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Comparison of the clinical outcome after total hip endoprosthesis via the direct anterior or lateral approach: a systematic review with metaanalysis

Primerjava kliničnega izida vstavitve totalne endoproteze kolka preko anteriornega in lateralnega pristopa: sistematični pregled z metaanalizo

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Abstract

Background: The total hip endoprosthesis is one of the most successful elective surgical procedures in orthopaedic surgery. The choice of a surgical approach importantly influences the outcome of the intervention and globally, there is a preference towards the lateral approach. However, the direct anterior approach is gaining popularity, primarily due to less soft tissue trauma than in the lateral approach.

Methods: Our meta-analysis only included randomised control trials, which were selected from three English databases: *PubMed*, *Cochrane Library*, and *Clinical Trials*. The search was performed in December 2019. Information on country, sample size, intervention, outcome, and follow-up period has been extracted. The meta-analysis was performed using *Review Manager 5.3*.

Results: Seven randomized controlled trials totalling 723 patients were included. Comparing direct anterior and lateral approach to the total hip arthroplasty, no difference was found in the functional status graded using the Harris hip score at the end of follow-up, pain reported with visual analogue scale in the early and late postoperative period, blood loss, need for transfusion, length of hospital stay and appearance of the intra- and postoperative complications.

Conclusions: Comparison of the direct anterior and the lateral approach shows that there is no significant difference between the two approaches in functional status, pain reported in the early and late postoperative period, blood loss, need for transfusion, length of hospital stays, and occurrence of the intra- and postoperative complications. To date, there is no randomized controlled trial directly comparing clinical outcomes between the two approaches with a well-determined protocol.

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Key words: total hip arthroplasty; lateral approach; direct anterior approach; clinical outcome; metaanalysis

Ključne besede: totalna endoproteza kolka; stranski pristop; neposredni sprednji pristop; klinični izid; metaanaliza

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Izvleček

Izhodišča: Totalna endoproteza kolka velja za enega najuspešnejših posegov v ortopedski kirurgiji. Pomemben dejavnik vpliva na izid je izbira kirurškega pristopa. Trenutno je v svetu najbolj razširjen stranski pristop, v zadnjem času pa postaja zaradi manj poškodb mehkih tkiv vse bolj priljubljen sprednji pristop.

Metode: V sistemski pregled smo vključili randomizirane kontrolirane raziskave iz podatkovnih baz *PubMed* in *Cochrane Library* ter raziskave, prijavljene pri *Clinical Trials*. Iskanje smo opravili decembra 2019. Zabeležili smo podatek o državi, velikosti vzorca, posegu, izidu in času spremljanja. Metaanalizo smo opravili s programom *Review Manager 5.3*.

Rezultati: V metaanalizo smo vključili 7 randomiziranih kontroliranih raziskav s 723 preiskovanci. Med sprednjim in stranskim pristopom totalne endoproteze kolka ni razlik v funkcionalnem stanju, vrednotenem po Harrisu ob koncu spremljanja, v oceni bolečine po vizualni analogni lestvici tako v zgodnjem kot poznem obdobju po operaciji, v izgubi krvi, v potrebi po transfuziji, v trajanju bolnišnične oskrbe in v pojavnosti zapletov med operacijo in po njej.

Zaključki: Primerjava sprednjega in stranskega pristopa kaže, da med pristopoma ni statistično pomembnih razlik v funkcionalnem stanju ob koncu spremljanja, v oceni bolečine tako v zgodnjem kot poznem obdobju po operaciji, v izgubi krvi, v potrebi po transfuziji, v trajanju bolnišnične oskrbe in v pojavnosti zapletov med operacijo in po njej. Trenutno ne poteka nobena randomizirana kontrolirana raziskava, ki bi primerjala izid sprednjega in stranskega pristopa z natančno zastavljenim protokolom spremljanja.

1 Introduction

Total hip arthroplasty (THA) is one of the most common and successful elective procedures in orthopaedic surgery. It is the treatment of choice in advanced osteoarthritis regardless of the cause, significantly improving an individual's quality of life (1). The development of the THA protocol has enabled shorter hospital stays, faster rehabilitation and greater patient satisfaction with the procedure. Among the important factors influencing the improvement of THA success rate is the choice of surgical approach (2). Particularly in Europe, the lateral approach (LA) is probably the most commonly used; worldwide, it is used by approximately 42% of surgeons (3). The posterior approach, slightly more popular in the United States than in Europe, is also commonly used. The downside of the lateral approach is the need for at least a partial disinsertion, damaging the muscles during the approach to the joint (4). In contrast to LA, the direct anterior approach (DAA) has recently become more popular, but is currently performed by significantly fewer surgeons than LA (3). When describing DAA, most authors have the patient in the supine position; however, certain authors note the patient in the lateral decubitus position. For the anterior approach, a normal operating table or a specialized extension table are used; with the latter, the table allows hip hyperextension. In DAA, the incision is normally oblique, 2–4 cm distally and laterally to the anterior superior iliac spine (ASIS) to a few centimetres before the major trochanter. This is followed by the appearance of the fascia of the tensor fasciae latae muscle under the subcutaneous tissue, which is incised longitudinally. Blunt dissection in the interval between the sartorius and lateral tensor fasciae latae muscles enables access to the hip joint (5). DAA proponents argue that unlike LA, DAA results in less soft tissue damage because the joint is accessed between muscles and in the plane between nerves. Proponents of LA, on the other hand, argue that it allows for a better hip joint visualization and is associated with a low complication rate (4). Several randomized controlled trials (RCTs) are currently available comparing DAA and LA (6-12). Most of these have small sample sizes and report different outcomes. So far, four meta-analyses comparing DAA and LA have been conducted (13-16). In their meta-analysis, Yue et al included RCTs and other types of clinical research. In their conclusion, they report that current evidence is insufficient to determine which approach is better (14). Putanon et al also included the posterior approach alongside DAA and LA in their network meta-analysis. By indirectly comparing individual approaches in the meta-analysis, they concluded that DAA was superior, followed by LA (15). In their meta-analysis, Kucukdurmaz et al compared DAA with other approaches and, based on indirect comparisons, concluded that DAA provided the best functional outcome in the early postoperative period, while after six weeks, there was no difference between individual approaches (16). However, in their

meta-analysis, Wang et al compared only DAA and LA. The study concluded that in DAA, a trend towards less pain and blood loss was seen compared to LA, but further RCTs with larger sample sizes are needed to confirm this (13).

The problem with all meta-analyses to date is that in addition to RCTs, they include other types of clinical studies or compare all three THA approaches, performing only an indirect comparison of DAA and LA. None of the meta-analyses to date include an additional review of ongoing research in this field reported to the Clinical Trials database. The aim of our meta-analysis is to review the current RCTs comparing LA and DAA and to further analyze the ongoing research on the comparison between LA and DAA, included in the Clinical Trials database.

2 Materials and methods

The systematic review with meta-analysis was performed in accordance with the PRISMA recommendations (Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Figure 1).

2.1 Literature search

Publications in English from the PubMed and Cochrane Library databases were included in the systematic review. We conducted the search in December 2019. We used the following search string: ("Arthroplasty, Replacement, Hip [MeSH Terms]" OR "THA" OR "THR" OR "total hip replacement" OR "total hip arthroplasty") AND ("direct anterior approach «OR» anterior approach «OR» anterior »OR» Hueter approach «OR» Smith-Petersen approach «OR» lateral approach «OR» Hardinge approach").

Additionally, we included currently ongoing research comparing DAA and LA in the systematic review. A search of the Clinical Trials database of the National Institute of Health (NIH) was conducted in December 2019. We used "total hip arthroplasty" and "total hip replacement" for the search strings.

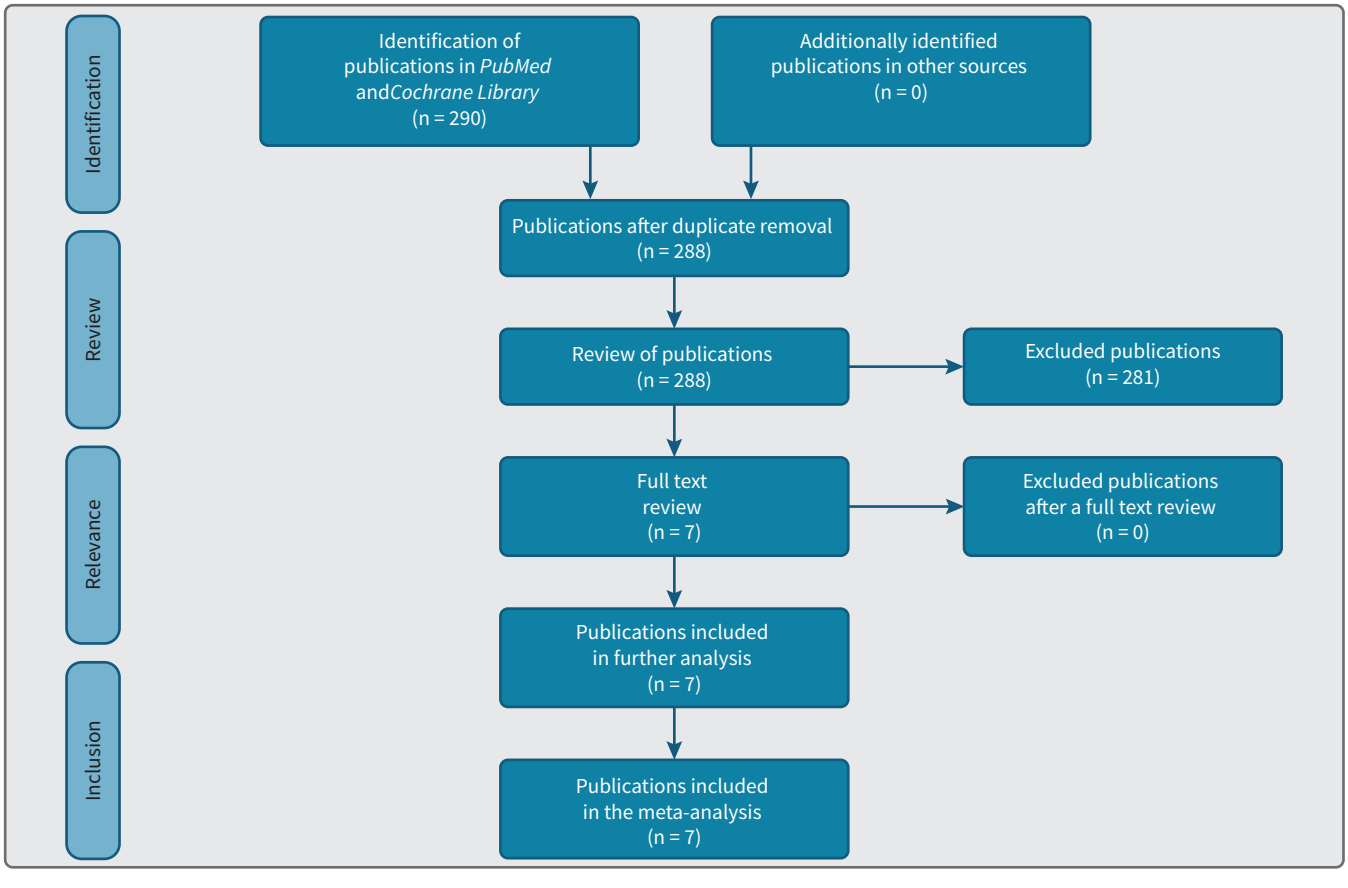

Figure 1: PRISMA diagram of the meta-analysis selection process.

2.2 Inclusion criteria

1. Subjects: Patients with clinically and radiologically confirmed advanced osteoarthritis of the hip joint.
2. Procedure: THA with DAA.
3. Control: THA with LA.
4. Recorded outcome: functional outcome determined by the Harris hip score (HHS) at the end of follow-up, duration of surgery, blood loss, need for transfusion, duration of hospitalization, visual analogue scale (VAS) pain assessment and the incidence of THA-related complications.We included all studies that recorded at least one of the identified outcomes.
5. Study design: RCT.

2.3 Choice of studies

Studies for the meta-analysis were selected by one of the authors. Based on a review of the title and abstract and defined inclusion criteria, they decided to select studies that were then reviewed in their entirety. Data for meta-analysis were obtained from the results reported in each published article.

2.4 Data acquisition

Data in included studies include: general study characteristics (authors, year of publication, country, number of subjects, mean age of subjects, proportion of female subjects, body mass index - BMI), recorded results (HHS, VAS, duration of surgery, blood loss, need for transfusion, duration of hospitalization, THA complications incidence) and follow-up duration.

2.5 Statistical analysis

Statistical analysis was performed with Review Manager 5.3 software (The Cochrane Collaboration, Copenhagen, Denmark). The statistical significance was set at a p-value ≤ 0.05. The odds ratio (OR) with a 95% confidence interval (CI) was calculated for discrete variables, need for transfusion and incidence of complications, while the mean difference and 95% CI were used for continuous variables. In cases of statistically insignificant heterogeneity between individual studies (I^2 <50%), we used the fixed effects model. However, when high sample heterogeneity ($I^2 \geq 50\%$) was identified, the random effects model was used.

3 Results

3.1 Meta-analysis characteristics

During the search and selection of relevant published studies for our meta-analysis, we found 290 publications by searching databases. Based on the inclusion criteria, we excluded 281 studies. Finally, we fully reviewed and included data from seven studies (6-12). General characteristics of the included studies

Table 1: General characteristics of studies, included in the meta-analysis.

	State	DAA	LA	Mean age	Proportion of women (%)	BMI	Outcome	Study type	Follow-up duration
Mayr 2009	Austria	16	17	66.9	66	25.6	2, 3, 4	RCT	3 months
Resterpo 2010	USA	50	50	67.2	70	27.6	1, 3, 4, 5, 6, 7	RCT	4 years
Mjalaand 2015	Norway	84	80	66.9	66	27.6	1, 2, 3, 4, 5	RCT	Until discharge
Parvizi 2016	USA	50	50	72.4	62	28	4, 6	RCT	1 year
Zomar 2018	Canada	36	42	60.2	52	27.9	1, 2, 6	RCT	3 months
Brismar 2018	Sweden	50	50	66.5	65	27.8	3, 4, 6, 7	RCT	5 years
Reichert 2018	Germany	77	71	62.6	43	28.2	1, 2, 7	RCT	1 year

Legend of monitored outcomes: 1 – functional state; Harris hip score (HHS); 2 – pain assessment with a visual analogue scale (VAS); 3 – surgery duration; 4 – intraoperative blood loss; 5 – need for transfusion; 6 – hospitalization duration; 7 – incidence of intraoperative and postoperative complications. DAA – direct anterior approach; LA – lateral approach; BMI – body mass index; RCT – randomized controlled trial.

Table 2: Currently ongoing studies comparing the direct anterior approach (DAA) and lateral approach (LA), included in the Clinical Trials database.

Principal investigator	Year of application	State	Study type	Expected sample size	Inclusion criteria	Status
Hozack	2009	USA	RCT	100	All with hip arthrosis	Finished, without publication
Sorladent Hospital HF	2012	Norway	RCT	120	Persons 20 – 80 years old with hip arthrosis	Ongoing, does not currently include patients
Viorel Nistor	2016	Romania	RCT	100	Persons 35 – 80 years old with hip arthrosis	Still including patients

are shown in Table 1. A total of 723 subjects were included in the meta-analysis. Of these, 363 underwent THA with DAA and 360 with LA. All included studies were published between 2009 and 2018.

During the search of ongoing studies in the Clinical Trials database, we found 733 registered studies with the "total hip arthroplasty" string and 712 studies with the "total hip replacement" string. After exclusion of inconsistent or overlapping studies and studies that did not fit our inclusion criteria, we included three studies in our meta-analysis (Table 2) (17-19).

3.2 Evaluation of individual outcomes

3.2.1 Functional outcome defined by the Harris hip score at the end of follow-up

At the end of follow-up, HHS was reported by five studies involving 590 subjects (297 DAA and 293 LA). At the end of the study, there was no statistically significant difference in the functional status of patients who underwent DAA or LA (mean difference = 0.97, 95% CI (-1.13; 3.08), p = 0.37) (Figure 2).

3.2.2 Pain assessment with the visual analogue scale

Pain assessment with VAS was reported by four studies involving 375 subjects (186 DAA and 189 LA). Among the study groups, the VAS assessment at discharge showed no difference in pain intensity between the two approaches, both in the early postoperative period and later during follow-up. On discharge from hospital, the mean difference was –0.49, 95% CI (–1.86; 0.88), p = 0.49; after six weeks of follow-up, the mean difference was 0.02, 95% CI (–0.99; 1.03), p = 0.97; after 12 weeks of follow-up, the mean difference was 0.13, 95% CI (–0.12; 0.37), p = 0.68 (Figure 3).

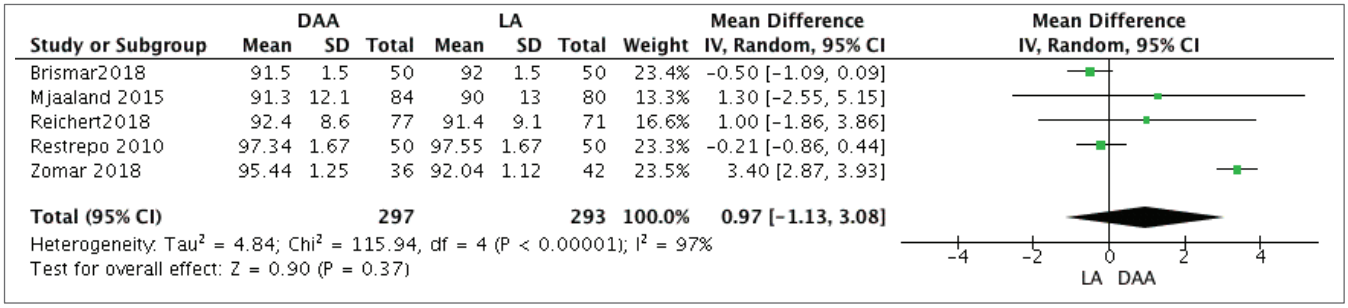

Figure 2: Forest plot of the functional state, assessed with the Harris hip score (HHS) in THA with the direct anterior approach (DAA) and lateral approach (LA).
DAA below the graph means that the functional state, assessed with HHS, is better with DAA; when LA is below the graph, the functional state is better with it.
Legend: SD – standard deviation; IV – inverse variance; random – random effects model; 95% CI – 95% confidence interval; df – degrees of fredom.

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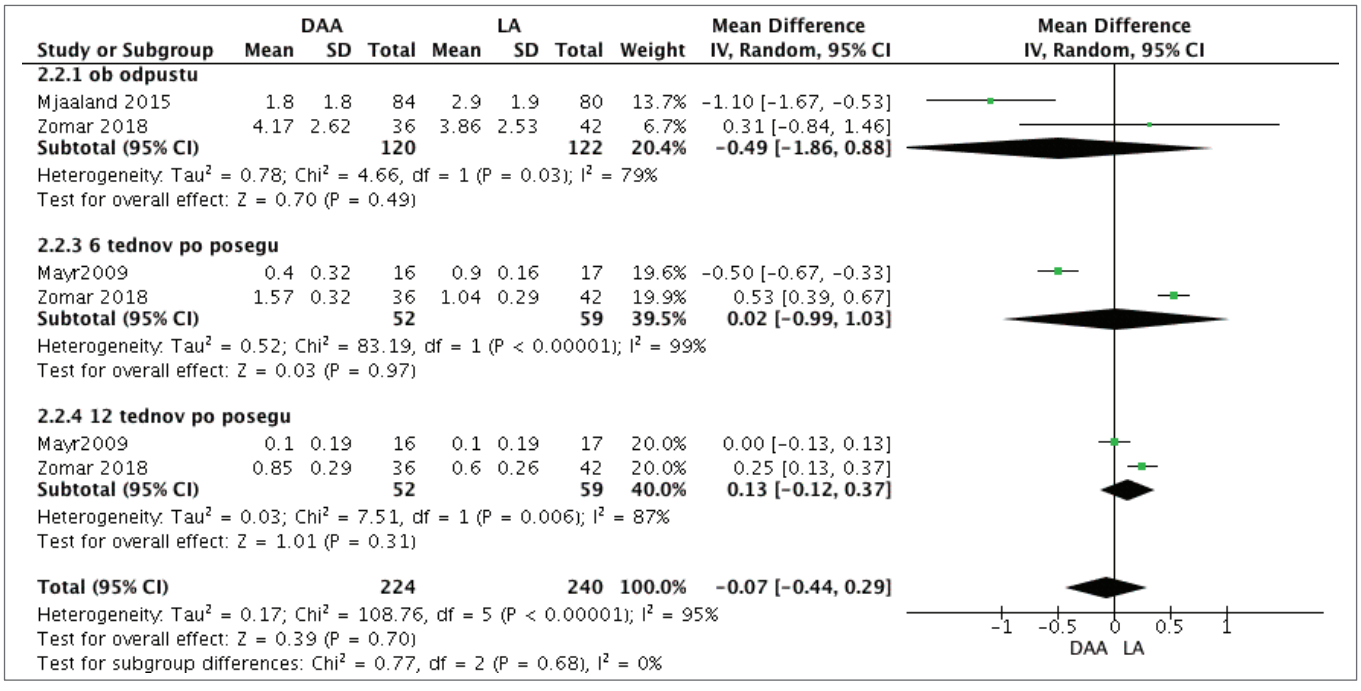

Figure 3: Forest plot of pain assessment with VAS in THA with the direct anterior approach (DAA) and lateral approach (LA).
VAS, recorded at discharge, six weeks after surgery and 12 weeks after surgery.
DAA below the graph means that the VAS-assessed pain was lesser with DAA; when LA is below the graph, pain is lesser with it.
Legend: SD – standard deviation; IV – inverse variance; random – random effects model; 95% CI – 95% confidence interval; df – degrees of freedom.

3.2.3 Surgery duration

The data on surgery duration was reported by five studies involving 497 subjects (DAA 250 and LA 247). Among the study groups, LA had a slightly shorter surgery duration (mean difference = 6.97 min, 95% CI (–3.54; 17.45), p = 0.19), but the difference was not statistically significant (Figure 4).

3.2.4 Intraoperative blood loss and the need for transfusion

Intraoperative blood loss was reported by five studies involving 497 subjects (DAA 250 and LA 247). The comparison of the study groups did not show a statistically significant difference (mean difference = –28.93 ml, 95% CI (–68.06; 10.20), p = 0.15) (Figure 5).

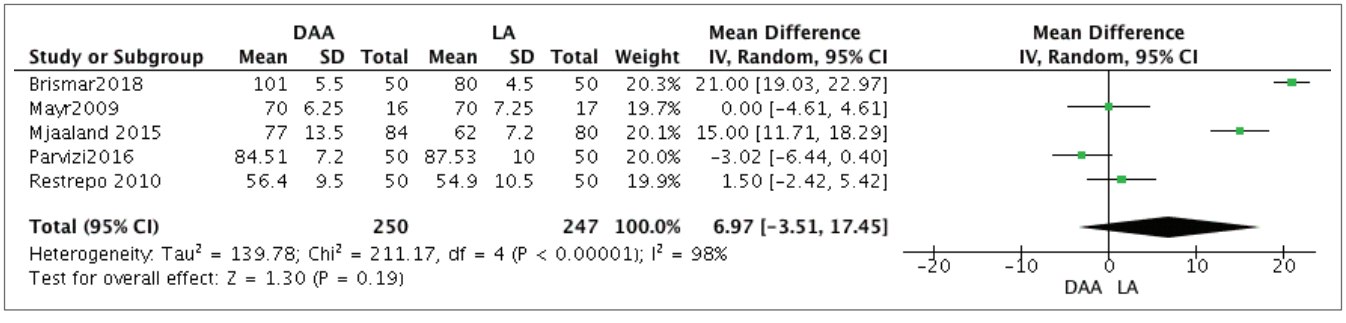

Figure 4: Forest plot of the surgery duration in THA with the direct anterior approach (DAA) and lateral approach (LA).
DAA below the graph means that the surgery duration was shorter with DAA; when LA is below the graph, the surgery duration was shorter with it.
Legend: duration in minutes; SD – standard deviation; IV – inverse variance; random – random effects model; 95% CI – 95% confidence interval; df – degrees of freedom.

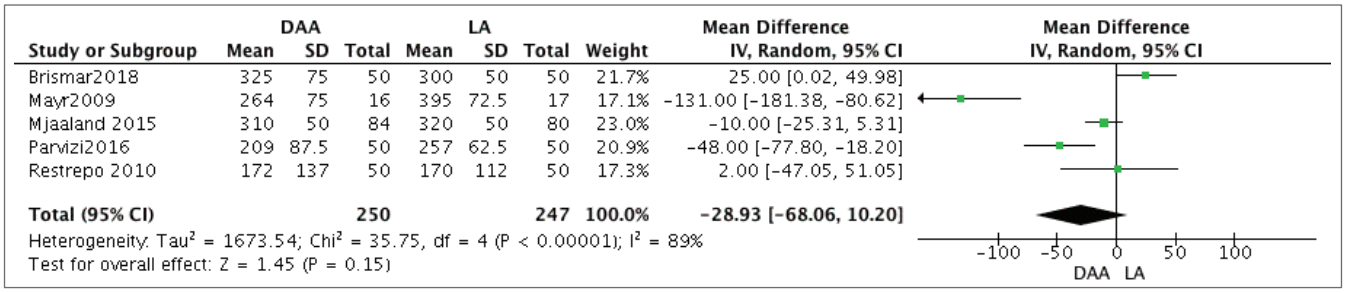

Figure 5: Forest plot of recorded blood loss in THA with the direct anterior approach (DAA) and lateral approach (LA).
DAA below the graph means that blood loss was less extensive with DAA; when LA is below the graph, blood loss was less extensive with it.
Legend: mean blood loss in mililitres; SD – standard deviation; IV – inverse variance; random – random effects model; 95% CI – 95% confidence interval; df – degrees of freedom.

The need for transfusion was reported by two studies involving 164 subjects (DAA 134 and LA 130). A comparison of the study groups showed no statistically significant difference (odds ratio = 0.8, 95% CI (0.38; 1.67), p = 0, 55) (Figure 6).

3.2.5 Duration of hospitalization

The duration of hospitalization after surgery was reported by four studies involving 387 subjects (DAA 186, LA 201). There was no statistically significant difference in the duration of hospitalization after THA (mean difference = –0.63 days, 95% CI (–1.27; 0.00), p = 0.05) (Figure 7).

3.2.6 Incidence of complications

Complications associated with THA were reported by five studies involving 582 subjects (DAA 290 and LA 292). The reported complications vary between authors. Complications of DAA include transient lateral femoral cutaneous nerve sensory abnormalities and early hip dislocation, which is treated with closed reduction. In both approaches, superficial and deep infections, differences in leg length greater than one centimetre and fractures have been reported. Complications in LA include hip abductor insufficiency, gluteus minimis and medius disinsertion and late dislocation with the need for open reduction with internal fixation. There was no statistically significant difference in the incidence of complications during and after surgery between the study groups (odds ratio = 1.17, 95% CI (0.7; 1.95), p = 0.56) (Figure 8).

4 Discussion

4.1 Main findings

In our systematic review of the literature with a meta-analysis, we found that individual studies included comparable patient populations. Only patients with primary hip osteoarthritis were included in all studies,

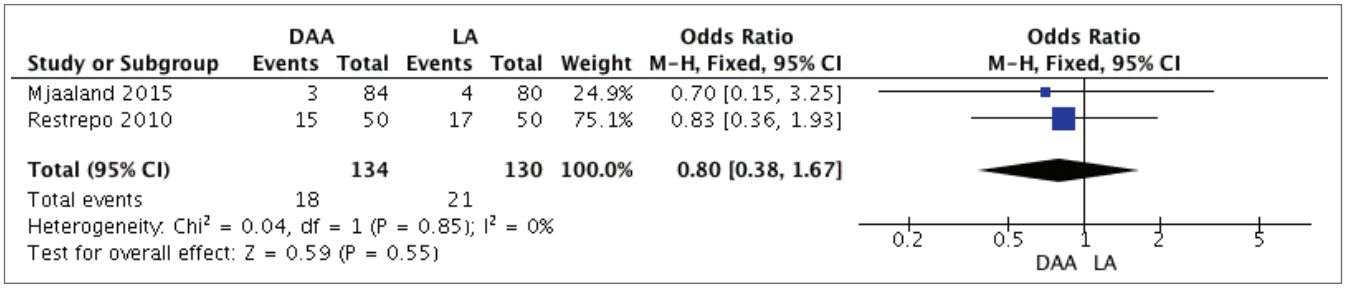

Figure 6: Forest plot of the need for transfusion in THA with the direct anterior approach (DAA) and lateral approach (LA).
DAA below the graph means that transfusion was less frequently needed with DAA; when LA is below the graph, transfusion was not needed as frequently with it.
Legend: SD – standard deviation; M-H – Mantel-Haenszel test; fixed – fixed effects model; 95% CI – 95% confidence interval; df – degrees of freedom.

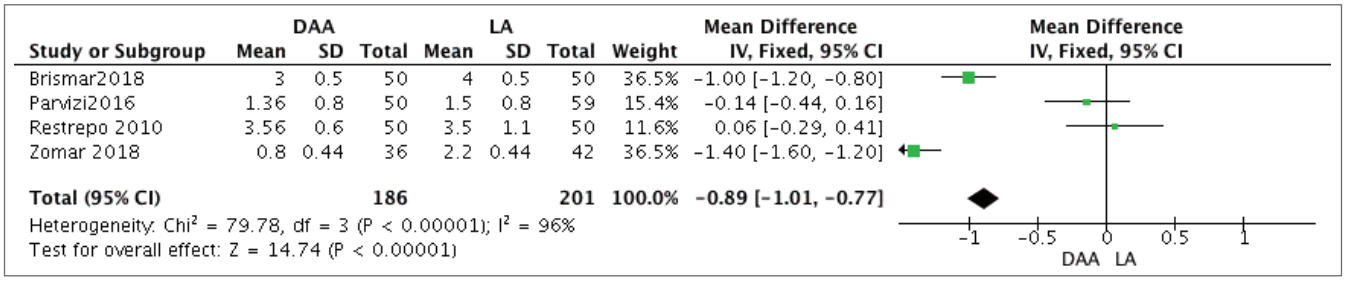

Figure 7: Forest plot of the hospitalization duration in THA with the direct anterior approach (DAA) and lateral approach (LA).

Legend: hospitalization duration, defined as the number of hospital days after the procedure; SD – standard deviation; IV – inverse variance; random – random effects model; 95% CI – 95% confidence interval; df – degrees of freedom.

DAA below the graph means that the hospitalization duration after THA was shorter with DAA; when LA is below the graph, the hospitalization duration after THA was shorter with it.

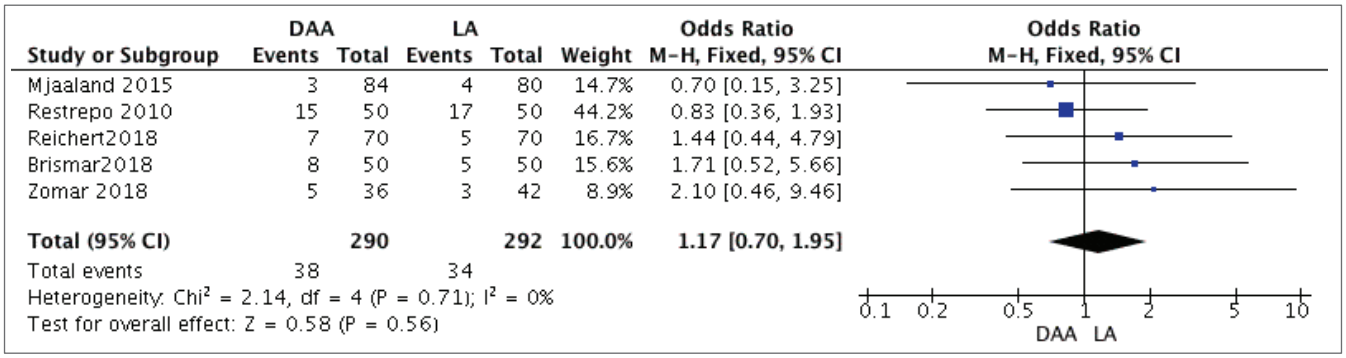

Figure 8: Forest plot of intraoperative and postoperative surgery complications in THA with the direct anterior approach (DAA) and lateral approach (LA).

DAA below the graph means that there were less complications with DAA; when LA is below the graph, there were less surgery complications with it.

Legend: SD – standard deviation; M-H – Mantel-Haenszel test; fixed – fixed effects model; 95% CI – 95% confidence interval; df – degrees of freedom.

their mean age ranged from 60 to 70 years; the studies included a higher proportion of women than men, and the mean BMI ranged from 25 to 30 kg/m^2. Our meta-analysis, which compared THA with DAA versus LA, found that there was no statistically significant difference between the approaches to THA. The meta-analysis showed that there was no difference between HHS at the end of follow-up, pain assessment with VAS in both early and late postoperative periods, blood loss, need for transfusions, and incidence of complications during and after surgery. Only in the duration of hospitalization after THA was the difference between DAA and LA on the border of statistical significance (p = 0.05), with the two studies included in our meta-analysis showing statistically significantly shorter hospital stays with DAA compared to LA (6,12).

4.2 Comparison with other meta-analyses

So far, four meta-analyses have been published comparing different THA approaches (13-16). In addition to RCTs, most included other types of clinical research. They compared all three THA approaches, performing only an indirect comparison of DAA and LA. None of the meta-analyses to date included an additional review of relevant ongoing studies included in the Clinical Trials database. Only one of the previous meta-analyses directly compared DAA and LA and included only RCTs, analyzing five RCTs with 457 subjects (13). Our meta-analysis included seven RCTs with a total of 723 subjects. Although Yue et al published a meta-analysis of 12 studies with a total of 4,901 subjects, they included cohort studies in addition to the RCTs (14). In their meta-analysis, Wang et al reported that DAA was associated

with significantly less blood loss and less pain six weeks after surgery. For the other variables considered, there were no significant differences between DAA and LA in previous or our meta-analysis (12). Our meta-analysis differs significantly from previous ones in that it deals only with RCTs that compare only DAA and LA. Additionally, our meta-analysis provided an overview of currently ongoing studies included in the Clinical Trials database, which are the basis for new publications in this field in the near future.

4.3 Clinical significance of findings

Like Wang et al, our meta-analysis found that there was no difference between DAA and LA in the HHS-evaluated functional status of patients at the end of follow-up (13). It is important to emphasize the fact that all meta-analyses of functional status, including ours, compared HHS, estimated at different times during follow-up, which ranged from a few days (time to discharge) to five years between individual studies. Individual studies assessed HHS at different points in time without a uniform time of recording HHS. In studies that monitored the functional status of patients with HHS for a longer period of time, we observed that in the early postoperative period, HHS was higher when DAA was used, while after a longer follow-up period, there were no differences in HHS between DAA and LA (6,10,11). Thus, in their study, Zomar et al reported that the functional outcome, evaluated with HSS, was statistically significantly better with DAA compared to LA; the patients were followed for up to three months after discharge (12). However, the remaining studies with clinical follow-up durations of more than a year did not report a difference in functional outcome between DAA and LA.

In an analysis of pain assessment, Wang et al found less VAS-assessed pain in the early postoperative period in the DAA group (13). When reviewing the literature, we found that in the original article by Mjalaand et al, we were unable to decipher data on pain assessment with VAS pain six months after THA, which Wang et al included in their meta-analysis. In pain assessment with VAS after six weeks, Mayr et al showed that with DAA, there was less pain, while Zomar and co-workers showed less pain with LA (7,12). After 12 weeks, however, only Zomar et al found less pain with LA (12). Our meta-analysis includes three studies reporting pain assessment with VAS at discharge and after six and 12 weeks, with no differences between the two approaches. Based on varying assessments of pain, we can only say that further research and a longer duration of follow-up are required to differentiate between the degree of postoperative pain with DAA or LA.

Similar to previous meta-analyses, we did not find statistically significant differences in surgery duration between DAA and LA (13-16). It should be noted that individual studies, included in the meta-analysis, did not report the surgeon's experience with DAA. Studies to date have shown that the surgeon's experience is important, particularly for DAA (13). In our meta-analysis, we found that Mjalaand et al and Brismar et al reported shorter surgery durations with LA compared to DAA; the first study involved five surgeons, each with at least several hundred performed surgeries, and the second included two surgeons, each with at least 40 performed surgeries (6,8).

In contrast to previous meta-analyses, which show statistically significantly lower blood loss in THA with DAA compared to LA (13,14), our meta-analysis did not find statistically significant differences in recorded intraoperative blood loss between the approaches. Additionally, similar to previous meta-analyses, no statistically significant difference in the need for transfusion was found between the two approaches (13).

Like Wang et al, our meta-analysis did not reveal statistically significant differences in hospitalization duration, with the inclusion of recent studies by Risterp et al and Reichert et al (10,11,13). It is worth noting the difference in the reported hospitalization duration between European and American studies, as the mean hospitalization duration after THA is on average longer in Europe than in the US (6,9,11,12).

In our study, similarly to previous meta-analyses, due to their low incidence, we could not avoid combining intraoperative and postoperative complications. Complications of DAA include transient lateral femoral cutaneous nerve sensory abnormalities and early hip dislocation, which is treated with closed reduction. In both approaches, superficial and deep infections, differences in leg length greater than one centimetre and fractures have been reported. Complications in LA include hip abductor insufficiency, gluteus minimis and medius disinsertion and late dislocation with the need for open reduction with internal fixation. Similar to previous meta-analyses, we find that there are no statistically significant differences in the incidence of complications between DAA and LA (13).

A review of the Clinical Trials database shows that no randomized clinical trial is currently underway that includes a sufficiently large sample size and has a well-defined follow-up protocol for both groups (17-19). A

review of the database revealed that a cohort multicentre study was reported in May 2011, which was expected to include 500 DAA, 100 LA, and 100 posterior THA approaches (20). The survey is currently noted to be completed with only 50 patients included, but without further explanation. According to the findings of previous meta-analyses and our meta-analysis, to more precisely define the differences between DAA and LA, we need new, larger RCTs, which will consistently measure individual variables over a longer period.

4.4 Limitations

Our meta-analysis included only seven RCTs with a total of 723 subjects with conflicting study results. With the availability and inclusion of more RCTs, even smaller differences between DAA and LA could be identified. There were important differences in the recording of outcomes between the individual studies we included, as comparable outcomes only partially overlapped. Most of the included studies had a short follow-up period, with only two surveys following subjects for more than one year. Among the limitations of our meta-analysis, it is important to note that not all studies included indicated the level of experience of the surgeons involved in each study, which can have a significant impact on the recorded outcome.

5 Conclusion

Comparison of THA approaches (DAA and LA) shows that there are no statistically significant differences in functional status at the end of follow-up, early and late postoperative pain, blood loss, need of transfusion, duration of hospitalization and the incidence of intraoperative and postoperative complications. A review and meta-analysis of previous studies shows that in order to more accurately identify possible differences between DAA and LA, we need new, larger RCTs that will consistently measure individual variables. A review of ongoing reported studies shows that no RCTs are currently underway that compare DAA and LA outcomes with a well-defined follow-up protocol. A RCT is still missing that would focus specifically on trochanteric pathology, which is an important source of persistent symptoms after THA, but is still completely unexplored in terms of approach.

Conflict of interest

None declared.

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