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Review Article

Efficacy of different positions for neuraxial anesthesia in caesarean section: a meta-analysis

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Abstract: Background and objectives: Positions during induction of neuraxial anesthesia are related to maternal and fetus health. The aim of our analysis was to evaluate whether lateral position could make more benefit than oxford and sitting positions to both anesthesia and physical conditions of parturients and neonatus. Methods: The Pubmed, the Cochrane Library and Embase database was searched for relevant studies. The Cochrane collaboration's tool for assessing risk of bias was used to assess quality of studies. Review manager and Stata were used for statistical analysis. Results: Thirteen randomized controlled trails with 702 participants were included. Lateral position was more effective on anesthesia effect compared with sitting (mean difference (MD)=-2.02, 95% confidence interval (CI): -3.38 to -0.67) and oxford position (MD=-5.36, 95% CI: -6.58 to -4.14), respectively. Sitting position had higher hypotension incidence than lateral position (odds ratio (OR)=0.53, 95% CI: 0.26 to 1.05). Ephedrine consumption among groups represented obvious heterogeneity and a conclusion could not be drawn. Result of combined side effects including nausea and vomiting and shivering was consistent with anesthesia effect between lateral and sitting positions (OR=1.59, 95% CI: 1.03 to 2.45). Neonatal status showed no significant differences among different positions. Conclusions: This study suggested that lateral position might be more beneficial to parturients and neonatus in more adequate anesthesia and lower complication incidence. Potential hemodynamics fluctuation affected by positions needed further disclosure. Positions during induction of neuraxial anesthesia may not influence neonatal status.

Keywords: Position, cesarean section, neuraxial anesthesia, lateral

Introduction

Intervertebral anesthesia is the most frequently used method in Cesarean section. Positions of parturients during induction of neuraxial anesthesia affected curves of vertebral and body center of gravity [1], which could influence the displacement of cerebrospinal fluid (CSF) and spread of local anesthetics [2] and subsequently led to variability of anesthesia effects [1] and hypotension [3]. Different positions also changed compression of gravid uterus on inferior vena cava that can influence maternal blood pressure and fetal condition [4]. Choosing proper position during induction of anesthesia is necessary for parturients and anesthetist to prevent potential incomplete anesthesia and ischemia and hypoxia injury of mother and fetus. At present, most commonly adopted positions include classic Oxford position, lateral and sitting position [5] and so on. Clinical researchers have already studied the effects of all three different positions during neuraxial anesthesia. Nevertheless, controversy about the effectiveness of these positions for neuraxial anesthesia on parturients undergoing caesarean section is still ongoing, with different results reported in associated literatures.

This review provides a quantitative analysis on a consolidation of related data and the comparison among different positions during induction of neuraxial anesthesia in parturients scheduled for caesarean section. We aimed to evaluated the effects of all three positions to provide credible conclusion for clinical use. The primary outcome was anesthesia effect among groups, secondary outcome included hypoten-

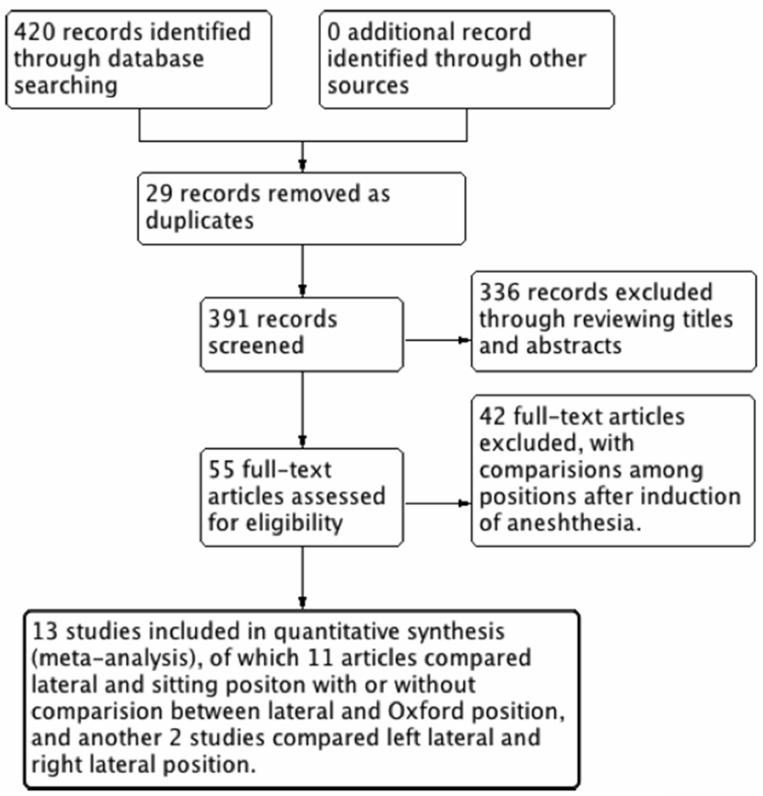

Figure 1. Flowchart of study selection.

sion incidence, Ephedrine consumption and neonatal status.

Materials and methods

The authors followed the PRISMA statement for reporting systematic reviews and meta-analyses in preparing this review.

Inclusion and exclusion criteria

The current authors included randomized controlled trails (RCTs) that investigated the efficacy and safety of different positions of induction of intervertebral anesthesia in women who were undergoing caesarean section without language limitation. Women with ASA physical status I-II, term singleton pregnancies and scheduled for elective Cesarean delivery under intervertebral anesthesia were included.

We mainly assessed positions in intervertebral anesthesia as the intervention, and effects of different positions were compared.

Outcome measure was focused on efficiency of different positions on the anesthesia effect, changes of hemodynamics, complications caused by position and neonatal status.

The exclusion criteria included patients with pre-existing or pregnancy induced complications such as hypertension, diabetes mellitus, and parturients <150 cm or >170 cm in height, <16 years, bleeding disorders, fetal abnormality and contraindication to intervertebral anesthesia, with extremes of weight (BMI <20 kg/m^2 or >35 kg/m^2, multiple pregnancies. Studies used other anesthesia techniques, without control group settings were excluded.

Articles reporting animal experiments, cases, reviews, other treatments, missing data, incorrect statistical analysis were also excluded.

Search strategy

We broadly searched the Pubmed, the Cochrane Library, Embase until May 2015 without language limitation. The search terms were “cesarean OR caesarian OR cesarean section”, “intervertebral anesthesia”, “position”, “supine”, “oxford”. All reference lists of retrieved papers were reviewed to identify additional relevant articles.

According to the inclusion and exclusion criteria, two of current authors (Xu, Yao) reviewed the titles and abstracts of all selected articles. Subsequently the two authors assessed full text to determine whether or not to include studies. If there was any disagreement, discussion with the third reviewer (Zhang) was attempted to be a solution.

Quality assessment

Two reviewers (Xu, Yao) independently assessed the risk of bias and methodological quality of included studies according to the method defined by the *Cochrane Handbook For Systematic Reviews of Interventions Version 5.1.2* [6]. Six categories, randomization, allocation concealment, blinding of personnel, blinding of outcome assessment, data integrity,

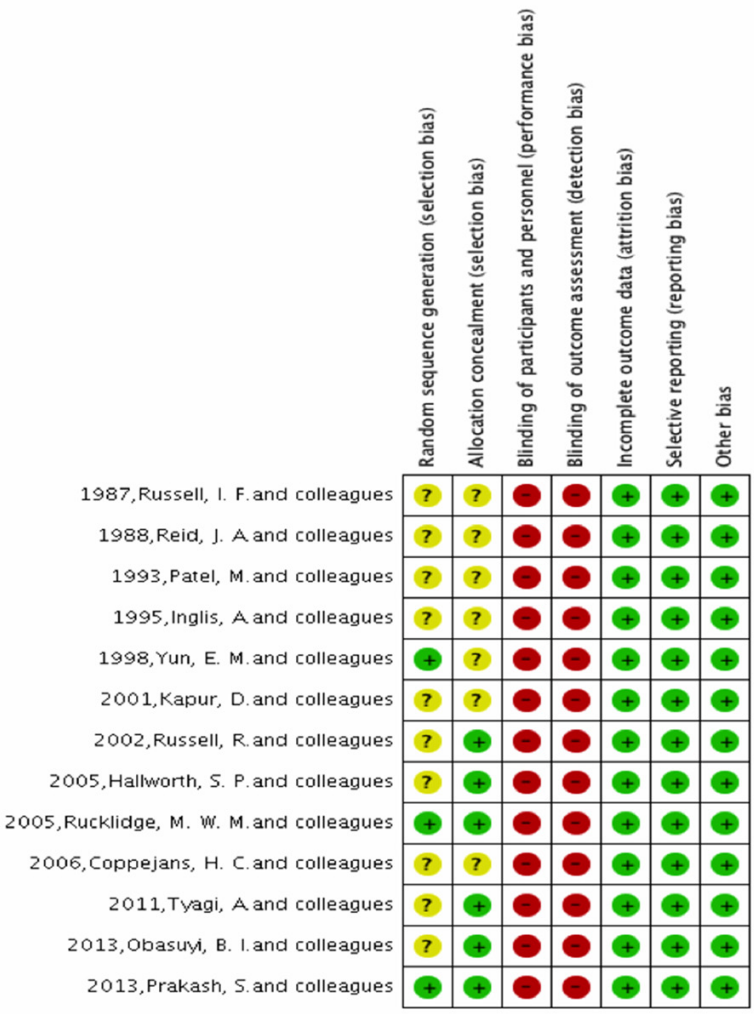

Figure 2. Risk of bias graph: Author's evaluation of all included thirteen articles through six categories of risk bias.

selective reporting and other bias were evaluated. Each category has three evaluation criteria: low risk, unclear and high risks.

Data extraction

A standardized data collection form was used for outcome data extraction. Data were recorded independently by two of the authors (Xu, Yao) to avoid transcription errors; discrepancies were resolved by re-inspection of the original data. All data was rechecked by the third author (Shen). The following data were retrieved: name of each first author, publication year, sample size, study design; type of anesthesia, position during anesthesia, puncture site, local anesthetics, main outcomes (including time to adequate anesthesia, change of hemodynamics, neonatal status and other complications), randomization, blinding, allocation concealment.

If data was represented with median and inter-quartile range, median would be approximately equal to mean, and the width of inter-quartile range would be approximately 1.35 fold standard deviations when members were equal or greater than 25 and the distribution of the data was similar to normal distribution according to *Cochrane Handbook For Systematic Reviews of Interventions Version 5.1.2* [6].

Statistical analysis

The data were then entered into the statistical program (by Yao) and rechecked (by Xu). The I^2 statistic and Chi-square test was used to assess heterogeneity among studies. We consider heterogeneity substantial if *P* value <0.10 and I^2>50%, and then random effects model was used to combine the data. Otherwise fixed effects model was selected. Continuous data was pooled as mean difference (MD) with 95% confidence intervals (CI), discontinuous data was summarized as risk ratio (RR) and numbers treated and total. Sensitivity analysis was used to test the stability of the results by removing outliers. Subgroup analysis was based on different time to achieve adequate anesthesia, type of anesthesia methods, complications, Apgar score after birth. Review Manager (Revman 5.3, Cochrane library, Oxford, UK) was used to analyze the data and generate forest plot. Egger's test was performed to quantify the publication bias by Stata12.0 (Stata Corp, College Station, TX, USA).

Results

Study selection

The search strategy identified 420 articles with 29 of them were duplicates. Screening by title

Table 1. Main characteristics of 13 included studies

Studies	No. participants	Trail design	Anesthesia	Positions	Puncture site	Anesthetics
1987, Russell, I. F. and colleagues	35	Randomized controlled trial	Subarachnoid analgesia	Left or right	L2-3	0.75% plain bupivacaine
1988, Reid, J. A. and colleagues	30	Controlled study	Extradural anesthesia	Sitting or lateral	L2-3 or L3-4	0.5% plain bupivacaine
1993, Patel, M. and colleagues	48	Randomized controlled trial	CSE	Sitting or the left lateral position	L2-3	0.5% hyperbaric bupivacaine
1995, Inglis, A. and colleagues	38	Controlled study	Spinal anesthesia	Sitting or right lateral position	L2-3	0.5% hyperbaric bupivacaine
1998, Yun, E. M. and colleagues	22	Controlled study	CSE	Sitting or lateral position	L2-3 or L3-4	0.75% hyperbaric bupivacaine
2001, Kapur, D. and colleagues	34	Randomized controlled trial	Spinal anesthesia	Right or left lateral position	/	0.5% hyperbaric bupivacaine
2002, Russell, R. and colleagues	90	Randomized controlled trial	CSE	Oxford, right lateral sitting position	L3-4	0.5% bupivacaine
2005, Hallworth, S. P. and colleagues	50	Double-blind prospective study	CSE	Sitting or right lateral positions	L3-4	1.01930% hyperbaric bupivacaine
2005, Rucklidge, M. W. M. and colleagues	96	Randomized controlled trial	CSE	Left lateral, Oxford or sitting position	L3-4	0.5% hyperbaric bupivacaine
2006, Coppejans, H. C. and colleagues	56	Prospective, randomized study	CSE	Sitting or right lateral decubitus position	L3-4 or L4-5	hyperbaric bupivacaine
2011, Tyagi, A. and colleagues	28	Randomized controlled trial	CSE	Lateral or sitting position	L4-5	0.5% hyperbaric bupivacaine
2013, Obasuyi, B. I. and colleagues	100	Randomized controlled trial	Spinal anesthesia	Lateral or sitting position	L3-4	0.5% plain bupivacaine
2013, Prakash, S. and colleagues	75	Prospective, randomized controlled trail	spinal anesthesia	Left lateral, modified lateral or sitting position	L3-4	0.5% hyperbaric bupivacaine

CSE: combined spinal epidural.

Table 2. Main outcomes of 13 included studies

Studies	Primary outcome	Secondary outcome	Other outcomes
1987, Russell, I. F. and colleagues 13	Mean segmental levels of analgesia	Incidence of hypotension; numbers of supplementary analgesia	/
1988, Reid, J. A. and colleagues 11	Dose of extradural drugs; numbers of supplementary analgesia	Change in SAP	/
1993, Patel, M. and colleagues 10	Onset of analgesia to T4 and motor block to grade 3	Numbers of supplementary analgesia; efficacy of sensory block during surgery; time to Bromage score 3; time to first demand for PCEA	Ephedrine requirement; adverse effects
1995, Inglis, A. and colleagues 9	Time taken to site spinal and achieve analgesic and anesthetic	Maximum height of block	Ephedrine requirement; patient satisfaction
1998, Yun, E. M. and colleagues 8	Time to achieve highest sensory block	Duration of SBP below baseline; decrease in SBP	Ephedrine requirement; adverse effects
2001, Kapur, D. and colleagues 12	Block height	Numbers of supplementary analgesia	/
2002, Russell, R. and colleagues 7	Block height	Time for the block to reach T5; numbers of supplementary analgesia; time to first demand for PCEA	Ephedrine requirement, Apgar scores
2005, Hallworth, S. P. and colleagues 6	Maximum sensory blockade	Modified Bromage score3; numbers of supplementary analgesia; incidence of hypotension	Ephedrine requirement; adverse effects and Apgar scores
2005, Rucklidge, M. W. M. and colleagues 5	Reduction in ephedrine requirements	Time for sensory block to reach T5; maximum sensory level; time to first demand for PCEA	/
2006, Coppejans, H. C. and colleagues 4	Hemodynamic effects	Block characteristics; numbers of supplementary analgesia;	Ephedrine requirement; adverse effects and Apgar scores
2011, Tyagi, A. and colleagues 3	Maximum sensory blockade	Time to achieve maximum sensory level; time to first demand for PCEA,	Ephedrine requirement; adverse effects and Apgar scores
2013, Obasuyi, B. I. and colleagues 2	Lowest recorded systolic BP	Lowest MAP; incidence of hypotension; upper sensory level; time to Bromage score 3	Ephedrine requirement; adverse effects and Apgar scores
2013, Prakash, S. and colleagues 1	Onset time for sensory block to reach T5 dermatome	Maximum sensory level and time to reach it; numbers of supplementary analgesia; time to motor block grade 3	Ephedrine requirement; adverse effects and Apgar scores
1987, Russell, I. F. and colleagues 13	Mean segmental levels of analgesia	Incidence of hypotension; numbers of supplementary analgesia	/
1988, Reid, J. A. and colleagues 11	Dose of extradural drugs; numbers of supplementary analgesia	Change in SAP	/
1993, Patel, M. and colleagues 10	Onset of analgesia to T4 and motor block to grade 3	Numbers of supplementary analgesia; efficacy of sensory block during surgery; time to Bromage score 3; time to first demand for PCEA	Ephedrine requirement, adverse effects
1995, Inglis, A. and colleagues 9	Time taken to site spinal and achieve analgesic and anesthetic	Maximum height of block	Ephedrine requirement, patient satisfaction
1998, Yun, E. M. and colleagues 8	Time to achieve highest sensory block	Duration of SBP below baseline; decrease in SBP	Ephedrine requirement, adverse effects
2001, Kapur, D. and colleagues 12	Block height	Numbers of supplementary analgesia	/

PCEA: patient-controlled epidural analgesia; BP: blood pressure; MAP: mean arterial pressure; SBP: systolic blood pressure; SAP: systolic arterial pressure.

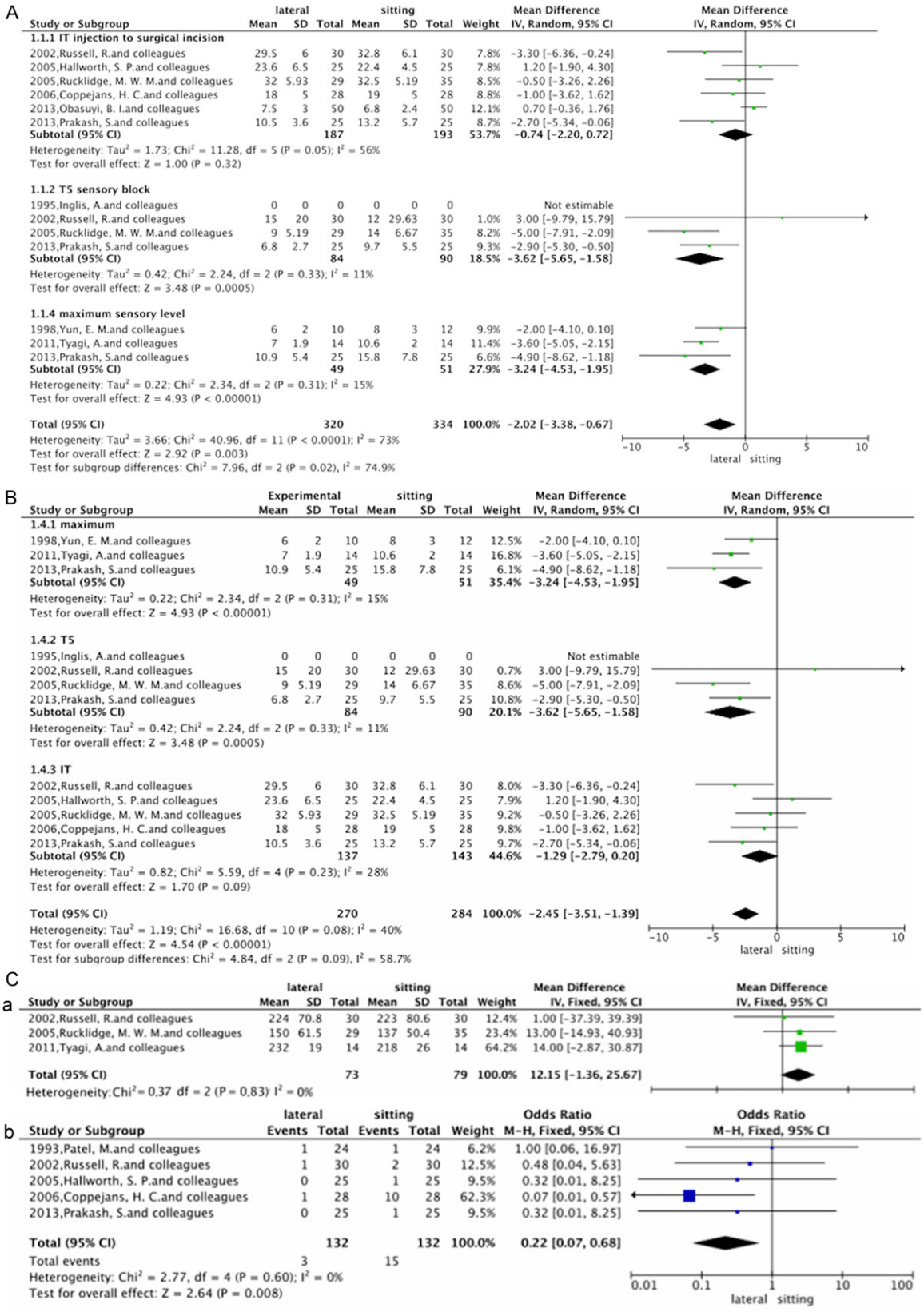

Figure 3. A. Subgroup analysis of time to achieve adequate anesthesia between lateral and sitting positions. B. Sensitivity analysis of time from IT injection to surgical incision between lateral and sitting positions. C. Forest plots of comparison between lateral and sitting position of anesthesia effect. a. Comparison of time to first postoperative analgesia; b. Comparison of number of patients supplemented with analgesic during Cesarean section.

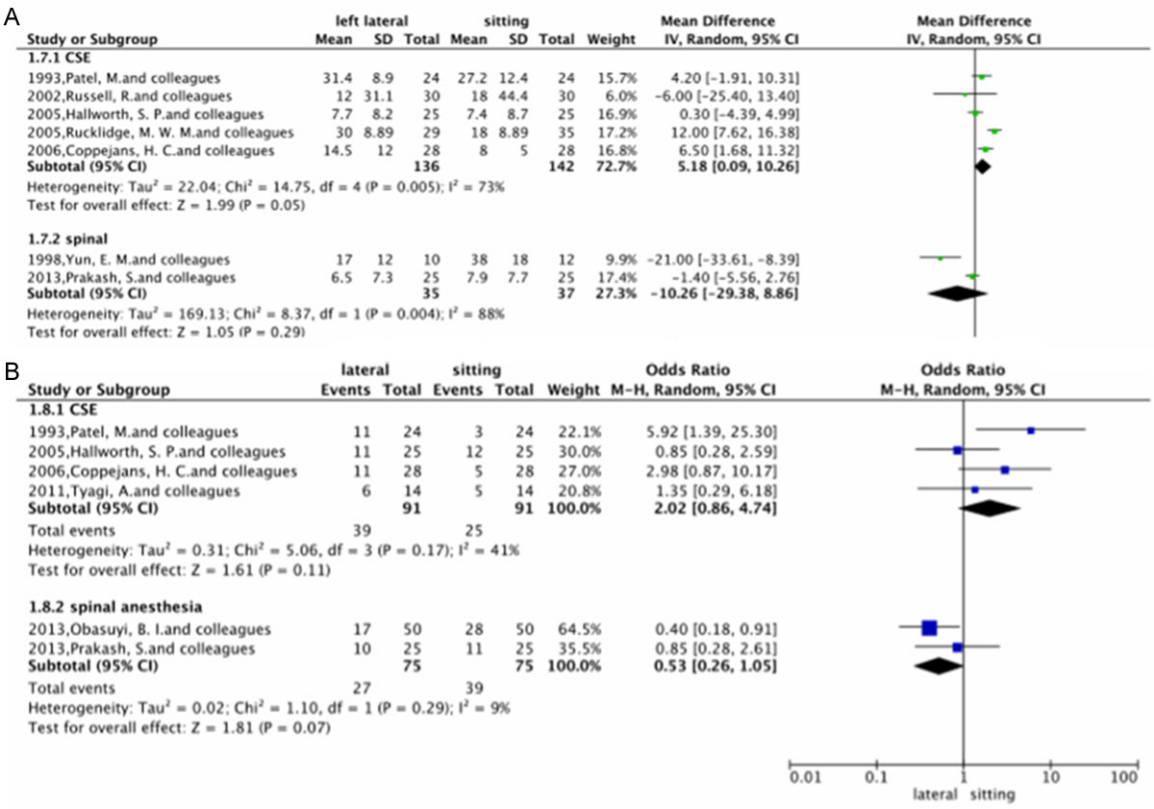

Figure 4. Subgroup analysis of hemodynamic changes between lateral and sitting group. A. Comparison of ephedrine requirement; B. Comparison of hypotension incidence.

and abstract, 391 studies were subsequently reviewed. According to the Inclusion and Exclusion Criteria, 336 studies were excluded, and the final 13 trails were included. The work flow was shown in **Figure 1**.

Risk of bias and quality assessment

The risk of bias was assessed by two of current authors independently and data was processed by Review Manager 5.3. The results were shown in **Figure 2**. All studies were judged to have unclear risk of bias across the criteria in one or more domains. The blinding of personnel and outcome measure, in which all studies showed high risk of bias, was the major source of bias in our study. The randomization and allocation concealment was unclear in 50-70% studies, and that may be the moderate risk of bias.

Main characteristic of included studies

We included 13 RCTs in current meta analysis, 11 of the studies compared lateral and sitting position, of which three studies were simultaneously investigated the lateral and oxford position, the other two made the comparison between right lateral and left lateral position.

702 participants were all healthy singleton pregnancy women scheduled for elective Cesarean delivery under neuraxial anesthesia without any complications. Effects of different positions participants received during the neuraxial anesthesia were assessed and compared on anesthesia effect, change of hemodynamics, neonatal status and complications. The study design, main outcomes, puncture site of neuraxial anesthesia and the anesthetics were summarized in **Tables 1** and **2**.

Lateral vs. sitting position

Ten studies [5, 7-15] including 516 parturients compared lateral and sitting position. In general, lateral position showed faster onset time and longer duration of neuraxial anesthesia, and the result was consistent with total effect of time to adequate anesthesia among sub-

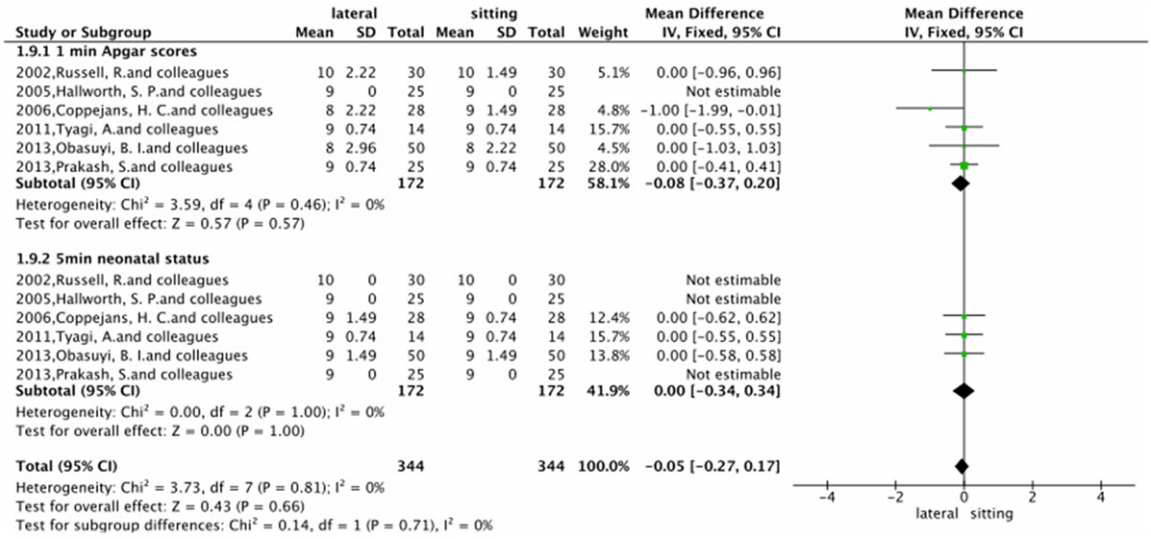

Figure 5. Subgroup analysis of neonatal status between lateral and sitting position.

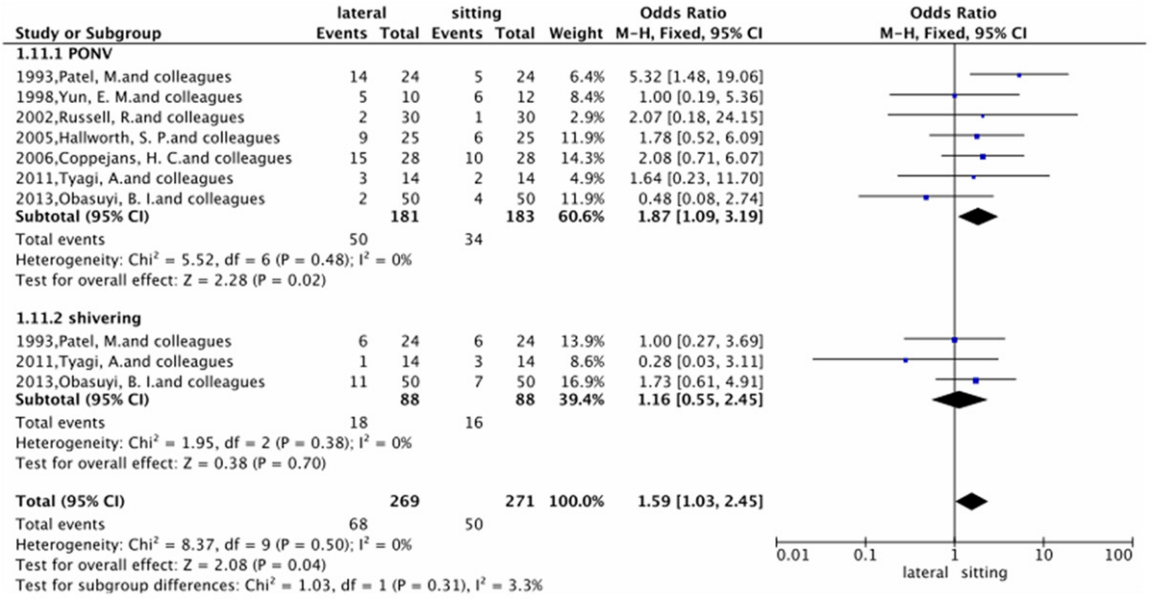

Figure 6. Subgroup analysis of complication incidence between lateral and sitting position.

groups (MD -2.02, (95% CI from -3.38 to -0.67)). Results were presented in **Figure 3A**.

A sensitivity analysis of time from intrathecal (IT) injection to surgical incision was performed through excluding Obasuyi et al. 2013 [15] and result had not changed, the heterogeneity was smaller. Results were shown in **Figure 3B**.

Other results related to anesthesia effect including time to first postoperative analgesia and number of patients supplemented with analgesic between lateral (MD=12.15, 95% CI: -1.36, 25.67) and sitting position (OR=0.22, 95% CI: 0.07, 0.68) during surgery were shown in **Figure 3C**.

Data of changes in Hemodynamics were summarized in **Figure 4**. Ephedrine requirement between lateral and sitting position (MD=1.18, 95% CI: -4.57, 6.92) had no difference while hypotension incidence in lateral position was lower (OR=0.53, 95% CI: 0.26, 1.05). However, heterogeneity (I^2=84%) in ephedrine require-

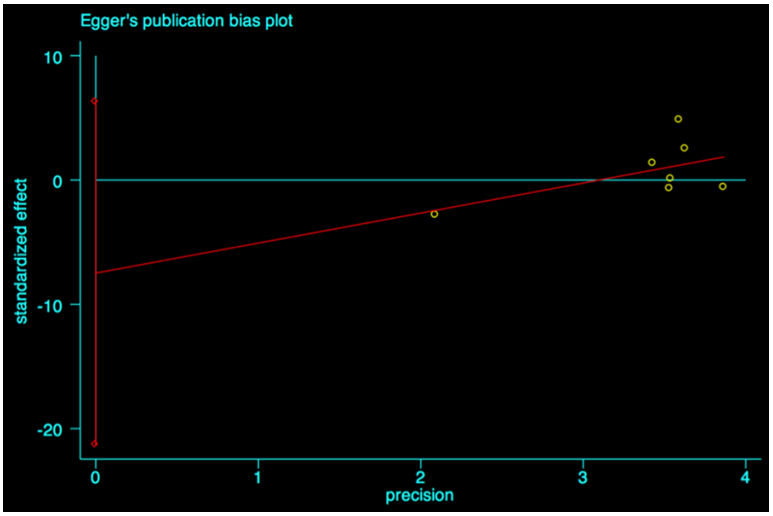

Figure 7. Egger's test for publication bias.

ment was too obvious to draw a robust conclusion.

Neonatal status between the two groups had few differences in total Apgar score at 1 min and 5 min after birth (MD=-0.05, 95% CI: -0.27, 0.17) (**Figure 5**).

Side effects including intraoperative nausea and vomiting (IONV) and shivering were also analyzed and exhibited in **Figure 6**. Sitting position had higher incidence of complications (MD=1.59, 95% CI: 1.03 to 2.45).

Egger's test suggested no publication bias (P=0.223) in the comparison of ephedrine requirement (**Figure 7**).

Lateral vs. Oxford position

Analysis of pooled data extracted from three trails [5, 12, 16] showed that lateral position was more effective on anesthesia effect (MD =-5.36, 95% CI: -6.58, -4.14) with sensitivity analysis that excluded Prakash et al. 2013 [5].

The supplementary analgesia (OR=0.32, 95% CI: 0.05, 2.08) showed no significant differences between the two positions.

Ephedrine requirement was also detected (MD=5.36, 95% CI: 2.85, 7.88) and the heterogeneity was too obvious (I^2=60%) to make a conclusion.

All pooled data had no heterogeneity (I^2=0) excepting for ephedrine requirement (I^2=60%) and were summarized in **Figure 8**.

Left lateral vs. right lateral position

Two trails [17, 18] including 67 participants investigated numbers of patients who needed supplemental analgesia between left lateral and right lateral position. The results showed no significant difference in the two positions with OR=1.66, 95% CI from 0.47 to 5.88 and heterogeneity of 0% (**Figure 9**).

Discussion

Intervertebral anesthesia including spinal and epidural anesthesia and combination of the two methods become more and more popular in cesarean section. Positions during induction of neuraxial anesthesia may significantly influenced maternal and fetus physiological conditions. Choosing one appropriate position would be beneficial to parturients, anesthesiologists and obstetricians. This meta-analysis was performed to verify effectiveness of different positions during induction of intervertebral anesthesia for parturients undergoing caesarean section.

In general, lateral position was the most effective position for neuraxial anesthesia both in onset time and duration of anesthesia. The sensitivity analysis of time from IT injection to surgical incision suggested that baricity of bupivacaine and different technique of neuraxial anesthesia, such as spinal anesthesia and CSE, might be potential sources of heterogeneity both in lateral *vs.* sitting position and lateral *vs.* oxford position. Previous studies showed that injection of hyperbaric local anesthetic using lateral position would not cause unilateral block [19, 20], meanwhile, maximum sensory level was higher because of raised intrathecal pressure caused by turning movement [21]. Although spread of local anesthetic is affected by many factors [22], baricity in relation to position during administration may be the most important [23]. That may clearly explain the heterogeneity and support our findings.

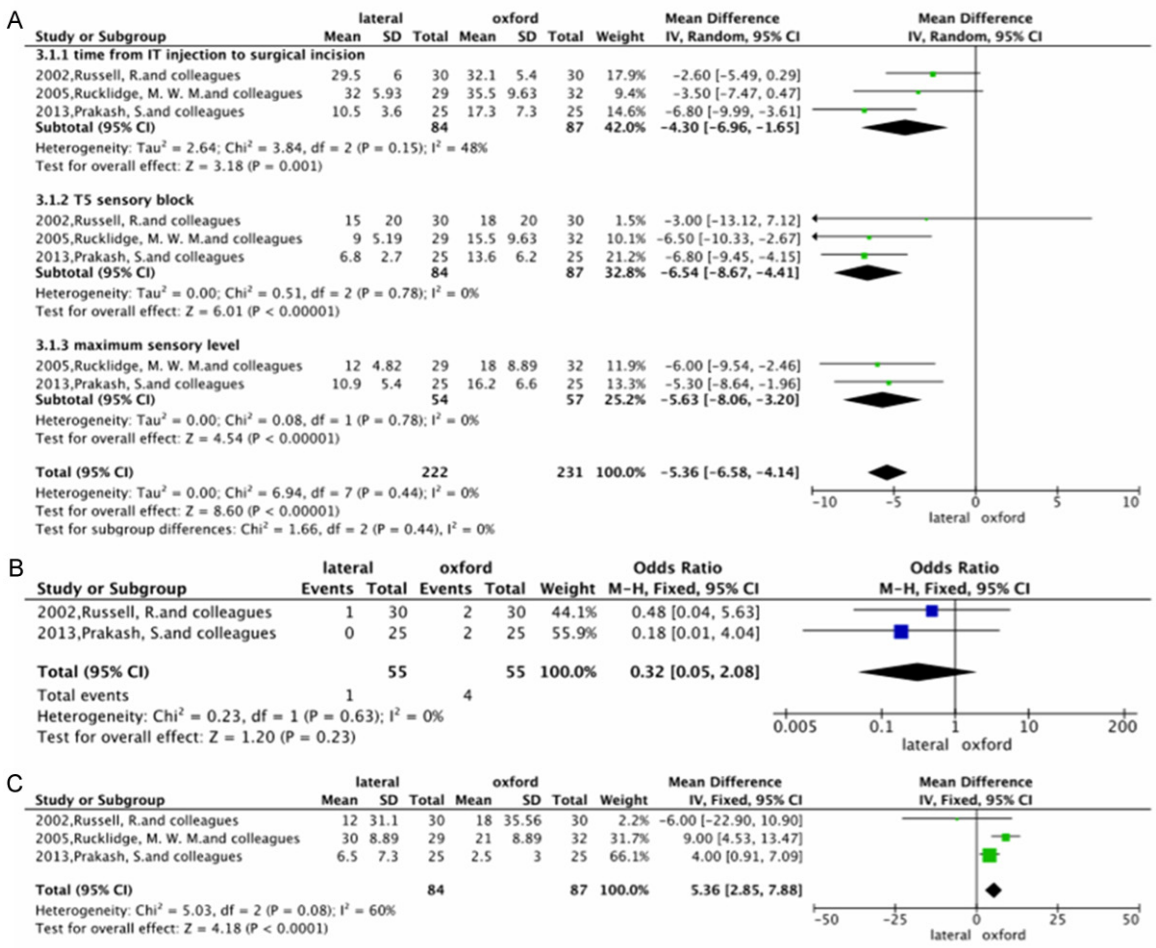

Figure 8. Forest plots of comparison between lateral and oxford position. A. Subgroup analysis of comparison of time to adequate anesthesia. B. Comparison of ephedrine requirement. C. Comparison of supplementary analgesia.

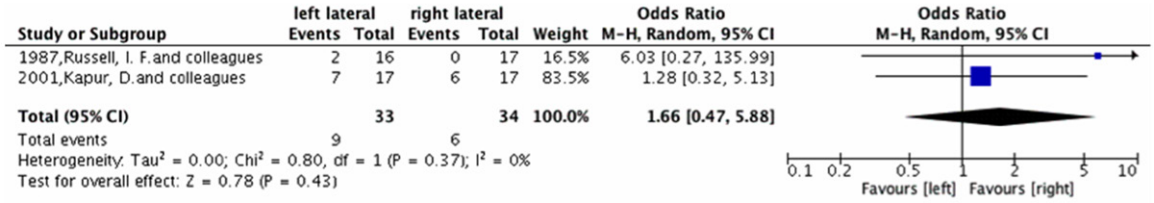

Figure 9. Forest plots of supplementary analgesia between left and right lateral position.

As to changes in hemodynamics, all the three positions showed variable differences. We have done subgroup analysis of the hypotension incidence in the comparison of lateral and sitting position according to different anesthesia methods (spinal *vs.* CSE), the results of subgroups were conflicting. Compared with single shot spinal anesthesia (SSS), CSE led to higher maximum sensory level and the mechanism was not yet clear [23]. As described by Carpenter RL et al. [24], higher blockade level was correlated to unstable circulatory. Hartmann. B et al. [25] also demonstrated that sensory block height >T6 was a predictor for hypotension. After anesthesia, cardiac output usually decreased, which might be another reason why hypotension happened [26]. Incidence of hypotension was obviously different between CSE and spinal anesthesia. A universal definition of hypotension was needed when including

articles. The overall effect of positions on hemodynamic stability should be done separately according to different anesthesia technique. Meanwhile numbers of trails were too small to make analysis in hypotension incidence and no conclusion could be made according to the results in the comparison of lateral and oxford position. Other studies [27] showed Oxford position exhibited more stable haemodynamics and lower ephedrine usage than sitting position under spinal anesthesia. Results of ephedrine requirement between lateral and sitting position also showed high heterogeneity. That might because of different clinical data acquisition time. Two studies [20, 28] have shown that lateral position had lower usage rate of ephedrine both under CSE and spinal anesthesia. Interestingly, Rees et al. [28] demonstrated circulatory in full lateral position was more stable than in 15 degrees left table tilt position.

In all, further research is needed to be integrated to draw a conclusion about the effect of positions on cardiovascular system stability.

Placenta could maintain its own perfusion by autoregulation [29], short-term decrease of maternal blood pressure may not do serious harm to fetus. Neonatal status (mainly referred to Apgar score) in all positions had no distinct diversity. Recently, umbilical artery blood gas has been considered as a better marker for predicting neonatal morbidity than pH [30]. Our study has not summarized this issue because few studies had mentioned neonatal blood gas. Consistenting with our results, other related research also showed no differences in neonatal status, probably because the maternal hypotension was transient.

Complications during and after surgery showed that lateral position had lower incidence than sitting position. Although pregnant women have high susceptibility to nausea and vomiting due to physiological changes during pregnancy, intraoperative hypotension and large sympathetic block segment caused by anesthetics could significantly led to IONV. This finding was consistent with our previous result about anesthesia effect [31]. Shivering is another frequent complication and is an unpleasant experience for patients. In spinal and epidural anesthesia, neuraxial blocking caused autonomic thermoregulation disorder, combined with other issues such as cold fluid, shivering arised. Incidence of shivering under spinal or epidural anesthesia was different, the latter was lower [32]. Whether positions could influence shivering was not yet elucidated.

Findings of our study should be interpreted with some limitations. First, all included studies presented high performance and selection bias of blinding, there might be a negative impact on evidence intensity. Second, included trails were short of studies reporting comparison between left lateral and right lateral position. More related research should be developed to support this conclusion when used for clinical guidance. So far as we know, this is the first time the effects of distinct positions on parturients undergoing local anesthesia and cesarean section have been summarized.

In conclusion, this study quantified anesthesia effects of different positions during induction of local anesthesia on patients undergoing cesarean section. Lateral position may be more beneficial on the aspect of onset time of anesthesia and adequate analgesia even the incidence of hypotension and complications. Maternal positions may have limited influence on neonates. More studies are needed to provide reliable evidence on hemodynamic fluctuations due to change of position.

Disclosure of conflict of interest

None.

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