V, Traina F, Faldini C. Leg length discrepancy after total hip arthroplasty performed by direct anterior approach: a systematic review comparing surgical approaches and strategies for prevention. *EFORT Open Rev*. 2024;9(8):733-44.
 33. Dunn H, Rohlfing G, Kollmorgen R. A comparison of leg length discrepancy between direct anterior and anterolateral approaches in total hip arthroplasty. *Arthroplasty*. 2020;2(1):30.
 34. Biçici V, Bingöl I, Sazak T. Mid-term results of total hip arthroplasty with subtrochanteric Z-osteotomy in Crowe type 3-4 developmental hip dysplasia. *Turk J Med Sci*. 2021;51(4):1976-83.
 35. Ma HY, Lu Q, Sun JY, Du YQ, Shen JM, Gao ZS, et al. One-Stage Total Hip Arthroplasty with Modular S-ROM Stem for Patients with Bilateral Crowe Type IV Developmental Dysplasia. *Orthop Surg*. 2020;12(6):1913-22.
 36. Cheng TE, Wallis JA, Taylor NF, Holden CT, Marks P, Smith CL, et al. A Prospective Randomized Clinical Trial in Total Hip Arthroplasty-Comparing Early Results Between the Direct Anterior Approach and the Posterior Approach. *J Arthroplasty*. 2017;32(3):883-90.
 37. Peng L, Zeng Y, Wu Y, Zeng J, Liu Y, Shen B. Clinical, functional and radiographic outcomes of primary total hip arthroplasty between direct anterior approach and posterior approach: a systematic review and meta-analysis. *BMC Musculoskelet Disord*. 2020;21(1):338.
 38. Fagotti L, Falotico GG, Maranhão DA, Ayeni OR, Ejnisman B, Cohen M, et al. Posterior versus anterior approach to total hip arthroplasty: a systematic review and meta-analysis of randomized controlled trials. *Acta Orthop Bras*. 2021;29(6):297-303.
 39. Li L, Yu M, Yang C, Gu G. Total hip arthroplasty (S-ROM stem) and subtrochanteric osteotomy for Crowe type IV developmental dysplasia of the hip. *Indian J Orthop*. 2016;50(2):195-200.
 40. Petis S, Howard JL, Lanting BL, Vasarhelyi EM. Surgical approach in primary total hip arthroplasty: anatomy, technique and clinical outcomes. *Can J Surg*. 2015;58(2):128-39.
 41. Slaven SE, Ho H, Sershon RA, Fricka KB, Hamilton WG. Motor Nerve Palsy After Direct Anterior Versus Posterior Total Hip Arthroplasty: Incidence, Risk Factors, and Recovery. *J Arthroplasty*. 2023;38(7S):S242-6.
 42. Farrell CM, Springer BD, Haidukewych GJ, Morrey BF. Motor nerve palsy following primary total hip arthroplasty. *J Bone Joint Surg Am*. 2005;87(12):2619-25.
 43. Yang TC, Chen CF, Tsai SW, Chen WM, Chang MC. Does restoration of hip center with subtrochanteric osteotomy provide preferable outcome for Crowe type III-IV irreducible development dysplasia of the hip?? *J Chin Med Assoc*. 2017;80(12):803-7.
 44. Krych AJ, Howard JL, Trousdale RT, Cabanela ME, Berry DJ. Total hip arthroplasty with shortening subtrochanteric osteotomy in Crowe type-IV developmental dysplasia. *J Bone Joint Surg Am*. 2009;91(9):2213-21.
 45. Sofu H, Kockara N, Gursu S, Issin A, Oner A, Sahin V. Transverse Subtrochanteric Shortening Osteotomy During Cementless Total Hip Arthroplasty in Crowe Type-III or IV Developmental Dysplasia. *J Arthroplasty*. 2015;30(6):1019-23.
 46. Liu ZY, Zhang J, Wu ST, Li ZQ, Xu ZH, Zhang X, et al. Direct Anterior Approach in Crowe Type III-IV Developmental Dysplasia of the Hip: Surgical Technique and 2 years Follow-up from Southwest China. *Orthop Surg*. 2020;12(4):1140-52.
 47. Imbuldeniya AM, Walter WL, Zicat BA, Walter WK. Cementless total hip replacement without femoral osteotomy in patients with severe developmental dysplasia of the hip: minimum 15-year clinical and radiological results. *Bone Joint J*. 2014;96-B(11):1449-54.
 48. Hasegawa Y, Iwase T, Kanoh T, Seki T, Matsuoka A. Total hip arthroplasty for Crowe type IV

- developmental dysplasia. *J Arthroplasty*. 2012;27(9):1629-35.
49. Liu T, Wang S, Huang G, Wang W. Treatment of Crowe IV developmental dysplasia of the hip with cementless total hip arthroplasty and shortening subtrochanteric osteotomy. *J Int Med Res*. 2019;47(7):3223-33.
50. Sofu H, S Ahin V, Gürsu S, Yildirim T, Issin A, Koçkara N. Cementless total hip arthroplasty in patients with Crowe type-4 developmental dysplasia. *Hip Int*. 2013;23(5):472-7.
51. Viamont-Guerra MR, Chen AF, Stirling P, Nover L, Guimarães RP, Laude F. The Direct Anterior Approach for Total Hip Arthroplasty for Severe Dysplasia (Crowe III and IV) Provides Satisfactory Medium to Long-Term Outcomes. *J Arthroplasty*. 2020;35(6):1642-50.
52. Sheth D, Cafri G, Inacio MC, Paxton EW, Namba RS. Anterior and Anterolateral Approaches for THA Are Associated With Lower Dislocation Risk Without Higher Revision Risk. *Clin Orthop Relat Res*. 2015;473(11):3401-8.
53. Tsukada S, Wakui M. Lower Dislocation Rate Following Total Hip Arthroplasty via Direct Anterior Approach than via Posterior Approach: Five-Year-Average Follow-Up Results. *Open Orthop J*. 2015;9:157-62.
54. Goldstein WM, Gleason TF, Kopplin M, Branson JJ. Prevalence of dislocation after total hip arthroplasty through a posterolateral approach with partial capsulotomy and capsulorrhaphy. *J Bone Joint Surg Am*. 2001;83-A:2-7.
55. White RE, Jr, Forness TJ, Allman JK, Junick DW. Effect of posterior capsular repair on early dislocation in primary total hip replacement. *Clin Orthop Relat Res*. 2001;393:163-7.
56. Sierra RJ, Raposo JM, Trousdale RT, Cabanela ME. Dislocation of primary THA done through a posterolateral approach in the elderly. *Clin Orthop Relat Res*. 2005;441:262-7.
57. Ang JJM, Onggo JR, Stokes CM, Ambikaipalan A. Comparing direct anterior approach versus posterior approach or lateral approach in total hip arthroplasty: a systematic review and meta-analysis. *Eur J Orthop Surg Traumatol*. 2023;33(7):2773-92.
58. Wang Z, Hou JZ, Wu CH, Zhou YJ, Gu XM, Wang HH, et al. A systematic review and meta-analysis of direct anterior approach versus posterior approach in total hip arthroplasty. *J Orthop Surg Res*. 2018;13(1):229.
59. Nambiar M, Cheng TE, Onggo JR, Maingard J, Troupis J, Pope A, et al. No Difference in Functional, Radiographic, and Survivorship Outcomes Between Direct Anterior or Posterior Approach THA: 5-Year Results of a Randomized Trial. *Clin Orthop Relat Res*. 2021;479(12):2621-9.
60. Higgins BT, Barlow DR, Heagerty NE, Lin TJ. Anterior vs. posterior approach for total hip arthroplasty, a systematic review and meta-analysis. *J Arthroplasty*. 2015;30:419-34.
61. Malek IA, Royce G, Bhatti SU. A comparison between the direct anterior and posterior approaches for total hip arthroplasty: the role of an 'Enhanced Recovery' pathway. *Bone Joint J*. 2016;98-B(6):754-60.

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