Cohort Study

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Impact of being lateral and sitting position for spinal anesthesia administration on maternal hemodynamic variability and the timing of hypotension among cesarean section patients in a resource-constrained area: a prospective observational cohort study

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Background: Type of anesthesia used for cesarean section can be general, spinal, or epidural. However, peripheral nerve blocks, such as the lower and upper extremity nerve blocks, can be referred to as other types of anesthesia. Spinal anesthesia is the most frequently used method because of its ease, dependability, and rapidity in attaining proper anesthesia. The purpose of this study was to determine the effects of spinal anesthesia induction position on maternal hemodynamics and the timing of hypotension.
Method: A prospective observational cohort study design was employed. A simple random sampling technique was used. A total of 190 patients received spinal anesthesia, with 95 in the lateral and 95 in the sitting position in each group. The data were entered into Epi Data version 4.6 and then exported to SPSS version 26 for analysis. Independent sample *t*-tests and chi-square (χ^2) tests were performed. Kaplan–Meier survival analysis and log-rank test were used and *P* value ≤0.05 considered significant.
Results: The overall incidence rates of hypotension in the lateral and sitting groups were 54.6% [95% CI, 52.3–72.1] and 73.8% [95% CI, 69.8–87.2], respectively (*P* = 0.025). The timing of first hypotension was 8.86 minute [95% CI, 8.690–13.272] and 15.75 minute [95% CI, 14.569–19.372] (*P* = 0.001) for sitting and lateral, respectively.
Conclusion and recommendation: In this study, we found a significant difference between the lateral and sitting groups with different measurement parameters, such as blood pressure, intraoperative adverse events, and onset of hypotension. The incidence of hypotension, intraoperative adverse effects of spinal anesthesia, and fluid consumption were lower in the lateral groups. Nonetheless, instead of being technically challenging during spinal anesthesia induction, the lateral position results in better hemodynamics and onset of hypotension than in the sitting posture.

Keywords: cesarean section, hemodynamics, lateral position, sitting position and spinal anesthesia

Background and importance

Introduction

The type of anesthesia used for cesarean section can be general, spinal, or epidural. However, peripheral nerve blocks, such as the lower and upper extremity nerve blocks, can be referred to as other types of anesthesia. Spinal anesthesia is the most frequently used method because of its ease, dependability, and rapidity in attaining proper anesthesia. The purpose of this study was to determine the effects of spinal anesthesia induction on maternal hemodynamics[1-5].

Regional anesthesia is becoming more common for cesarean sections because of its superior maternal and fetal benefits. Spinal anesthesia is performed in various situations, such as sitting or lying in the lateral decubitus position. Various researchers have proposed different positions for patients[2,6,7].

In the sitting position, patients should be encouraged to keep their spines flexed while sitting with one leg hanging off the side of the bed to help the Interspace open up[6,8].

The lateral position is defined as side-lying with a pillow carefully situated along the patient's back, possibly buttocks, and a pillow positioned between the patient's flexed legs to prevent hip adduction and internal rotation[9].

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In addition to positioning for spinal anesthesia, patient positioning may be used to improve arterial blood oxygenation, facilitate the drainage of respiratory secretions, reduce gastroesophageal reflux disease, and enhance patient comfort and hemodynamic status[10].

Hemodynamics is a term used to describe the basic parameters of cardiovascular function such as arterial blood pressure and cardiac output[11,12].

The maternal position may influence hemodynamics by altering the diffusion of local anesthetics. However, studies of different maternal positions have yielded contradictory outcomes in terms of hemodynamic stability and block onset speed[7].

Spinal anesthesia presents various complications related to patient placement, both before and after anesthesia. Position may influence the diffusion of local anesthetic, the speed of onset of sensory block, and hence, the hemodynamic consequences[13].

Position-dependent complications of spinal anesthesia are categorized as minor or major. A minor complication of spinal anesthesia is a brief change in the patient's physiological status, such as arterial hypotension, high block, bradycardia, and total spine[14,15].

Hypotension typically occurs following spinal anesthesia during caesarean section, and the degree of hypotension is determined by the height of the block, the patient's position, and the volume status of the patient, which influences the spread of local anesthetics. Maternal position can affect the rate of hemodynamic effects[7,16,17].

The incidences of hypotension in the lateral and sitting groups were 48% and 13%, respectively. A total of 22% of the parturients in the sitting group and 61% of those in the lateral group reported experiencing nausea. According to recent studies, IONV occurs frequently during cesarean section under spinal anesthesia, accounting for up to 80% of cases. Because of their pregnancy by itself and position, pregnant women are more likely to experience nausea and vomiting[18,19].

Previously, most researchers concentrated on hemodynamic differences and the incidence of adverse events related to spinal anesthesia. However, these studies used a combination of spinal and epidural anesthesia. Some patients receive spinal anesthesia with adjuvants such as opioids[16,20,21].

Unfortunately, studies comparing the timing of hypotension between groups are scarce[7]. Although several studies have been conducted on this topic, there are still contradictory ideas among scholars concerning which position is better for pregnant mothers who undergo cesarean section during spinal anesthesia induction. Currently, studies on this topic conducted in resource-limited areas are scarce.

Nonetheless, most researchers focused on the hemodynamic difference and prevalence of complication of spinal anesthesia. And there is a gap on timing of first hypotension related to sitting and left lateral position between the groups. And now a day most clinicians prefer to use sitting position for induction of spinal anesthesia, but most literatures support that to use lateral position to alleviate inferior vena caval compression. The main purpose of this study is to fill the gap. Previously there is no published research on intra operative adverse event and timing of first hypotension associated to sitting and left lateral position during induction of spinal anesthesia.

Therefore, this study aimed to address the controversies raised by different researchers and provide a rational and evidence-based practical framework to reduce the occurrence of post spinal hypotension.

Research hypothesis

- HO1: There is no effect on maternal hemodynamic variability with lateral and sitting position, who undergo cesarean section under spinal anesthesia.
- HA1: There is an effect on maternal hemodynamic variability with lateral and sitting position, who undergo cesarean section under spinal anesthesia.
- HO2: There is no effect on timing of hypotension with lateral and sitting position, who undergo cesarean section under spinal anesthesia.
- HA2: There is no effect on timing of hypotension with lateral and sitting position, who undergo cesarean section under spinal anesthesia.

Methods and materials

Study design and areas

This institution-based prospective observational study was conducted at Wolaita Sodo University Comprehensive and Specialized Hospital, located in southern Ethiopia region. The town is 328 km from Addis Ababa. The hospital provides general patient services and teaching and research activities. Patient services include inpatient and outpatient services, such as medical, surgical, pediatric, psychiatric, ophthalmic, emergency, oncological, dialysis, gynecologic, and obstetric care. The hospital provides approximately 1210 cesarean section (C/S) services under spinal anesthesia every year[22].

Ethical approval for this study was obtained from the ethical review board of the University College of Health Sciences and Medicine, with a unique protocol (No. chsm/erc/03/15). Written informed consent was obtained from all study participants. Privacy and confidentiality of the interviews and information were secured. This research has registered with researchregistry10566, on 5 August 2024.

Eligibility

Inclusion criteria

- ASA class I–II pregnant mothers.
- Patients who take only 0.5% bupivacaine between 10 and 12.5 mg.
- Pregnant mothers indicated for general anesthesia were included in the study population from May 15 to 15 August 2023.

Exclusion criteria

- Pregnant patients above ASA physical status class II.
- Pregnant mothers with severe bleeding.
- Pregnant mothers with severe preeclampsia (≥160/110 mmHg).
- Pregnant mothers with platelet count $<100 \times 10^3$.
- Patients who were complicated with total spinal and intraoperative cardiac arrest and those who were converted to general anesthesia were excluded from the study.

Sample size determination and sampling technique

The sample size was calculated using G*power version 3.1.9.7 software from Erdfelder, Faul, & Buchner, and the proportion

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difference between the two groups was taken from a previous study performed in Nigeria. In this study, the incidence of hypotension in the lateral group was 17 (34%), and the incidence of hypotension in the sitting group was 28 (56%)[7]. with the use of G*power version 3.1.9.7 software, the calculated critical z value was 1.9599640. The sample size was calculated a priori using the difference between the two independent proportions (two groups). Power (90, proportion (p1) = 0.34, proportion (p2) = 0.56), using a power of 90%, alpha = 0.05.

The effect size was 0.5, and the calculated sample size was 172. We have added the nonresponse rate (10% of the total study population), which becomes 172 + 17 = 190, n1 = 95, and n2 = 95.

We used a simple random sampling technique; we prepared a draw of 0 and 1 for every patient who arrived at the Operation Theatre for a cesarean section. Zero represents not to be included in the study and 1 represents to be included in the study until the calculated sample size is reached in the study period.

Data collection tool and procedure

The structured questionnaire was written in English, and the Amharic (local language) version was used after different studies were reviewed. The tool includes sociodemographic data, preoperative vital signs, intraoperative vital signs, ASA classification, baricity of the drug, position during induction of spinal anesthesia, total volume of drug, and the professional who administered the procedure.

Intraoperative data were collected after providing information about the procedure and informed written consent from a patient in English from an anesthesia sheet with four anesthetists after training with the spinal anesthesia. The principal investigator supervised the completion of the data.

Participant intraoperative follow-up

After the parturient was preloaded with 10 mL/kg of crystalloids, they were monitored using ASA standard II monitoring, such as noninvasive blood pressure (NIBP), electrocardiogram (ECG), and pulse oximetry (SPO2%). Then, 10–12.5 mg of 0.5% isobaric bupivacaine was administered by experienced BSc and MSc Anesthesia professionals between lumber number three and four or lumber number four and five levels. All the patients selected for the study were informed of their consent to participate. The patients were followed up to the end of surgery. Data were collected through face-to-face and face-to-face interviews. Hemodynamic parameter has been recorded every 5 minute after the spinal anesthesia administration.

Data quality assurance

Principal investigators trained the data collectors. The instrument was created by the principal investigator and examined by professional specialists. Following their review and comments, it was corrected, and a pre-test was conducted at Wachemo University Comprehensive and Specialized Hospital on 5% of the total sample size.

Throughout the data collection process, regular monitoring and follow-up were performed, as needed. Every day, the principal investigator verified the accuracy and consistency of the data. Everything used to collect data was organized sequentially and stored securely.

Data processing and analysis

Data were personally verified for accuracy before being coded, entered, and entered into EPI data version 4.6, and SPSS version 27 was used for analysis.

The data were checked for normality via graphical tests such as histograms and analytical tests such as the Shapiro–Wilk test ($P > 0.05$, normally distributed). A box plot was used to investigate the outliers. Continuous variables, such as hemodynamic parameters, are reported as the mean ± SDs for normally distributed data. We used frequency and cross-tabulation to characterize the relevant variables in relation to the resulting variables. After validating the normality assumption, a *t*-test for independent samples was employed to compare the means of the two independent groups to compare the baseline continuous variables.

To analyze categorical and nominal data, the χ^2 (chi square) test was employed. Kaplan–Meier survival analysis was used to assess the timing of hypotension development. The log-rank test was used to compare results between the lateral and sitting groups. Variables with a P value ≤0.05 were considered statistically significant. Descriptive statistics were employed to demonstrate the outcomes, including data, text, tables, and figures.

Operational definition

- ASA status is a subjective assessment of a patient's overall health based on five classes (I–V)[23].
- Postoperative nausea and/or vomiting (PONV): When a patient has at least one bout of nausea or vomiting within 24 h, it is an unpleasant feeling that affects surgical patients after general anesthesia.[24].
- Hemodynamics: The physical study of flowing blood and all the solid structures (such as arteries) through which it flows[11].
- Hypotension: Hypotension was defined as a decrease in systolic blood pressure >20%, a value <90 mmHg, or a mean arterial pressure change of less than 65 mmHg[7,25].
- Bradicardia: heart rate of less than 60 bpm[26].
- Positioning is the way to place patients in anatomical alignment and to prevent harm by padding on hard surfaces that may come into contact with it[27]. This work has been reported in line with the STROCSS criteria[28].

Results

Study participant characteristics

An analysis of data from 190 respondents with a response rate of 100% was conducted (Fig. 1).

Patient demographic data

In this study, 190 women, including 95 women in the sitting group and 95 women in the lateral group, were included over a three-month study period. There were no statistically

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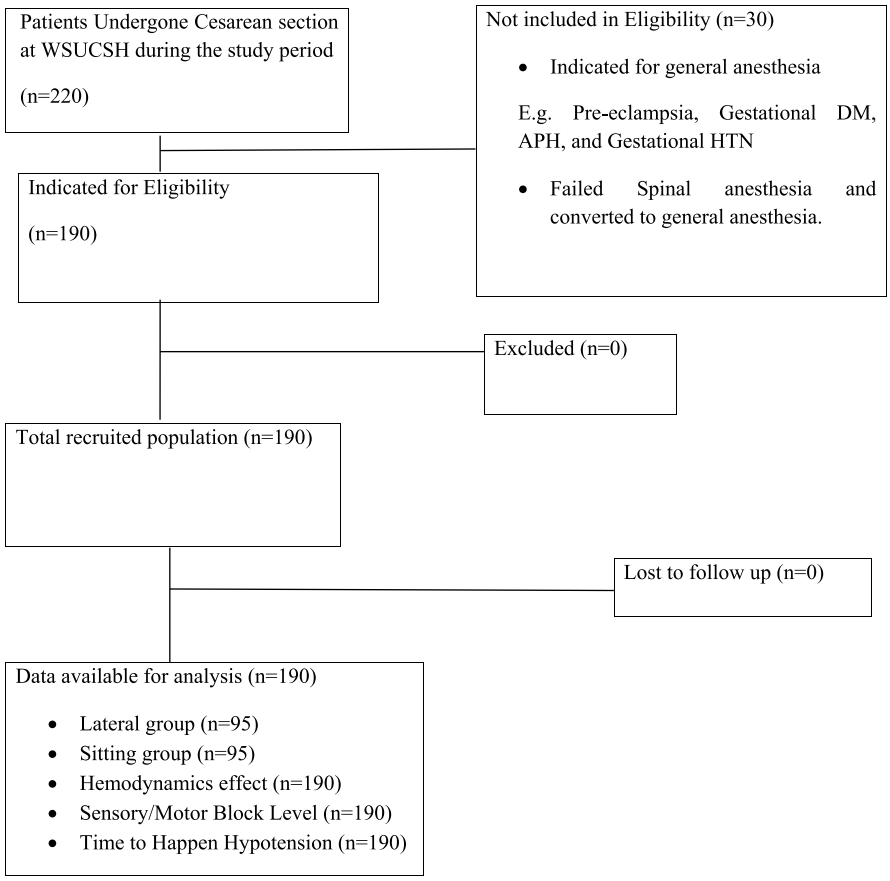


Figure 1. Patient recruitment diagrams.

significant differences in age or other demographic characteristics between the two groups (Table 1).

Comparison of SBP and MAP between the sitting and lateral groups

The mean systolic blood pressure and mean arterial blood pressure immediately after induction to the 30th min were significantly lower in the sitting group than in the lateral group ($P < 0.05$) (Table 2).

Incidence of hypotension between groups

The incidence of hypotension in the lateral and sitting groups of patients after receiving spinal anesthesia was recorded using the systolic blood pressure and mean arterial blood pressure. The overall incidence rates of hypotension in the lateral and sitting groups were 54.6% [95% CI, 52.3–72.1] and 73.8% [95% CI, 69.8–87.2], respectively ($P < 0.05$).

Table 1

Sociodemographic data of the patient during the study setting

Variables	Lateral group mean ± SD	Sitting group mean ± SD	*P* value
Age	26.30 ± 4.583	25.39 ± 3.665	0.163
Weight	62.15 ± 9.936	63.55 ± 7.064	0.310
Height	1.6512 ± 0.07202	1.601 ± 0.09514	0.088
Gestational age	39.53 ± 1.622	38.87 ± 1.793	0.189

Data are mean ± SD.

Risk of hypotension among groups

The risk of hypotension in the lateral group was 55.5% lower than that in the sitting group (95% CI: [21.6%–83.7%]; chi-square $P = 0.005$).

Comparison of intraoperative adverse events between groups

The intraoperative fluid consumption after spinal anesthesia was significantly greater in the sitting group than in the lateral group ($P < 0.05$). However, the number of spinal needle insertion attempts was significantly greater in the lateral group than in the sitting group ($P < 0.05$). Hence, intraoperative blood loss in both the lateral and sitting groups after spinal anesthesia was not significantly different (Table 3).

Comparison of the timing to first hypotension between groups via the log rank test

A log-rank test revealed that the estimated survival times of the two groups were significantly different. The incidence of onset to first hypotension was 8.86 minute [95% CI, 8.690–13.272]

Table 2

Comparison of systolic blood pressure and mean arterial pressure in sitting and lateral groups during the study setting

	Systolic blood pressure (mmHg)			MAP (mmHg)		
Time	**Lateral group mean ± SD**	**Sitting group mean ± SD**	***P* value**	**Lateral group mean ± SD**	**Sitting group mean ± SD**	***P* value**
Baseline	121.97 ± 15.877	122.65 ± 10.675	0.74	88.16 ± 9.627	89.37 ± 10.197	0.425
Immediately after induction	115.40 ± 10.474	105.41 ± 14.998	0.000*	82.52 ± 9.694	70.40 ± 15.050	0.000*
5th min	108.59 ± 11.305	96.42 ± 15.584	0.000*	77.99 ± 9.322	69.76 ± 14.758	0.000*
10th min	105.67 ± 10.846	94.69 ± 14.505	0.000*	78.92 ± 8.730	67.84 ± 12.588	0.000*
15th min	105.62 ± 13.327	94.48 ± 13.211	0.000*	79.22 ± 11.238	66.10 ± 11.662	0.000*
20th min	106.38 ± 12.691	95.16 ± 12.455	0.000*	78.93 ± 9.834	65.50 ± 10.759	0.000*
25th min	107.51 ± 11.297	93.50 ± 12.168	0.000*	79.67 ± 8.195	66.95 ± 10.953	0.000*
30th min	109.70 ± 10.194	92.03 ± 13.767	0.000*	77.50 ± 7.929	69.31 ± 11.947	0.000*

Data are mean ± SD.
"*" indicates significant.

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and 15.75 minute [95% CI, 14.569–19.372] ($P < 0.05$) for sitting and lateral, respectively (Fig. 2).

Discussion

In this study of healthy women receiving an anesthetic solution of isobaric bupivacaine, those in the sitting position had a high incidence of hypotension. In this study, the overall incidence rates of hypotension in the lateral and sitting groups were 54.6% [95% CI, 52.3–72.1] and 73.8% [95% CI, 69.8–87.2], respectively ($P < 0.05$). The number of patients who developed hypotension was significantly greater in the sitting group than in the lateral group, which is in line with the findings of Simin *et al*, who reported 50% and 76.3% hypotension in the lateral and sitting groups, respectively[29]. Ortiz-Gómez *et al* reported 50.7%, 60%, and 69.2% in the sitting, left lateral, and right lateral groups, respectively[30]. However, in a study by Obasuyi *et al*, the incidence of hypotension was 34% in the lateral group and 56% in the sitting group[7]. Manouchehrian *et al* reported a rate of 24.5% in the lateral group and 57.7% in the sitting group[4]. Ali *et al*[13], these findings are inconsistent with those of the current study. A possible reason for the different outcomes may be the differences in the study population.

However, in the study performed by Obasuyi *et al*, the time from onset to first hypotension in minutes was 11.8 ± 10.7 in the lateral group and 9.8 ± 8.2 in the sitting group, as in this study, there was no statistically significant difference between the groups[7]. In the present study, the time to first hypotension in the sitting group was 8.86 minutes [95% CI, 8.690–13.272] and 15.75 minutes [95% CI, 14.569–19.372] ($P < 0.05$), respectively. The results of the present study revealed that the sitting group had a shorter time to develop hypotension than did the lateral group.

Table 3

Comparison of number of attempt, intraoperative fluid consumption, and intraoperative blood loss in lateral and sitting groups during the study setting

Variables	**Lateral group mean ± SD**	**Sitting group mean ± SD**	***P* value**
Number of attempts during spinal anesthesia administration	2.80 ± 0.871	1.91 ± 0.717	0.000*
Intraoperative fluid consumption (ML)	2662.79 ± 550.518	2874.42 ± 670.239	0.025*
Intraoperative blood loss (ML)	635.41 ± 206.773	673.37 ± 301.793	0.325

Data are mean ± SD.
"*" indicates significant.

Although few studies have compared spinal needle insertion attempts between groups, available studies support the findings of the current study. In the present study, the number of attempts during spinal anesthesia was compared between the groups, and the results revealed that the mean number of attempts was significantly greater in the lateral group (2.80 ± 0.871) than in the sitting group (1.91 ± 0.717). This finding was in line with the findings of studies by Tan *et al*, who compared the number of attempts to detect the epidural space under combined spinal–epidural anesthesia; the lateral group had considerably more attempts than the sitting group[31]. According to a study conducted by Inglis *et al*, the lateral group took a longer time to place spinal needles in the lateral position to the subarachnoid space than the sitting group (240 vs. 115 s)[32]. However, in a study performed by Coppejans *et al*, there were fewer technical difficulties in identifying the intrathecal space on the first attempt with patients in the sitting position[33,34]. Rather than technical difficulty, the overall benefit of the lateral position over the sitting position outweighs that of the traditional position.

A study performed by Stoneham *et al* revealed that the use of additional fluid for intraoperative use was not significantly different between groups. The mean fluid consumption in milliliters was 880 ± 370 and 810 ± 210 for the lateral and Oxford groups, respectively[34]. An additional study performed by Hajian *et al* revealed no significant difference in intraoperative fluid consumption between the groups[35]. In this study, fluid consumption differed significantly between the groups. This may be due to population differences as elective cases occur after resuscitation.

Ortiz-Gómez *et al*[30], Tan *et al*[31], and Esther *et al*[34] reported that there were no differences between groups in the number of patients with intraoperative adverse effects of spinal anesthesia. There was no statistically significant difference between the groups in terms of possible intraoperative and postoperative adverse events of spinal anesthesia, such as nausea, vomiting, skin flushing, and shivering. Nonetheless, in our study, the number of patients who experienced intraoperative

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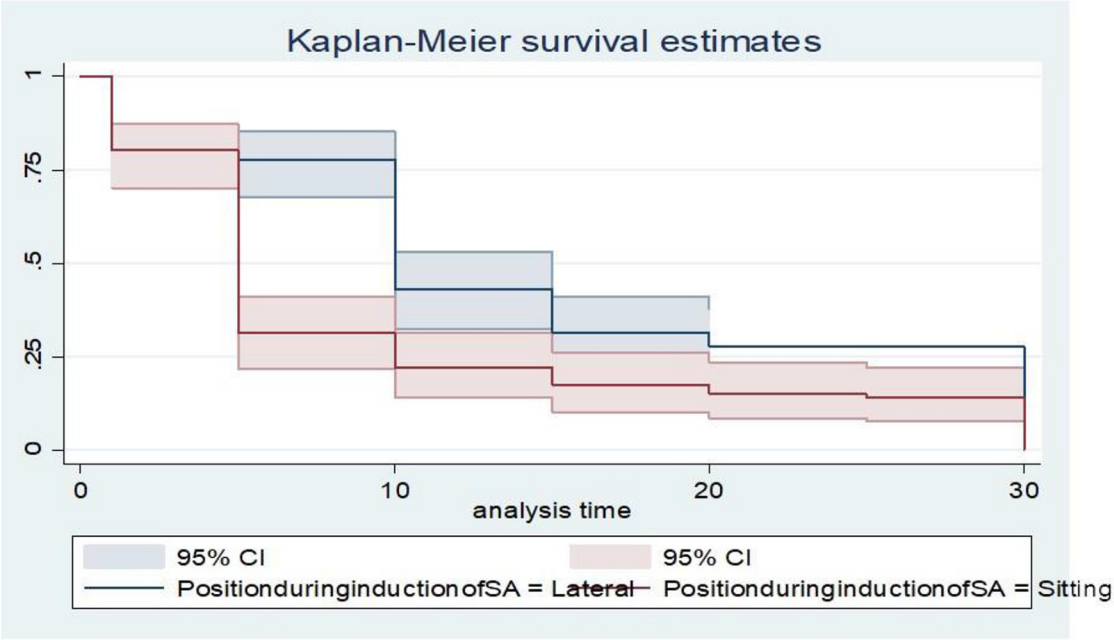


Figure 2. Comparison of the timing to first hypotension in minutes between groups via the log rank test.

complications, such as nausea, vomiting, and bradycardia, was significantly greater in the sitting group than in the lateral group. The lateral group had a significantly greater number of patients with shivering than the sitting group did. This is due to differences in the study population and study area, and the greater spread of sensory blocks cranially in the sitting group than in the lateral group.

Overall, scholars recommend different types of positions for critically ill patient such as a patient with spinal cord injury and spine surgery[36].

Strengths and limitations of the study

This can serve as a foundation for further research in the study area. Homogeneity of the study population can be seen positively with the use of a very advanced analytical model. However, because this study is observational, being different in the age group of the study population, taking a pregnant mother, who has disturbed physiology as the study population, and the data, particularly the vital sign follow-up timing, are not vivid due to a lack of hemodynamic measurement materials, such as beat-to-beat and following each minute, which may be a study limitation.

Conclusion

In this study, we found a significant difference between the lateral and sitting groups in different measurement parameters, such as blood pressure, intraoperative adverse events, and onset of hypotension. The incidence of hypotension, intraoperative adverse effects of spinal anesthesia, and fluid consumption were lower in the lateral groups. Nonetheless, instead of being technically challenging during spinal anesthesia induction, the lateral position results in better hemodynamics and onset of hypotension than in the sitting posture. To maintain hemodynamic status, spinal anesthesia should be delivered in the lateral position rather than in the sitting position.

Finally, patients in the lateral group have an advantage over patients in a sitting position in different aspects, such as avoiding hemodynamic derangement, fetal distress, high magnitude and onset of hypotension, and even patient comfort during administration of spinal anesthesia.

Implications for practice and research

This study implicates how positioning affects the hemodynamics and how it can be avoided in resource constrained area to minimize maternal and fetal mortality. As per the conclusion of this study we recommend that to do high evidence level study like randomized control trial and meta-analysis with high sample size.

Ethics approval

Ethical approval was obtained from the Institutional Review board of Wolaita Sodo University, College of Health Sciences and Medicine, with a protocol unique number of CHSM/ERC/03/15.

Consent

Informed written consent has taken Written informed consent has taken from each participant for participation, publication and information was kept confidential.

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Woliata Sodo University.

Author's contribution

S.S. were involved in the conception, design, analysis, interpretation, report and manuscript writing. B.K. and T.D. had participated in the conception, design, analysis, interpretation, and report writing. T.M., S.R., A.K., N.S., S.G., A.A., G.D., and Y. W. had participated in the interpretation, and report writing.

Conflict of interest

The authors declare that they have no competing interests. All the authors have read and approved the final manuscript.

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Data availability statement

The data that support the findings of this study are available from the corresponding authors upon reasonable request.

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