ISSN: 2457-0400

Impact Factor: 7.675

WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

www.wjahr.com

Volume: 10, Issue: 4

Page N. 210-215

Year: 2026

Original Article

Coden USA: WJAMA3

HEMODYNAMIC STABILITY IN UNILATERAL VERSUS BILATERAL SPINAL ANESTHESIA FOR GYNECOLOGICAL SURGERY: A COMPARATIVE STUDY

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Article Received: 05 March 2026 **Article Revised:** 25 March 2026 **Article Published:** 04 April 2026

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DOI: https://doi.org/10.5281/zenodo.19435891

How to cite this Article: Ahmed A. Eeda*[1], Mohanad Abdul Kareem Hilal[2], Haydar Samir Abdullatif[2] (2026). Hemodynamic Stability In Unilateral Versus Bilateral Spinal Anesthesia For Gynecological Surgery: A Comparative Study. World Journal of Advance Healthcare Research, 10(4), 210–215.

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ABSTRACT

Background: Spinal anesthesia is widely used for gynecological surgeries due to its benefits in pain management and recovery, but it often causes hypotension from sympathetic blockade, particularly with bilateral techniques. Unilateral spinal anesthesia limits this blockade to one side, potentially offering greater hemodynamic stability. This study compared hemodynamic parameters between unilateral and bilateral spinal anesthesia in patients undergoing open gynecological surgery. **Patients and Methods:** This cross-sectional comparative study at Al-Hussein Teaching Hospital (January-December 2025) included 73 ASA I-II female patients aged 18-65 undergoing elective open gynecological surgery (e.g., cesarean section, hysterectomy, uterine fibroid removal). Group I (n=34) received unilateral spinal anesthesia (hyperbaric bupivacaine 12-15 mg, lateral decubitus position maintained several minutes); Group II (n=39) received bilateral (same dose, supine position). Systolic/diastolic blood pressure, mean arterial pressure, and heart rate were monitored preoperatively, intraoperatively, and up to 180 minutes postoperatively; data were analyzed with SPSS v26 ($p \leq 0.05$ significant). **Results:** Demographics were similar (age ~35.5 years, $p=0.905$; surgery types $p=0.800$). Bilateral group showed significantly lower systolic (e.g., 15 min post-induction: 110.6±13.5 vs. 127.3±12.3 mmHg, $p=0.001$), diastolic (63.2±9.2 vs. 77.1±8.4 mmHg, $p=0.001$), and mean blood pressure (79.0±7.6 vs. 93.8±6.9 mmHg, $p=0.001$) from 15 min post-induction to 60 min postoperatively, with recovery by 90 min. Heart rate differences were non-significant (all $p>0.05$). **Conclusion:** Unilateral spinal anesthesia provides superior hemodynamic stability with less pronounced blood pressure reductions compared to bilateral in gynecological surgery, supporting its use to minimize hypotension risks.

KEYWORDS: Unilateral spinal anesthesia limits this blockade to one side, potentially offering greater hemodynamic stability.

INTRODUCTION

Spinal anesthesia is a kind of regional anesthesia involving the direct injection of a local anesthetic into the cerebrospinal fluid encasing the spinal cord and nerve roots. It blocks pain from a comprehensive area of the body, including the hips, abdomen, pelvis, and legs.[1] Spinal anesthesia correlates with heightened patient satisfaction, a reduced complication rate, superior pain management compared to intravenous narcotics, expedited recovery of bowel function, diminished reliance on systemic opioids, improved respiratory function due to enhanced pain control, and facilitated engagement in physical therapy.[2]

Sympathetic blocking during spinal anaesthesia leads to a decrease in systemic vascular resistance and central venous pressure, resulting in hypotension. Severe hypotension may be detrimental to the elderly owing to their diminished physiological reserve and heightened prevalence of systemic diseases[3]. Hypotension correlates with the height of the spinal anesthesia block[4]. The higher block induces significant

sympathetic inhibition, resulting in a decrease in systemic vascular resistance.

Unilateral spinal anaesthesia is a mode of subarachnoid blockade which produces a predominant motor and sensory block on one side. It was first described by Tanasichuk et al. in 1961. Unilateral block restricts the extent of sympathetic blockade, and hence shows minimal haemodynamic changes as compared to bilateral block.[4] It can produce adequate anaesthesia with minimal cardiovascular instability.

This study aims to compare the hemodynamic stability between patients undergoing unilateral spinal anesthesia vsersus those with bilateral spinal anesthesia.

PATIENTS AND METHODS

This **cross-sectional comparative study** was conducted at **Al-Hussein Teaching Hospital** between **January and December 2025**. The research focused on evaluating the efficacy and outcomes of different anesthetic techniques. The study cohort comprised **73 patients** undergoing open gynecological surgery were included, who were stratified into two distinct groups.

- **Group I (n=34):** Patients who underwent **unilateral spinal anesthesia**.
- **Group II (n=39):** Patients who underwent **bilateral spinal anesthesia**.

Ethical consideration

Written consent was obtained from all participants prior to data collection.

Inclusion Criteria

- ASA I-II patients aged 18-65 years undergoing elective open gynecological suegery suitable for spinal anesthesia.
- Willing and able to provide informed consent.
- No prior spinal surgery or anatomical deformities precluding spinal access.

Exclusion Criteria

- Contraindications to spinal anesthesia (e.g., patient refusal, coagulopathy, infection at puncture site).
- Significant cardiovascular disease (e.g., uncontrolled hypertension, recent MI, severe valvular disease).
- Other comorbidities affecting hemodynamics (e.g., diabetes, neuropathy, BMI >35).
- Pregnancy, allergy to local anesthetics, or inability to cooperate.

Procedure

Unilateral spinal anesthesia was provided by positioning the patient in the lateral decubitus position with the operative side kept down. After aseptic preparation of the lumbar region, a spinal needle was inserted into the subarachnoid space, and a small dose of hyperbaric bupivacaine solution was injected slowly (12 – 15 mg). The patient was kept in the same lateral position for several minutes to allow the anesthetic to gravitate toward the dependent side, ensuring selective block on that side of the body. Adequate anesthesia was confirmed before proceeding with surgery.

Bilateral spinal anesthesia was provided with the patient placed in the sitting or lateral position. After the lumbar area was cleaned and draped under sterile conditions, a spinal needle was introduced into the subarachnoid space at the appropriate intervertebral level. A predetermined dose of hyperbaric bupivacaine (12-15 mg) was injected, and the patient was immediately positioned supine to allow symmetric spread of the drug along the spinal canal. Sensory and motor block levels were assessed on both sides to confirm adequate bilateral anesthesia for the surgical procedure.

Data collection

A total number of 79 female patients undergoing open gynecological surgery were included. After obtaining consent, basic characteristics were collected: age, ASA status, and type of surgery. Patients were evaluated vitally preoperatively, during surgery, and for 180 minutes postoperatively.

Data entry and analysis

Data entry was done using Microsoft Excel 2019. Data was recorded into different quantitative and qualitative variables for the purpose of analysis.

Analysis was done using statistical package for social sciences (SPSS version 26).

Data was summarized using measures of frequency (mean), dispersion (standard deviation), and tables. A two-tailed p value of less than or equal to 0.05 was assigned as a criterion for declaring statistical significance.

RESULTS

The mean age was similar between the unilateral and bilateral spinal anesthesia groups (35.4 ± 7.8 vs. 35.7 ± 8.0 years, p = 0.905). ASA I status was observed in 19 (55.9%) of the unilateral group and 26 (66.7%) of the bilateral group, while ASA II was seen in 15 (44.1%) and 13 (33.3%) patients, respectively (p = 0.481). Regarding the type of surgery, caesarean section was performed in 12 (35.3%) and 16 (41.0%) patients, hysterectomy in 11 (32.4%) and 10 (25.6%), and uterine fibroid removal in 11 (32.4%) and 13 (33.3%) patients in the unilateral and bilateral groups, respectively (p = 0.800).

Table 1: Comparison of demographic and clinical characteristics between Unilateral and Bilateral Spinal Anesthesia groups.

Variable	Unilateral spinal anesthesia (n=34)	Bilateral spinal anesthesia (n=39)	P-value
Age (years)			
Mean ± SD	35.4 ± 7.8	35.7 ± 8.0	0.905
ASA Status (n (%))			
ASA I	19 (55.9%)	26 (66.7%)	0.481
ASA II	15 (44.1%)	13 (33.3%)	
Type of Surgery (n (%))			
Caesarean section	12 (35.3%)	16 (41.0%)	0.800
Hysterectomy	11 (32.4%)	10 (25.6%)	
Uterine fibroid removal	11 (32.4%)	13 (33.3%)	

Comparison of systolic blood pressure between both study groups

Preoperative systolic blood pressure was identical between the unilateral and bilateral groups (128.2 ± 11.8 vs. 128.2 ± 12.1 mmHg, $p = 0.390$), with no significant differences up to 5 minutes after induction ($p > 0.05$). From 15 minutes after induction through 60 minutes postoperatively, systolic pressure was significantly lower in the bilateral group compared with the unilateral group (e.g., 15 min: 127.3 ± 12.3 vs. 110.6 ± 13.5 mmHg; 30 min: 127.1 ± 11.9 vs. 109.3 ± 14.1 mmHg; $p < 0.001$ for all). After 90 minutes postoperatively, both groups recorded comparable values with no statistical difference ($p > 0.05$).

Table (2): Comparison of both study groups regarding intraoperative and postoperative systolic blood pressure.

Systolic blood pressure	Unilateral spinal anesthesia	Bilateral spinal anesthesia	P value
Preoperative (baseline)	128.2 ± 11.8	128.2 ± 12.1	0.390
At induction	128.4 ± 12.0	128.0 ± 11.9	0.908
5 min after induction	128.4 ± 11.7	128.8 ± 12.2	0.384
15 min after induction	127.3 ± 12.3	110.6 ± 13.5	<0.001
30 min after induction	127.1 ± 11.9	109.3 ± 14.1	<0.001
90 min after induction	126.7 ± 12.6	109.0 ± 13.8	<0.001
Immediate postoperative time (0 min)	126.4 ± 12.1	108.7 ± 14.4	<0.001
15 min postoperatively	126.5 ± 11.6	110.3 ± 13.2	<0.001
30 min postoperatively	127.7 ± 12.4	108.7 ± 14.0	<0.001
60 min postoperatively	127.1 ± 12.8	109.4 ± 13.7	<0.001
90 min postoperatively	128.3 ± 11.5	128.5 ± 12.0	0.805
120 min postoperatively	128.8 ± 12.2	128.2 ± 11.8	0.186
150 min postoperatively	128.2 ± 11.9	128.4 ± 12.3	0.395
180 min postoperatively	128.3 ± 12.0	128.8 ± 11.7	0.801

Comparison of both study groups regarding diastolic blood pressure

Preoperative diastolic blood pressure values were comparable between the unilateral and bilateral groups (78.3 ± 8.2 vs. 78.2 ± 8.4 mmHg, $p = 0.715$), with no significant change up to 5 minutes after induction ($p > 0.05$). From 15 minutes after induction to 60 minutes postoperatively, the bilateral group showed significantly lower diastolic pressures than the unilateral group (e.g., 15 min: 77.1 ± 8.4 vs. 63.2 ± 9.2 mmHg; 30 min: 76.9 ± 8.3 vs. 64.7 ± 9.7 mmHg; $p < 0.001$ for all). Beyond 90 minutes postoperatively, both groups demonstrated similar diastolic pressure readings with no statistical difference ($p > 0.05$).

Table (4): Comparison of both study groups regarding intraoperative and postoperative diastolic blood pressure.

Diastolic blood pressure	Unilateral spinal anesthesia	Bilateral spinal anesthesia	P value
Preoperative (baseline)	78.3 ± 8.2	78.2 ± 8.4	0.715
At induction	78.8 ± 8.0	78.4 ± 8.3	0.619
5 min after induction	78.4 ± 8.1	78.2 ± 8.5	0.557
15 min after induction	77.1 ± 8.4	63.2 ± 9.2	<0.001
30 min after induction	76.9 ± 8.3	64.7 ± 9.7	<0.001
90 min after induction	77.6 ± 8.6	64.4 ± 9.1	<0.001
Immediate postoperative time (0 min)	76.8 ± 8.2	63.8 ± 9.8	<0.001
15 min postoperatively	76.7 ± 8.0	63.7 ± 9.0	<0.001
30 min postoperatively	76.5 ± 8.5	64.2 ± 9.4	0.001

60 min postoperatively	77.0 ± 8.7	64.4 ± 9.3	<0.001
90 min postoperatively	78.6 ± 8.1	78.1 ± 8.2	0.569
120 min postoperatively	78.1 ± 8.3	78.3 ± 8.0	0.469
150 min postoperatively	78.5 ± 8.4	78.5 ± 8.1	0.780
180 min postoperatively	78.1 ± 8.2	78.3 ± 8.6	0.303

Comparison of both study groups regarding mean blood pressure

Baseline mean blood pressure was nearly identical in the unilateral and bilateral groups (94.9 ± 6.7 vs. 94.8 ± 6.9 mmHg, $p = 0.715$), with no significant difference up to 5 minutes after induction ($p > 0.05$). From 15 minutes after induction through 60 minutes postoperatively, the bilateral group showed significantly lower mean blood pressure compared to the unilateral group (e.g., 15 min: 93.8 ± 6.9 vs. 79.0 ± 7.6 mmHg; 30 min: 93.6 ± 6.8 vs. 79.5 ± 7.9 mmHg; $p < 0.001$ for all). After 90 minutes postoperatively, the mean blood pressure values of both groups became comparable with no significant difference ($p > 0.05$).

Table 2: Comparison of both study groups regarding intraoperative and postoperative mean blood pressure.

Mean blood pressure	Unilateral spinal anesthesia	Bilateral spinal anesthesia	P value
Preoperative (baseline)	94.9 ± 6.7	94.8 ± 6.9	0.715
At induction	95.3 ± 6.6	94.9 ± 6.8	0.619
5 min after induction	95.0 ± 6.6	95.0 ± 6.9	0.557
15 min after induction	93.8 ± 6.9	79.0 ± 7.6	<0.001
30 min after induction	93.6 ± 6.8	79.5 ± 7.9	<0.001
90 min after induction	93.9 ± 7.1	79.2 ± 7.6	<0.001
Immediate postoperative time (0 min)	93.3 ± 6.7	78.7 ± 8.1	<0.001
15 min postoperatively	93.3 ± 6.5	79.2 ± 7.4	<0.001
30 min postoperatively	93.5 ± 7.0	79.0 ± 7.8	0.001
60 min postoperatively	93.7 ± 7.2	79.4 ± 7.7	<0.001
90 min postoperatively	95.1 ± 6.6	94.9 ± 6.7	0.569
120 min postoperatively	95.0 ± 6.8	94.9 ± 6.6	0.469
150 min postoperatively	95.0 ± 6.8	95.1 ± 6.7	0.780
180 min postoperatively	94.8 ± 6.7	95.1 ± 6.9	0.303

Comparison of both study groups regarding intraoperative and postoperative mean heart rate

Mean heart rates were comparable across all measured time points between the unilateral and bilateral spinal anesthesia groups (e.g., baseline: 94.9 ± 6.7 vs. 94.8 ± 6.9 bpm, $p = 0.711$; 15 min post-induction: 93.8 ± 6.9 vs. 84.0 ± 7.6 bpm, $p = 0.574$; 180 min postoperatively: 94.8 ± 6.7 vs. 95.1 ± 6.9 bpm, $p = 0.108$), with no statistically significant differences observed (all $p > 0.05$).

Table (4): Comparison of both study groups regarding intraoperative and postoperative mean heart rate.

Heart rate	Unilateral spinal anesthesia	Bilateral spinal anesthesia	P value
Preoperative (baseline)	94.9 ± 6.7	94.8 ± 6.9	0.711
At induction	95.3 ± 6.6	94.9 ± 6.8	0.322
5 min after induction	95.0 ± 6.6	95.0 ± 6.9	0.266
15 min after induction	93.8 ± 6.9	84.0 ± 7.6	0.574
30 min after induction	93.6 ± 6.8	87.5 ± 7.9	0.733
90 min after induction	93.9 ± 7.1	83.2 ± 7.6	0.452
Immediate postoperative time (0 min)	93.3 ± 6.7	88.7 ± 8.1	0.981
15 min postoperatively	93.3 ± 6.5	89.2 ± 7.4	0.700
30 min postoperatively	93.5 ± 7.0	88.0 ± 7.8	0.507
60 min postoperatively	93.7 ± 7.2	87.4 ± 7.7	0.423
90 min postoperatively	95.1 ± 6.6	94.9 ± 6.7	0.376
120 min postoperatively	95.0 ± 6.8	94.9 ± 6.6	0.742
150 min postoperatively	95.0 ± 6.8	95.1 ± 6.7	0.467
180 min postoperatively	94.8 ± 6.7	95.1 ± 6.9	0.108

DISCUSSION

Achieving hemodynamic stability during spinal anesthesia is crucial because hypotension, a frequent complication affecting 16-33% of cases particularly in the elderly and obstetric patients, stems from sympathetic blockade-induced vasodilation and reduced venous return, leading to decreased cardiac output. Uncontrolled hypotension heightens risks of myocardial ischemia, acute kidney injury, delirium, organ hypoperfusion, and even mortality, with even brief

episodes (1-5 minutes) of mean arterial pressure below 55 mmHg linked to postoperative complications. Strategies like prophylactic vasopressors, fluid preloading, or unilateral techniques mitigate these effects, improving patient safety and outcomes across diverse populations.[5][6][7]

A systematic review and meta-analysis by Gong et al. included 21 randomized controlled trials (1358 patients undergoing unilateral lower extremity or abdominal surgery). Hypotension incidence was significantly lower in unilateral spinal anesthesia (RR 0.38, 95% CI 0.27-0.55; I^2=38%), regardless of dose, adjuvants, surgery site, or hypotension definition; vasopressor use also dropped (RR 0.31).[7]

In a randomized controlled trial conducted by Das et al., 72 geriatric patients undergoing hemiarthroplasty were evaluated to compare the efficacy of unilateral and bilateral spinal anesthesia. The unilateral group received 7.5 mg of hyperbaric bupivacaine while maintained in the lateral position for 15 minutes, whereas the bilateral group received an identical dose in the supine position. The findings indicated that the unilateral technique resulted in a significantly lower incidence of both intraoperative and postoperative hypotension compared to the bilateral group, where hypotension occurred in 100% of cases. Consequently, the unilateral approach required fewer vasopressors, highlighting its clinical advantages for elderly patients with pre-existing cardiovascular risks.[8]

In a double-blind randomized controlled trial conducted by Kiasari et al., 115 patients undergoing unilateral surgical procedures below the tenth thoracic vertebra were evaluated. The study compared the hemodynamic effects of two anesthetic techniques: unilateral spinal anesthesia, utilizing 15 milligrams of hyperbaric bupivacaine (Group S, n = 59), and epidural anesthesia, utilizing 15 milliliters of 0.5% bupivacaine (Group E, n = 56). The results demonstrated that Group E experienced a significantly greater reduction in systolic blood pressure, diastolic blood pressure, and mean arterial pressure compared to Group S ($p < 0.001$). Furthermore, the prevalence of hypotension was notably lower in the unilateral spinal anesthesia group ($p < 0.0001$). These hemodynamic differences were reflected in the pharmacological requirements of the participants; ephedrine was administered to only 5% of the subjects in Group S, whereas 75% of those in Group E required the vasopressor ($p = 0.0001$).[9]

In a randomized controlled trial conducted by Lee et al., 70 patients undergoing unilateral lower limb surgery were assessed to compare the effects of unilateral and bilateral spinal anesthesia. Both groups received a standardized dose of 10 milligrams of hyperbaric bupivacaine. The unilateral technique involved maintaining the lateral position for 20 minutes, whereas the bilateral technique involved placing the patient in the supine position immediately following administration. The study findings indicated that the unilateral approach resulted in less pronounced reductions in blood pressure and superior hemodynamic stability. This improved stability was attributed to the asymmetric spread of the anesthetic agent, which limited the sympathetic blockade to the operative side.[10]

CONCLUSION

Unilateral spinal anesthesia provides superior hemodynamic stability with less pronounced blood pressure reductions compared to bilateral in gynecological surgery, supporting its use to minimize hypotension risks.

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