Meta-Analysis

Effectiveness of Lateral Decubitus Position for Preventing Post-Dural Puncture Headache: A Meta-Analysis

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Background: Post-dural puncture headache (PDPH) is a relatively common complication of lumbar punctures for spinal anesthesia or neurologic diagnosis. For many years, a high number of drugs has been evaluated to treat PDPH, yet there is a minority to prevent this complication. The lateral decubitus position instead of sitting position during lumbar puncture has become an interesting approach because of its feasibility and patient satisfaction.

Objectives: In this meta-analysis we hypothesized that lateral decubitus position is an effective manner to prophylactically reduce the incidence of PDPH.

Study Design: This meta-analysis pooled all data published in randomized controlled trials (RCTs) examining the impact of position (sitting versus lateral decubitus) during lumbar puncture and the incidence of PDPH.

Settings: This work was performed at Universidad del Valle, in Cali, Colombia, in collaboration with the Department of Anesthesiology at The Johns Hopkins Hospital.

Methods: Our group searched in PubMed, EMBASE, Cochrane Library and Google Scholar for relevant RCTs, dating from 1990 to July 2016, that compared the sitting and lateral decubitus position with regards to the incidence of PDPH in adult patients (age > 18 years) undergoing lumbar puncture for spinal anesthesia or neurologic diagnosis.

Results: Literature search identified 7 eligible RCTs (6 on spinal anesthesia and only one on neurologic diagnosis) with 1,101 patients, of which 557 had lumbar punctures in lateral decubitus position and 544 in sitting position. Only 3 (out of 7) RCTs favored the lateral decubitus position to significantly reduce the PDPH. Meta-analysis showed that the lateral decubitus position was associated with a significant reduction of the incidence of PDPH (risk ratio [RR] = 0.61, 95% confidence interval [CI] = 0.44-0.86, $P = 0.004$, $I^2 = 25\%$, P for heterogeneity = 0.24) compared with the sitting position. Subgroup analysis showed that lateral decubitus position is also associated with reduction of PDPH in spinal anesthesia (RR = 0.69, 95% CI = 0.50-0.95, $I^2 = 0\%$, P for heterogeneity = 0.42). We found no statistically significant association between lateral decubitus position and successful placement of spinal needle at first attempt (RR = 1.00, 95% CI = 0.92-1.09, $P = 0.94$, $I^2 = 73\%$, P for heterogeneity = 0.01). There was no evidence of publication bias in our analyses (Egger's bias = -0.05, $P = 0.96$).

Limitations: The low number of RCTs might be an important limitation on our results.

Conclusion: Our results indicate that lateral decubitus position during lumbar puncture seems to be a good alternative for preventing PDPH. Further research should focus on the new prophylactic alternatives to reduce the incidence of PDPH.

Keywords: Post-dural puncture headache, sitting, lateral decubitus, meta-analysis

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Spinal anesthesia is a commonly used technique for providing surgical anesthesia to patients undergoing urological, gynecological, and lower limb surgeries (1). Post-dural puncture headache (PDPH) is most commonly reported complication, with an incidence between 10% and 50% (2). Typically, this headache starts after 24–48 hours and lasts for 1–2 days (1). The location of the headache is variable and is often accompanied by neck stiffness, nausea, tinnitus, hearing loss, and photophobia (3). Several theories have been postulated regarding the pathophysiology. The most accepted theory is reduction of cerebrospinal fluid (CSF) pressure, following leak of CSF and resultant downwards movement of brain structures, resulting in stretching of meninges and vasodilatation of cerebral vessels (4,5). Commonly accepted contributory factors are gender of the patient, position of the patient at the time of performing the block, type and size of the needle, direction of bevel of the needle (parallel or vertical to longitudinal dural fibers), angle of approach, number of attempts, and saline injections (6-8).

Treatment of PDPH has been a focus of several reviews. Fluid intake, immobilization, posture, and drug therapy have been good approaches for the treatment of PDPH (9-11). Appendix 1 is describing the most important preventive and therapeutic strategies of PDPH management. Nonetheless, prevention of PDPH is more important. Effectiveness of bed rest and fluid intake was recently reviewed as an alternative for preventing PDPH. However, Arevalo-Rodriqguez et al (10) found no evidence supporting use of fluids and bed rest to prevent PDPH in patients after lumbar puncture.

The role of patient position during the time of puncture has also been considered as a factor for PDPH (12). The lateral decubitus position instead of the sitting position during lumbar puncture has become an interesting approach because of its feasibility and patient satisfaction (13). In this meta-analysis we hypothesized that lateral decubitus position is an effective manner to prophylactically reduce the incidence of PDPH.

Methodology

This meta-analysis was performed according to Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) and following the recommendations of the Cochrane Collaboration (14,15). The protocol for this review has been registered at PROSPERO International Prospective Register of Systematic Reviews (CDR42016045219).

Eligibility Criteria

Types of Studies

Two authors reviewed the literature and screened the abstracts independently. They selected all relevant articles in full text for detailed comprehension and further assessment of the quality and agreement of inclusion criteria. This meta-analysis focused on randomized controlled trials (RCTs), published poster presentations, systematic review and matched case-control studies with a methodology of randomization. We did not restrict our selection criteria to studies developed at specific regions nor studies with very low sample size.

Types of Participants

The participants included in this meta-analysis were adult patients (age > 18 years) who underwent lumbar puncture for spinal anesthesia or neurologic diagnosis in a sitting or lateral decubitus position.

Types of Intervention

The lateral decubitus position was considered the intervention in this meta-analysis, and the control group consisted of patients in the sitting position.

Types of Outcome Measures

The primary outcome in this meta-analysis was the incidence of PDPH defined as a headache that is characteristically worse when the head is elevated and becomes milder or completely relieved when the patient is supine (16,17). For the purpose of this meta-analysis, the time of follow-up (typically within one post-operative week) for assessing PDPH could vary between the studies but there was not criteria for exclusion regarding this aspect. Secondary outcomes were the incidence of success in the first attempt of lumbar puncture, nausea, and vomiting.

Exclusion Criteria

We excluded studies that assessed the impact of post-operative position on the incidence of PDPH. Studies evaluating only hemodynamic changes between the position approaches were also excluded.

Literature Search

The MEDLINE/PubMed (from 1950 to July 2016), Google Scholar (from 1960 to July 2016), EMBASE (from 1980 to July 2016), and Cochrane library (from 1990 to July 2016) were searched for randomized studies comparing the lateral decubitus and sitting position during lumbar punctures for spinal anesthesia or neurologic diagnosis.

Search Strategy

The terms included in the search strategy were 'post-dural puncture headache,' 'spinal anesthesia,' 'lumbar puncture,' 'posture,' 'lateral decubitus,' 'sitting,' and 'position.' We did not restrict for language. The search strategy was translated in accordance to the other database Boolean operators. In addition, we reviewed citations of included articles in order to ensure inclusion of relevant studies not captured in our initial literature search.

Data Extraction and Management

Two authors verified and extracted the data of the eligible articles. They completed a predefined database in Microsoft Excel that contained all the possibly relevant variables for this meta-analysis (year of publication, sample size, mean age, female percentage, needle design, indication of lumbar puncture, and incidence of PDPH for the intervention and control group).

Assessment of Methodological Quality

Two authors performed the methodological quality assessment. The quality of each study included in this meta-analysis was assessed by the Cochrane Review Criteria for Randomized Studies. The score was calculated for each study based on 7 items: random sequence generation, allocation concealment, blinding of personnel who performed lumbar punctures, blinding of outcome assessment, incomplete outcome data, selective reporting, and other bias. Each item was scored between 0 and 2 (0 being 'negative,' 1 'unclear,' and 2 'positive').

Quality of Evidence

The quality of the evidence provided in this meta-analysis was measured using 5 levels of evidence, ranging from level I to III, with 3 subcategories in level II, as previously reported (18).

Statistical Analysis

First, an exploratory qualitative analysis was conducted to describe the characteristics of the studies included in this meta-analysis. The meta-analysis was performed using the Review Manager 5.3 (Cochrane Collaboration, Oxford, UK) with random-effect model (DerSimonian & Laird method) (19). The incidence of PDPH was extracted as a dichotomous variable (present or absent) and compared using risk ratios (RR) with their respective 95% confidence intervals (CI). We used forest plots to illustrate the estimations and overall effect sizes (pooled RR represented as a solid diamond at the bottom of the forest plot). Heterogeneity of each meta-analyzed value was assessed by (I^2) with the correspondent chi-squared test ($I^2 < 50\%$ and $I^2 > 50\%$ were considered insignificant and significant heterogeneity, respectively). Publication bias was calculated using Stata version 13.0 (Stata, College Station, TX) with the Begg's and Egger's test. Funnel plots were constructed to represent any tendency for publishing in favor to the positive effect. Significant publication bias was considered when there was asymmetry in the funnel plot (meaning that smaller studies tend to show larger RRs) and a statistically significant bias coefficient according to the Egger's test. *P* values < 0.05 were considered as statistically significant in all statistical analyses.

Results

Study Identification and Selection

Initial search yielded 3,413 records. After excluding duplications, we screened a total of 2,671 titles and abstracts. Only 11 articles were read with detail. Two RCTs were excluded because they were performed in pediatric patients, one RCT because the authors only studied hemodynamic changes, and an additional article because of its observational design (20). The trial flow diagram illustrates the number of excluded and included articles in detail (Fig. 1).

Study Characteristics

Seven potentially eligible articles were reviewed (12,13,21-25). Most of the studies were published as original articles but only one study was a poster presention (21). Six studies enrolled patients in a prospective manner with a random allocation (12,13,21-24).There was only one study with a retrospective design that reviewed cases and controls using a matching methodology (without potential differences between intervention and control group) (25). Six out of the 7 articles included patients who underwent lumbar puncture for spinal anesthesia (4 studies enrolled gynecological surgeries, 2 enrolled urological procedures, and one included different types of surgeries) (13,21-25).Only one of these studies performed lumbar puncture for neurologic diagnosis (12). Table 1 summarizes the characteristics of the studies included in the analysis.

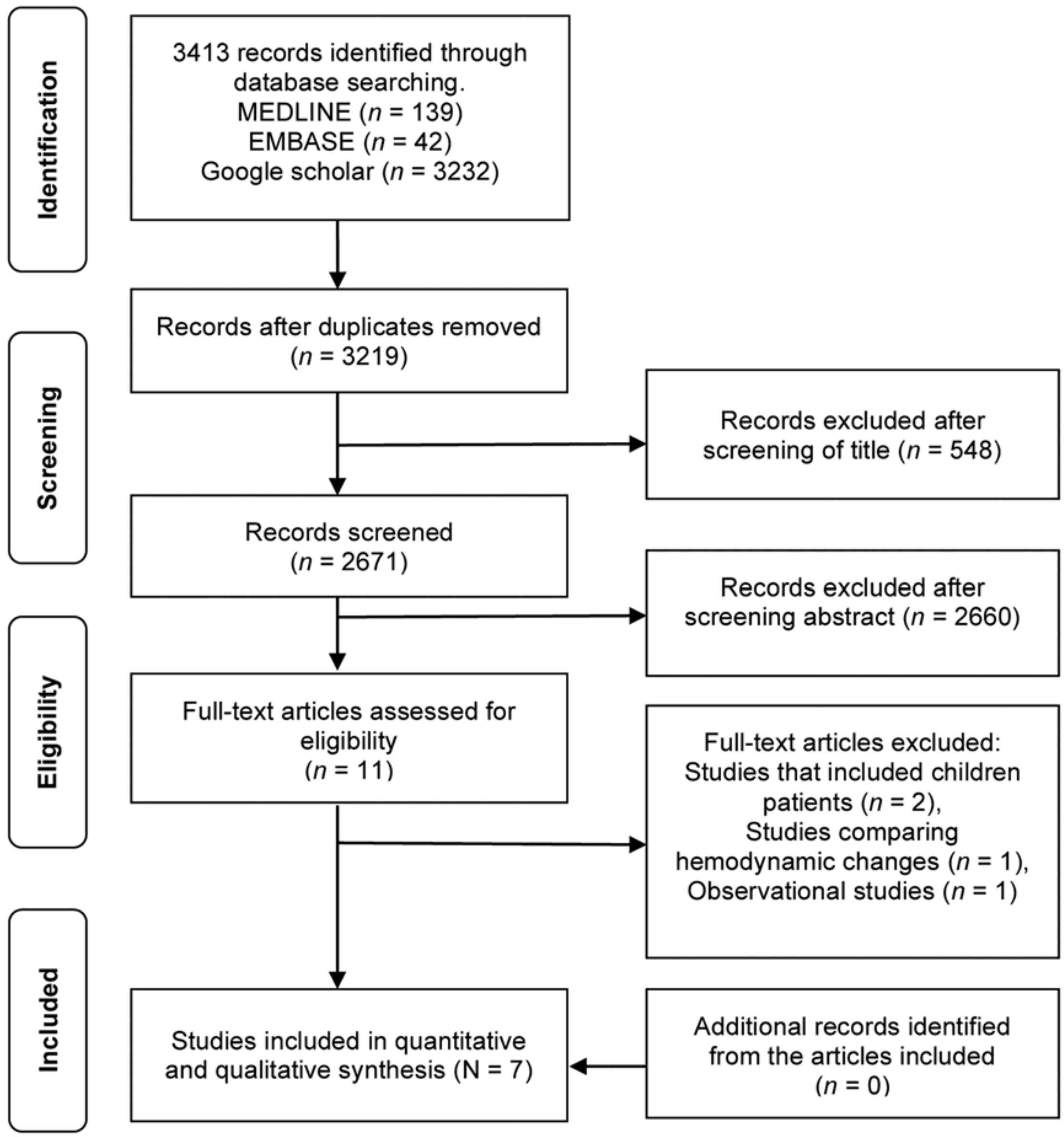

Fig. 1. *PRISMA diagram for search strategy and study selection for the meta-analysis.*

Methodological Quality Assessment

The results of the methodological quality assessment are shown in Fig. 2. The quality assessment criteria ranged from 13 to 7 points for evidence synthesis.

Primary Outcome

All of the studies reported the incidence of PDPH in both the intervention and control group. Three of the studies concluded a significant reduction in the incidence of PDPH when using lateral decubitus position during lumbar puncture (12,22,24), and 4 of them did not find a statistically significant reduction of PDPH when sitting and lateral decubitus position were compared. (13,21,23,25). In this meta-analysis, we found that lateral decubitus position is associated with a statistically significant reduction of PDPH compared

Table 1. *Characteristics of studies included in the analysis.*

Reference	Condition	Number of participants	Anesthetic management	Needle design (Gauge)	Female %	Age (Years)	Outcomes
Baysinger et al. 1992. (21)	Spinal anesthesia for post-partum tubal ligation	LD: 43 SIT: 47	Subarachnoid block using 70 mg of lidocaine in 1.4 cc of dextrose 7.5%	Quincke (25G)	100%	NA	PDPH, number of patch, number of attempts, failed blocks, blocks abandoned.
Lee et al. 1995.(13)	Spinal anesthesia for perineal or urologic surgery	LD: 80 SIT: 80	Subarachnoid block using 1% tetracaine with dextrose 10%	Quincke (25G)	51.3%	40.3	PDPH
Bayter et al. 2007.(22)	Spinal anesthesia for cesarean section	LD: 96 SIT: 87	Subarachnoid block using 10 mg of 0.5% bupivacaine plus fentanyl	Quincke (25G)	100%	24.6	PDPH, number of attempts, blood loss, hypotension, nausea, vomiting, other intraoperative complications.
Majd et al. 2011.(12)	Neurologic diagnosis	LD: 65 SIT: 60	NA	Quincke (21G)	52%	50.9	PDPH, number of attempts.
Ozturk et al. 2015.(25)	Spinal anesthesia for cesarean section	LD: 77 SIT: 72	Subarachnoid block using 2.5 mL of 0.5% bupivacaine	Quincke (25G)	100%	29.1	PDPH, number of attempts.
Chakraborty et al. 2016. (23)	Spinal anesthesia for different surgeries	LD: 150 SIT: 150	Subarachnoid block	Quincke (25G)	83.7%	32.3	PDPH, number of attempts, hypotension.
Davoudi et al. 2016.(24)	Spinal anesthesia for cesarean section	LD: 46 SIT: 48	Subarachnoid block using 2 mL of 0.5% bupivacaine plus sufentanil	Quincke (24G)	100%	26.9	PDPH, nausea, vomiting, sensory block duration, epidural blood patch requirement.

with the sitting position (Fig. 3; RR = 0.61, 95% CI = 0.44-0.86, $P = 0.004$). This association remained in subgroup analysis for spinal anesthesia (RR = 0.69, 95% CI = 0.50-0.95, $P = 0.02$). The subgroup of lumbar puncture for neurologic diagnosis was assessed in only one study (RR = 0.38, 95% CI = 0.20-0.69, $P = 0.002$).

Secondary Endpoints

Four studies compared the frequency of success in the first attempt of lumbar puncture between sitting and lateral decubitus position. We found no statistically significant differences between the 2 positions (Fig. 4; RR =1.00, 95% CI = 0.92-1.09, $P = 0.94$).

Heterogeneity and Publication Bias

In overall analysis, the pooled RR obtained a non-significant heterogeneity (I^2=25%, $P = 0.24$). Similarly, in subgroup analysis of spinal anesthesia there was a non-significant heterogeneity (I^2=0%, $P = 0.42$). In the analysis of success in the first attempt of lumbar puncture, there was significant heterogeneity (I^2=73%, $P = 0.01$). There was no evidence of publication bias in our analyses (Fig. 5; Egger's test bias=-0.05, $P = 0.96$).

Discussion

To our knowledge, this is the first meta-analysis assessing the influence of lateral decubitus position to prevent PDPH. We found a statistically significant reduction in the incidence of PDPH when using lateral decubitus position during lumbar puncture. Additionally, we found no relationship between position and successful first attempt of lumbar puncture.

Spinal anesthesia is a commonly performed anesthetic technique (1). PDPH is the most common adverse effect associated with immobilization, disability, and prolonged hospitalization (26,27). Increased fluid intake and patient positioning after the onset of PDPH have been reviewed (10). Review on the role of optimal position at the time of performing the procedure would update the performer and also allow weighing of risk benefits, in terms of easier blocks in sitting position as compared to lateral position in relation to the incidence of PDPH (24).

There are multiple factors associated with PDPH (16,17). The technique of spinal anesthesia has shown to be a decisive factor for preventing PDPH. The design

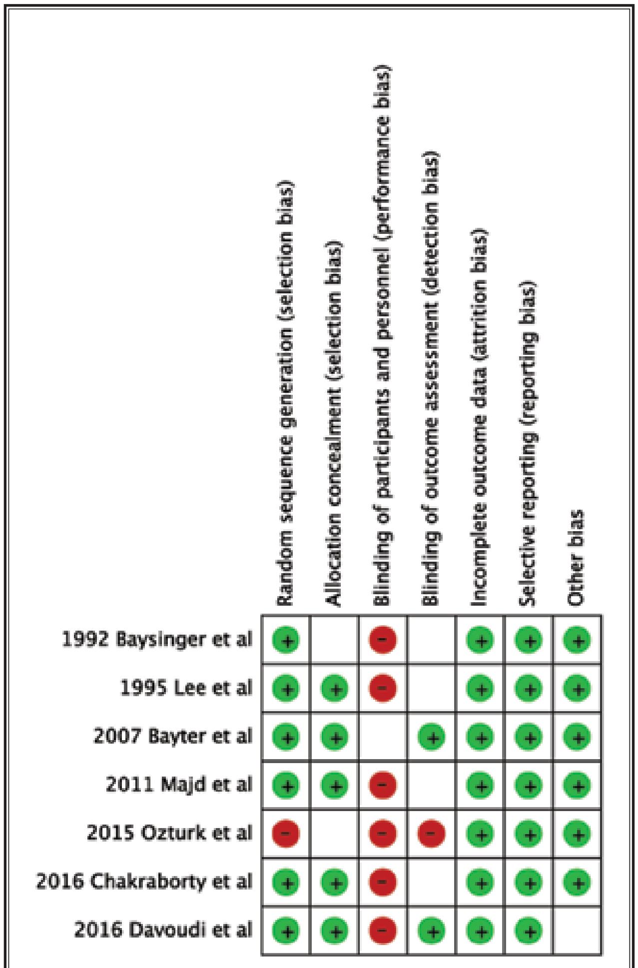

Fig. 2. *Risk of bias for each randomized controlled trial included in this meta-analysis.*

and gauge of the spinal needles is one of the most significant, modifiable factors associated with PDPH, followed by non-modifiable factors such as the age (younger patients have a greater risk) and gender (women are at at higher risk) (6-8,28). Several studies have also demonstrated that the direction of the bevel (midline or paramedian) is associated with PDPH, the paramedian approach being a protective factor (8,13). This study is another example that supports the significant impact of positioning during lumbar punctures on the incidence of PDPH.

The potential benefits of lateral decubitus position for preventing PDPH can be explained by the differences in CFS pressures between the sitting and lateral decubitus position. Sitting position is associated with a higher CSF pressure of 40 cm H_2O, as compared to 5–20 cm H_2O in lateral position (4,29). This higher pressure is hypothetically associated with a larger hole and a prolonged leak at a higher pressure (12). Further displacement of brain matter and meninges occur earlier in sitting position, resulting in more symptoms. This downward movement does not occur in the lateral position leading to a lower risk of developing PDPH (12).

Several anesthesiologists prefer the sitting position. The main reasons of why sitting position is usually preferred over the lateral decubitus position includes: comfort of the patients, lower risk of failures in obese patients, and it facilitates identification of the midline structures. Also, in obstetric patients this position avoids concealed aortocaval compression, which occurs in lateral decubitus position due

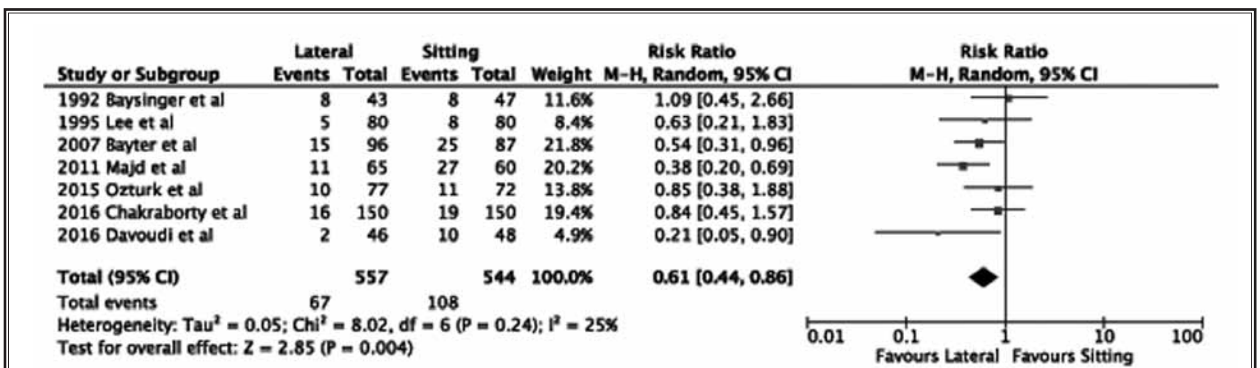

Fig. 3. *Forest plot for random-effects in this meta-analysis comparing the lateral decubitus versus sitting position for preventing PDPH.*

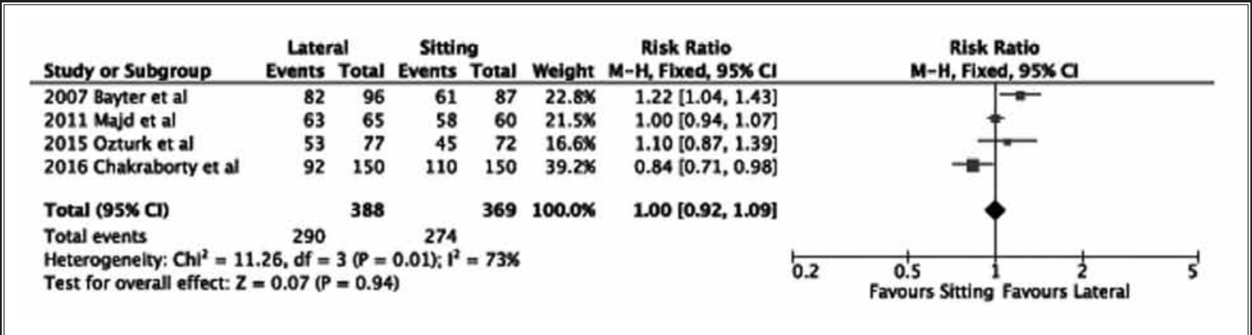

Fig. 4. *Forest plot for random-effects in this meta-analysis comparing the lateral decubitus versus sitting position for success in the first attempt of lumbar puncture.*

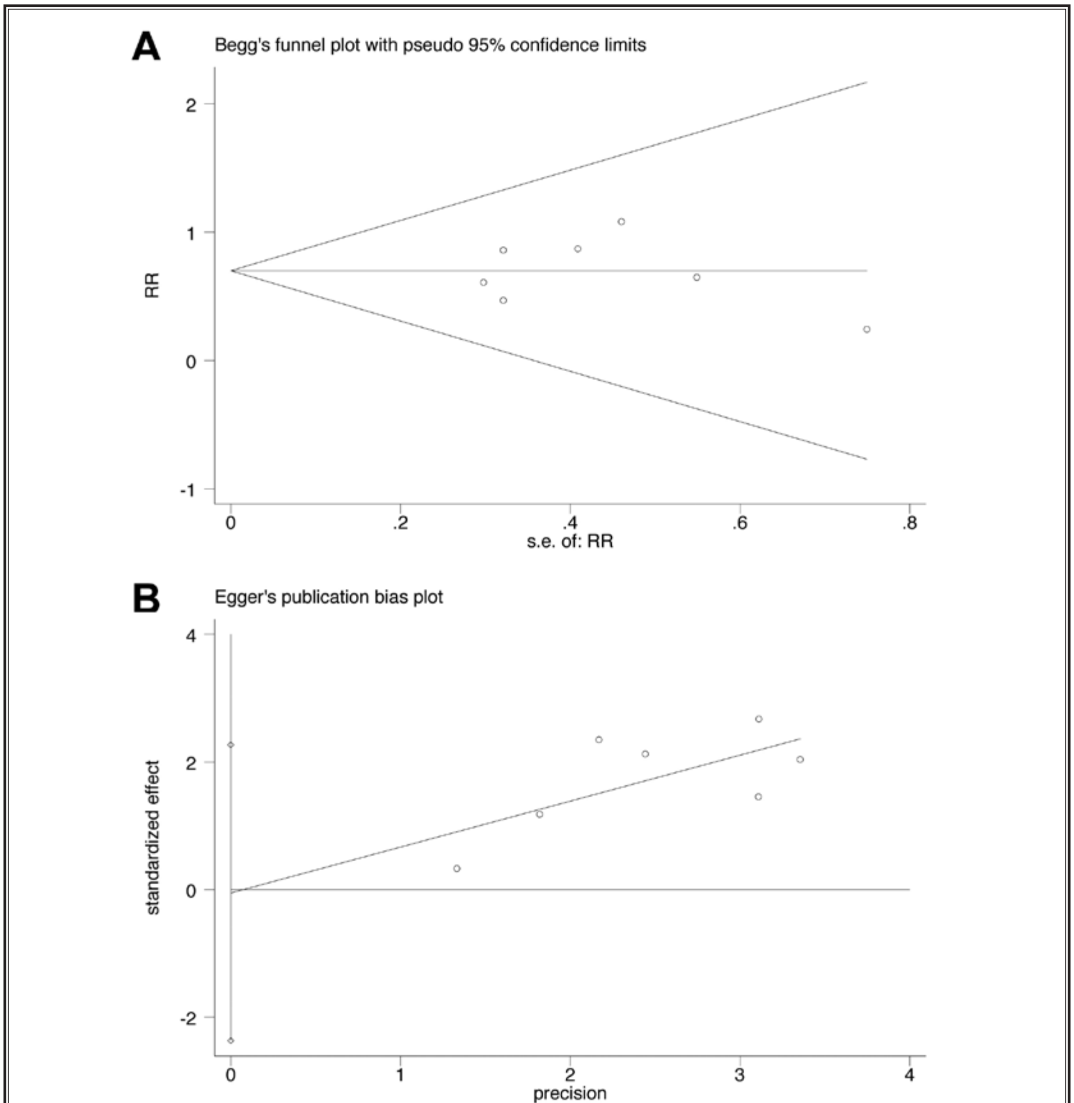

Fig. 5. *Funnel plot of the included studies comparing the sitting and lateral decubitus position on the incidence of PDPH.*

to the fetus collapsing the vessels and causing reduction in maternal cardiac output (25,30). The principal documented disadvantage of the sitting position is the orthostatic hypotension. However, several RCTs have shown comparable incidences of hypotension between the 2 positions (25,30). The lateral decubitus position also provides a number of advantages such as a better sensory block due to the spread of local anesthetics (31), and the tendency to be leaner, compared with patients undergoing lumbar punctures in the sitting position (30). The main concern of the lateral decubitus position is the compression of axillary neurovascular structures.

We recognize that the major strength of this meta-analysis is the robustness and consistency of the results, as well as the low heterogeneity and non-significant risk of publication bias. However, this meta-analysis has limitations. Firstly, only a few articles met the inclusion criteria leading to a low sample size. Secondly, we were not able to study other outcomes that can possibly influence the incidence of PDPH. Thirdly, we did not take into account the impact of protocols of duration of certain positions after performing the lumbar puncture. Lastly, the impact or applicability of our results remains uncertain as the sitting position is widely accepted in regional anesthesia.

Conclusions

Our results indicate that lateral decubitus position during lumbar puncture seems to be a good alternative for preventing PDPH. We encourage further investigation on new prophylactic alternatives to decrease the incidence of PDPH.

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