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Original Research Article

Incidence and Associated Factors of Hypotension Following Spinal Anaesthesia in Elective Lower-Limb and Lower-Abdominal Surgeries: A Retrospective Observational Study

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ABSTRACT
Background: Hypotension is a frequent haemodynamic complication of spinal anaesthesia and may be particularly important in older patients and those with cardiovascular comorbidity.
Objective: To estimate the incidence of hypotension after spinal anaesthesia and examine its unadjusted associations with routinely recorded demographic, clinical and anaesthetic variables.
Methods: This retrospective observational analysis included 50 elective surgical patients who received spinal anaesthesia. Hypotension was defined as systolic blood pressure <90 mmHg or a >30% reduction from baseline during the intraoperative or immediate postoperative period. Fisher exact tests were used for binary categorical comparisons and Mann-Whitney U tests for continuous variables. Multivariable regression was not performed because several predictors showed complete separation and strong collinearity.
Results: Hypotension occurred in 26/50 patients (52.0%; 95% CI 38.5-65.2%). Patients with hypotension were older (median 59.5 vs 36.5 years), had higher BMI (30.2 vs 25.0 kg/m^2) and higher baseline systolic pressure (151 vs 123 mmHg), all $p<0.001$. Hypotension occurred in all 26 patients with hypertension and none of 24 without hypertension ($p<0.001$), and in all 12 patients with diabetes compared with 14/38 without diabetes ($p<0.001$). ASA II-III status and the L2-L3 puncture interspace were also strongly associated with hypotension. All 26 hypotensive patients received vasopressor therapy.
Conclusion: Hypotension affected approximately half of this cohort and clustered among older patients with greater comorbidity and higher ASA status. The observed associations with puncture interspace and bupivacaine dose were strongly confounded by patient and procedural selection and should not be interpreted causally. Larger datasets with detailed haemodynamic and anaesthetic records are required for adjusted risk modelling.

Keywords: Spinal Anaesthesia, Hypotension, Bupivacaine, Hypertension, Vasopressor, Retrospective Study.

INTRODUCTION

Spinal anaesthesia remains a widely used technique for infraumbilical and lower-limb surgery because it provides dense neuraxial blockade while avoiding airway instrumentation and reducing the requirement for systemic anaesthetic drugs. Haemodynamic instability, however, remains one of its most familiar limitations. In a classic prospective series, hypotension occurred in about one-third of patients receiving spinal anaesthesia, with age, higher block and certain baseline characteristics influencing risk.[1]

The physiological basis is largely the sympathetic block produced by neuraxial local anaesthetic. Arterial and venous vasodilatation reduce vascular tone and venous return, while a fall in preload may further impair cardiac output, particularly in older patients with

limited cardiovascular reserve.[2] This is clinically relevant because perioperative hypotension is not merely a numerical change in blood pressure. Consensus work and systematic reviews have linked the depth and duration of perioperative hypotension with myocardial injury, acute kidney injury and mortality in non-cardiac surgery.[3,4]

Risk is not distributed uniformly. Large observational analyses have identified age, body mass index, pre-existing hypertension, ASA physical status, sensory block height and procedural factors among variables associated with hypotension after spinal anaesthesia.[5] At the bedside, these factors often travel together. An elderly hypertensive patient undergoing hip surgery, for example, may also have a higher ASA class, altered autonomic reserve and a different intrathecal dose strategy. This overlap makes simple causal attribution difficult, especially in small retrospective datasets.[6]

In routine Indian anaesthesia practice, the ability to recognise a higher-risk profile before spinal injection has practical value. It may prompt closer blood-pressure surveillance, rational fluid planning and readiness for vasopressor treatment without requiring complex prediction tools. The present study therefore examined the incidence of hypotension following spinal anaesthesia in elective lower-limb and lower-abdominal surgery and explored its associations with routinely documented demographic, comorbidity and anaesthetic variables.

MATERIALS AND METHODS

Study Design and Population

A retrospective observational analysis was conducted in various operation theatres of PGIMER & Capital Hospital, Bhubaneswar, Odisha from October 2024 to September 2025 for a period of one year on 50 adult patients who underwent elective lower-limb or lower-abdominal/urological surgery under spinal anaesthesia. The surgical procedures represented in the cohort were hernia surgery, transurethral resection of the prostate (TURP), knee arthroscopy, open reduction and internal fixation (ORIF) of femoral or tibial fractures, and hip hemiarthroplasty. All 50 records contained complete values for the variables included in the analysis.

Variables Assessed

The variables analysed were age, sex, body mass index (BMI), ASA physical status, history of hypertension, diabetes mellitus, baseline systolic blood pressure (SBP), surgical procedure, spinal puncture interspace, intrathecal 0.5% hyperbaric bupivacaine dose, intraoperative vasopressor administration and occurrence of hypotension. The field labelled "Block Level" in the clinical table contained L2-L3 and L3-L4 entries; because these denote intervertebral levels rather than sensory dermatomes, the variable was standardised as spinal puncture interspace. No cephalad sensory block height was available for analysis.

Outcome Definition

Hypotension was defined as SBP <90 mmHg or a decrease of >30% from baseline SBP, recorded at any point during the intraoperative or immediate postoperative period. The outcome field was documented within the first 24 hours. Vasopressor use was treated as a management response to hypotension and not as a baseline predictor.

Data Handling and Statistical Analysis

Categorical variables were summarised as frequency and percentage. Continuous variables were summarised using mean and standard deviation for overall description and median with interquartile range for outcome-group comparisons. Fisher exact tests were used for binary categorical comparisons because several cells were sparse or zero. Continuous variables were compared using the Mann-Whitney U test. Procedure-specific hypotension rates were reported descriptively because of small cell sizes across the six surgical categories. Standard multivariable logistic regression was not undertaken because hypertension and several other variables showed complete or near-complete separation, while spinal puncture interspace and bupivacaine dose were perfectly collinear. A two-sided p-value <0.05 was considered statistically significant. Statistical calculations were performed using Python 3.13 with SciPy 1.17 and statsmodels 0.14.

Ethical Considerations

Only anonymised information recorded during routine perioperative care was analysed. Patient identifiers were not included, confidentiality was maintained, and no research-specific intervention was performed. Ethical and consent requirements were followed according to the institutional policy

applicable to retrospective record-based studies.

RESULTS

Fifty patients were analysed. The mean age was 49.0±13.6 years, with an equal sex distribution (25 women and 25 men). Twenty-two patients were ASA I, 23 were ASA II and five were ASA III. Hypertension was recorded in 26 (52.0%) patients and diabetes mellitus in 12 (24.0%). Baseline characteristics are summarised in Table 1.

Characteristic	Value
Age, years	49.0 ± 13.6
Female sex	25 (50.0%)
Male sex	25 (50.0%)
BMI, kg/m²	27.69 ± 3.20
ASA I / II / III	22 (44.0%) / 23 (46.0%) / 5 (10.0%)
Hypertension	26 (52.0%)
Diabetes mellitus	12 (24.0%)
Baseline SBP, mmHg	137.6 ± 15.6
Spinal puncture interspace L2-L3 / L3-L4	24 (48.0%) / 26 (52.0%)
Hyperbaric bupivacaine 10 mg / 12.5 mg	24 (48.0%) / 26 (52.0%)
Hypotension	26 (52.0%)
Vasopressor administered	26 (52.0%)
Table 1. Baseline Demographic and Perioperative Profile (N=50)	
Values are mean ± SD or n (%). ASA: American Society of Anesthesiologists; BMI: body mass index; SBP: systolic blood pressure	

Hypotension occurred in 26 patients (52.0%; 95% CI 38.5-65.2%), while 24 (48.0%) had no recorded hypotensive episode (Figure 1). All 26 patients meeting the hypotension definition received vasopressor treatment; no vasopressor was recorded among patients without hypotension.

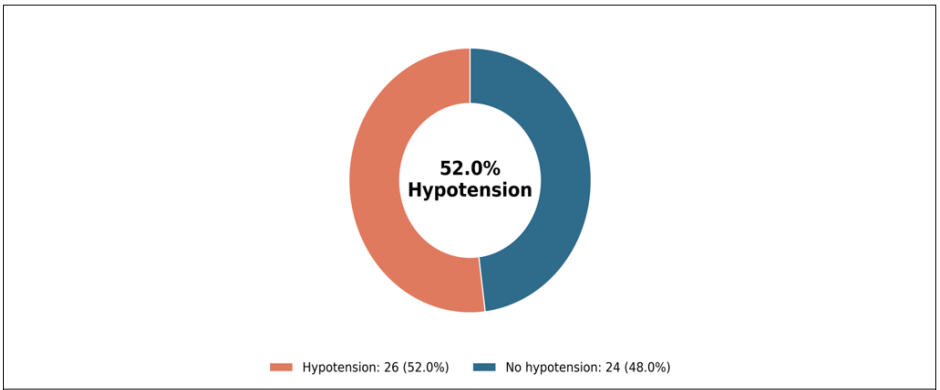

Figure 1. Incidence of hypotension following spinal anaesthesia

Donut chart shows the proportion of patients with and without hypotension; counts and percentages are shown in the legend

Variable	First Category	Hypotension, n/N (%)	Second Category	Hypotension, n/N (%)	p-value
Sex	F	13/25 (52.0%)	M	13/25 (52.0%)	1.000
Hypertension	Yes	26/26 (100.0%)	No	0/24 (0.0%)	<0.001
Diabetes mellitus	Yes	12/12 (100.0%)	No	14/38 (36.8%)	<0.001
ASA physical status	II-III	26/28 (92.9%)	I	0/22 (0.0%)	<0.001
Spinal puncture interspace	L2-L3	24/24 (100.0%)	L3-L4	2/26 (7.7%)	<0.001
Bupivacaine dose	10 mg	24/24 (100.0%)	12.5 mg	2/26 (7.7%)	<0.001
Table 2. Univariable Categorical Associations with Hypotension					
Fisher exact test. ASA II-III was compared with ASA I because of sparse cells. Odds ratios were not reported for variables with zero cells because conventional estimates are unstable or infinite					

There was no sex-based difference in hypotension (13/25 women and 13/25 men, 52.0% in each group; p=1.000). In contrast, all 26 patients with documented hypertension developed hypotension, whereas none of the 24 patients without hypertension did so (p<0.001). All 12 patients with diabetes developed hypotension compared with 14/38 (36.8%) patients without diabetes (p<0.001). Hypotension was also concentrated in higher ASA classes: 21/23 (91.3%) ASA II and 5/5 (100%) ASA III patients were affected, compared with 0/22 ASA I patients (Figure 2).

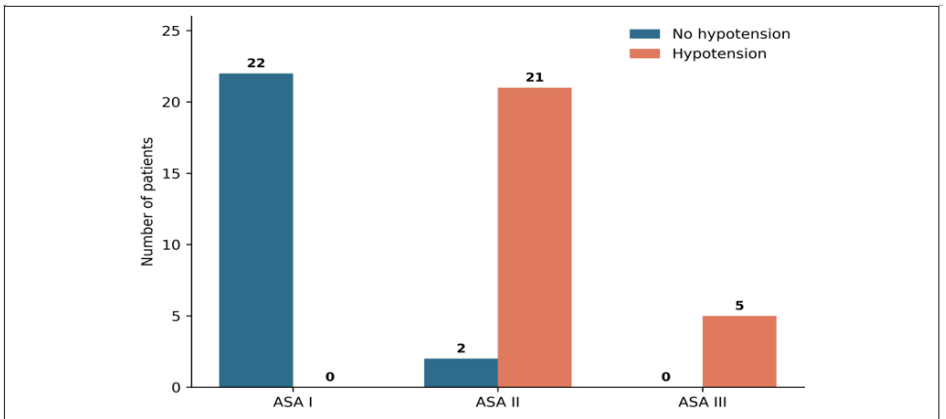

Figure 2. Distribution of hypotension according to ASA physical status

Grouped bars show patient counts with and without hypotension in each ASA class

Surgical Procedure	Total	Hypotension	No Hypotension	Incidence
Hernia surgery	9	0	9	0.0%
TURP	11	10	1	90.9%
Knee arthroscopy	9	0	9	0.0%
ORIF femur	5	2	3	40.0%
ORIF tibia	5	3	2	60.0%
Hip hemiarthroplasty	11	11	0	100.0%

Table 3. Procedure-Specific Distribution of Hypotension

Procedure-specific comparisons are descriptive because of small cell counts. TURP: transurethral resection of the prostate; ORIF: open reduction and internal fixation

Procedure-specific frequencies varied markedly. Hypotension occurred in 11/11 patients undergoing hip hemiarthroplasty and 10/11 undergoing TURP. It was observed in 3/5 ORIF tibia and 2/5 ORIF femur cases, while no hypotension was recorded after hernia surgery or knee arthroscopy in this cohort (Table 3; Figure 3).

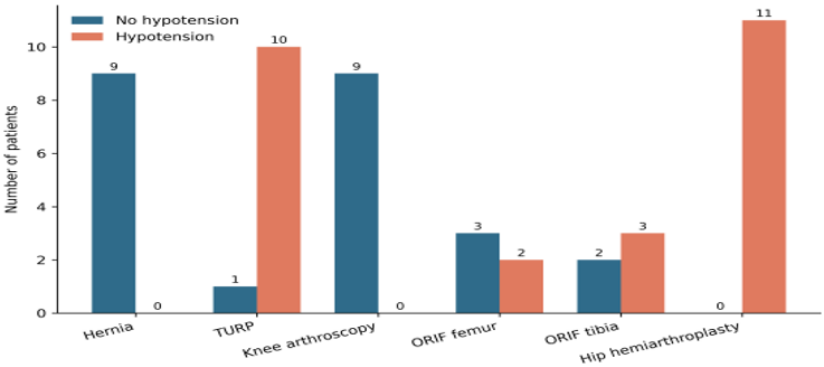

Figure 3. Hypotension according to surgical procedure

Grouped bars display patient counts with and without hypotension for each surgical category

Variable	Hypotension (n=26), median (IQR)	No hypotension (n=24), median (IQR)	p-value
Age, years	59.5 (55.2-65.8)	36.5 (31.8-42.2)	<0.001
BMI, kg/m²	30.2 (28.9-31.4)	25.0 (23.6-26.5)	<0.001
Baseline SBP, mmHg	151.0 (146.0-156.0)	123.0 (118.0-128.0)	<0.001

Table 4. Continuous Variables According To Hypotension Status

Mann-Whitney U test. BMI: body mass index; SBP: systolic blood pressure

Patients with hypotension were substantially older and had higher BMI and baseline SBP than those without hypotension. Median age was 59.5 years versus 36.5 years, median BMI was 30.2 versus 25.0 kg/m², and median baseline SBP was 151 versus 123 mmHg; all comparisons were significant at p<0.001 (Table 4).

All 24 patients whose spinal puncture was recorded at L2-L3 developed hypotension, compared with 2/26 (7.7%) at L3-L4 (p<0.001). The 10 mg and 12.5 mg bupivacaine categories exactly paralleled these interspaces: all L2-L3 cases received 10 mg and all L3-L4 cases received 12.5 mg. Consequently, dose and puncture interspace could not be separated analytically. The comorbidity pattern is illustrated in Figure 4.

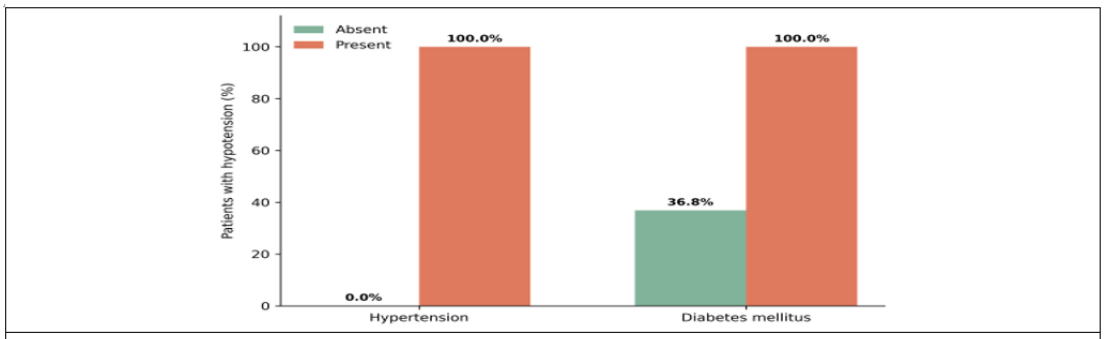

Figure 4. Hypotension rates according to hypertension and diabetes status

Bars show the percentage of patients with hypotension when each comorbidity was absent or present

DISCUSSION

The present cohort showed a 52.0% incidence of hypotension following spinal anaesthesia. That proportion is higher than the 33% reported in the classic prospective study by Carpenter and colleagues,[1] and far above the 5.4% rate described by Hartmann et al. using a narrower automated-record definition,[5] but is close to the 46% incidence reported in a recent prospective tertiary-hospital study.[7] Such variation is expected. Spinal-anaesthesia hypotension is highly sensitive to how hypotension is defined, the timing and frequency of blood-pressure measurement, the age and comorbidity profile of the population, intrathecal technique and the type of surgery. In elderly lower-limb cohorts, rates can be considerably higher; Meyhoff et al. observed hypotension in 21 of 32 elderly patients during spinal onset.[8]

Age was one of the clearest discriminators in this dataset. Patients who became hypotensive had a median age of 59.5 years compared with 36.5 years among those who remained stable. Older age has long been associated with spinal hypotension,[1] and contemporary work continues to identify age and ASA status as useful risk markers.[7] Physiologically, older patients often have reduced autonomic responsiveness, altered vascular compliance and less capacity to compensate for an abrupt reduction in venous return. Haemodynamic studies in elderly patients further suggest that a decline in stroke volume can be an important mechanism after spinal block.[9] For routine practice, age alone should not dictate technique, but it should lower the threshold for close blood-pressure monitoring and early treatment.

Pre-existing hypertension showed complete separation in the present cohort: every hypertensive patient developed hypotension and no normotensive patient did. This is an unusually strong pattern and must be interpreted cautiously. Earlier work in elderly patients demonstrated greater blood-pressure

reductions after spinal anaesthesia among treated hypertensive individuals,[10] while Hartmann et al. identified a history of hypertension as an independent risk factor in a much larger cohort.[5] One additional point is specific to the present outcome definition. Because hypotension could be triggered by a >30% reduction from baseline, patients beginning with a higher systolic pressure had more opportunity to meet the relative criterion even if their absolute nadir did not fall below 90 mmHg. The higher baseline SBP in the hypotension group may therefore partly reflect the mathematical behaviour of the composite definition rather than a direct harmful effect of higher starting pressure.

Diabetes and higher BMI were also associated with hypotension on unadjusted analysis. These findings are clinically plausible, but they cannot be treated as independent effects in this dataset. Diabetes occurred entirely within the hypotension group and travelled with older age, hypertension and higher ASA class. Similarly, BMI was higher among hypotensive patients, but larger studies have shown that anthropometric and comorbidity variables interact with anaesthetic and surgical factors.[5] A recent prediction study in older adults likewise identified age, BMI, baseline SBP and hypertension among multiple contributors to spinal-anaesthesia hypotension.[11] The present sample is too small and too strongly separated to establish a locally valid prediction model.

The puncture-interspace finding deserves particular attention. Hypotension occurred in all L2-L3 cases but in only two L3-L4 cases. Carpenter et al. previously reported increased hypotension with spinal puncture at or above L2-L3,[1] and a recent retrospective study of elderly hip-fracture patients similarly found vasopressor use to be more frequent with more cephalad lumbar puncture interspaces.[12] However, the current dataset does not contain actual cephalad sensory block height, which is the more direct physiological measure of sympathetic spread. The interspace association should therefore be viewed as procedural correlation rather than proof that the puncture site itself caused the blood-pressure fall.

Interpretation of the bupivacaine dose is even more constrained. All L2-L3 cases received 10 mg, whereas all L3-L4 cases received 12.5 mg. The lower dose therefore appeared to be associated with more hypotension, but this direction is not consistent with randomised and pooled evidence in elderly hip surgery, where lower intrathecal local-anaesthetic doses generally reduce hypotensive episodes and vasopressor requirement.[13-15] The likely explanation is confounding by indication: lower doses were preferentially used in older, higher-risk patients and in procedures such as hip hemiarthroplasty and TURP. Since dose, puncture interspace, age, procedure and comorbidity patterns were tightly linked, no causal conclusion about dose is justified from these data.

The procedure-specific pattern reinforces this concern. Every hip hemiarthroplasty patient and 90.9% of TURP patients developed hypotension, whereas no episode was recorded in hernia surgery or knee arthroscopy. Hip surgery in older patients is a recognised setting for haemodynamic vulnerability, and dose-focused meta-analysis has highlighted the frequency of hypotension in this population.[15] Yet the present procedure groups were small and clinically dissimilar. Surgery type here is therefore best understood as a marker of the patient and anaesthetic context rather than an isolated causal factor.

All patients meeting the hypotension definition received vasopressor treatment. That concordance is reassuring from a management standpoint, but vasopressor administration must not be interpreted as a predictor because it occurred after, or in response to, the haemodynamic event. Contemporary management reviews emphasise prompt correction of spinal-anaesthesia hypotension with vasopressors selected according to the clinical situation, alongside attention to preload, heart rate and the underlying mechanism.[2,6] In practical Indian theatre settings, particularly where beat-to-beat monitoring is unavailable, readiness to treat is as important as the initial choice of spinal dose.

This study has several limitations. It is a small retrospective analysis with highly separated risk profiles, which precluded stable conventional multivariable regression. The exact nadir SBP, mean arterial pressure, heart rate, timing and duration of hypotension, fluid loading, antihypertensive medications, blood loss, operative duration, vasopressor agent and dose, sedation, and postoperative outcomes were not available. The field originally labelled "block level" contained lumbar interspaces rather than sensory dermatomes, so actual cephalad sensory

spread could not be assessed. The composite hypotension definition combined an absolute threshold with a relative reduction, which may classify hypertensive patients differently from normotensive patients. Finally, the strong coupling between puncture interspace, bupivacaine dose, procedure and comorbidity creates substantial confounding by indication. These findings are therefore descriptive and hypothesis-generating rather than evidence of independent causal predictors.

CONCLUSION

Hypotension occurred in 52.0% of patients following spinal anaesthesia in this elective surgical cohort. Older age, higher BMI, hypertension, diabetes, higher ASA physical status and higher baseline SBP were strongly associated with the observed events on unadjusted analysis. Hypotension was also concentrated among L2–L3 punctures and selected procedures, but puncture interspace and bupivacaine dose were perfectly coupled with patient and procedural selection, preventing causal interpretation. A practical pre-spinal assessment that recognises age, comorbidity, ASA status and baseline haemodynamics may help identify patients who warrant closer surveillance and immediate vasopressor readiness. Larger datasets with detailed haemodynamic time series and adjusted modelling are required before independent predictors can be established.

Source of Funding
Nil.

Conflict of Interest
None declared.

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