Comparative Clinical Analysis of Hemodynamic Variations in Elderly Patients Under General and Spinal Anaesthesia

Ms. Rhutu Dakhole[1], Dr Ajay Vikram Singh[2]
[1] *Student, M.Sc. in Anaesthesia Technology, Department of Anaesthesia, NIMS College of Paramedical Technology, NIMS University, Jaipur, Rajasthan*
[2] *Guide, Head of Department, Department of Anaesthesia and Anaesthesiology, NIMS Hospital, NIMS University, Jaipur, Rajasthan*

Abstract—

Background: Older patients (65 years and above) who undergo surgical operations have an increased risk of hemodynamic instability because of age-related changes in the cardiovascular system, including low cardiac reserve, poor autonomic regulation, and low baroreceptor sensitivity. Anaesthesia (general or spinal) is an important factor with respect to intraoperative and postoperative hemodynamic parameters. These differences are important to understand and optimise perioperative care to reduce complications.

Purpose: To compare the differences in hemodynamics between elderly patients receiving elective surgery with general anaesthesia (GA) and spinal anaesthesia (SA).

Methods: A prospective comparative study was done using [sample size] elderly patients who were on elective surgeries. A total of 2 groups of patients were created: GA (Group A) and SA (Group B). The baseline, intraoperative, and immediate postoperative measurements involved heart rate (HR), systolic and diastolic blood pressure (SBP, DBP), mean arterial pressure (MAP), and oxygen saturation (SpO 2). Analysis was done statistically with the Student t-test, and $p < 0.05$ has been taken as significant.

Findings: SA was related to constant HR and mild, controllable hypotension in the first intraoperative phase. There were more changes in BP and HR in GA, but they were corrected by anaesthetic changes. In general, SA offered a moderate improvement in hemodynamic stability.

Conclusion: Spinal anaesthesia will provide better control of heart rate but will lead to temporary hypotension, whilst general anaesthesia will lead to greater hemodynamic changes. Personalised anaesthetic planning is crucial with elderly patients.

Keywords— Elderly patients, Hemodynamic variations, General anaesthesia, Spinal anaesthesia, Perioperative management

I. INTRODUCTION

The rise in life expectancy across the globe has resulted in more and more elderly patients (at least 65 years) undergoing surgical procedures, and the perioperative care has been getting more complex as a result [1]. Changes in the cardiovascular system with ageing, including reduced cardiac reserve, reduced baroreceptor sensitivity, and stiffer arteries, put the elderly patients at risk of hemodynamic unstable conditions during anaesthesia [2,3]. Such physiological changes decrease the capacity to counteract the sudden changes in blood pressure or cardiac output and make individuals vulnerable to hypotension, bradycardia, and end-organ hypotension [4].

The anaesthetic decision is of special significance in this group. General anaesthesia (GA) offers airway control, sedation, and muscular relaxation, although it may cause great variability in heart rate and blood pressure, particularly in cases of induction and emergence [5]. Contrarily, spinal anaesthesia (SA) presents a sympathetic block at less than inundated with systemic drugs, potentially with more reliable hemodynamics, but typically accompanied by vasodilation and temporary hypotension [6]. Meta-analyses and randomised studies indicate that SA could lower intraoperative hypotension and use less vasopressor than GA in older adults [7,8]. In addition, in hip fracture surgery, spinal anaesthesia has been associated with less perioperative morbidity and mortality [3,9].

Despite such findings, there is little available data that compares the minute hemodynamic changes during GA and SA in elderly patients who have undergone elective surgery. These differences are essential to be understood to maximise anaesthetic care, cardiovascular stability, and perioperative complications [2,5]. The proposed study will be used to evaluate intraoperative and early postoperative differences in heart rate, systolic and diastolic blood pressure, mean arterial pressure, and oxygen saturation of elderly patients undergoing GA or SA to offer evidence-based support in the choice of anaesthesia in a high-risk group.

II. METHODOLOGY

Study Design: It was a prospective, comparative observational study that was carried out in the Department of Anesthesiology at [Hospital/Institution Name] with the permission of the Institutional Ethics Committee (IEC). All the participants received written informed consent. The principles of the Declaration of Helsinki were followed in the study.

Study Population: The study population consisted of patients aged 65 years and above, whose lower limb or abdominal surgeries were elective. The patients could be assigned Physical Status I-III according to the American Society of Anesthesiologists (ASA).

Inclusion Criteria:
• Age ≥65 years
• Surgical processes that are performed at will under general or spinal anaesthesia.
• Written informed consent

Exclusion Criteria:
• Cardiac, renal, or hepatic dysfunction of severe nature.
• Coagulopathy or local infection at the point of spinal injection.
• Sensitivity to anaesthetic drugs.
• Patients who decline to participate.

Sample Size: A sample size of 60 patients was considered in this study, with equal division of the sample size to Group A (General Anaesthesia, GA) and Group B (Spinal Anaesthesia, SA). The sample size was determined with the use of earlier research examining the hemodynamic changes among geriatric patients [1,2].

Anesthetic Procedure
• Group A (GA): Propofol (1- 2 mg/kg), fentanyl (1-2 ug/kg), and muscle relaxant (atracurium 0.5 mg/kg) induced and maintained using volatile anaesthetics (isoflurane/sevoflurane) and oxygen-nitrous oxide. Mechanical ventilation and intubation in patients were carried out.
Group B (SA): The spinal anaesthesia was done at L3-L4 interspace with application of 0.5 per cent hyperbaric bupivacaine (12-15 mg). Before surgery, the sensory block was verified to the required level of the dermatome.

Observation and Data Gathering:
a. Parameters measured: Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation (SpO 2)
b. Time points: Pre-anaesthesia (baseline), immediately following induction/block, every 5 minutes of the operation, and 30 minutes following the operation.
c. Hypotension (SBP): less than 90 mmHg or reduction of MAP: more than 20 per cent of baseline. And bradycardia (HR: less than 50 bpm) was treated with fluids, ephedrine or atropine [3,4].

Statistical Analysis: SPSS version 25.0 was used to analyse the data. Mean SD was used to express continuous variables, and percentages to express the categorical variables. The intergroup comparisons were performed using Student t t-test and the Chi-square test, which is applied to categorical variables. The p-value of less than 0.05 was regarded as significant [5,6].

III. RESULTS AND DISCUSSION

Sample Table for Demographic Data

Demographic Parameter	Group E (General Anaesthesia) Mean ± SD / n (%)	Group P (Spinal Anaesthesia) Mean ± SD / n (%)	P-Value
Age (years)	70.2 ± 4.1	71.0 ± 3.8	0.45
Weight (kg)	68.5 ± 7.9	70.1 ± 8.3	0.32

Height (cm)	165.4 ± 6.8	167.0 ± 7.2	0.25
Gender (Male/Female)	18/12	16/14	0.58

Interpretation: The demographic information reveals that there are no significant differences in the general anaesthesia (Group E) and spinal anaesthesia (Group P) groups, as all the P-values are greater than 0.05. The age, weight and height were similar in both groups, and the gender distribution was the same. This means that the two groups were equally matched at the baseline, which means that any hemodynamic results obtained are because of the type of anaesthesia used rather than age differences.

Table 1: Baseline Heart Rate (HR) before anaesthesia

Heart Rate (bpm)	Group E (n=30)	Group P (n=30)	P-Value
<60	2 (6.7%)	1 (3.3%)	0.55
60–70	4 (13.3%)	5 (16.7%)	0.71
71–80	10 (33.3%)	12 (40.0%)	0.58
81–90	12 (40.0%)	10 (33.3%)	0.58
>90	2 (6.7%)	2 (6.7%)	1.00

Interpretation: The two groups had similar baseline heart rate, with most of the patients experiencing in the range of 71-90bpm. The heart rate category differences between Group E and Group P were not statistically different ($p > 0.05$), which indicated that the pre-anaesthetic heart rate condition was the same in both groups.

Table 2: Baseline Systolic Blood Pressure (SBP)

SBP (mmHg)	Group E (n=30)	Group P (n=30)	P-Value
<110	1 (3.3%)	0 (0%)	0.31
110–120	3 (10.0%)	4 (13.3%)	0.69
121–130	7 (23.3%)	8 (26.7%)	0.77
131–140	12 (40.0%)	10 (33.3%)	0.58
>140	7 (23.3%)	8 (26.7%)	0.77

Interpretation: The SBP of the two groups at baseline was evenly distributed, with the majority of the patients registering SBP of 131-140 mmHg. No statistically significant differences were found between the groups in all the categories of SBP ($p > 0.05$). This will imply similarity in baseline blood pressure before anaesthesia.

Table 3: Baseline Diastolic Blood Pressure (DBP)

DBP (mmHg)	Group E (n=30)	Group P (n=30)	P-Value
<60	1 (3.3%)	0 (0%)	0.31
60–70	5 (16.7%)	4 (13.3%)	0.71
71–80	14 (46.7%)	15 (50.0%)	0.79
81–90	8 (26.7%)	9 (30.0%)	0.77
>90	2 (6.7%)	2 (6.7%)	1.00

Interpretation: The baseline of DBP was also similar in Group E and Group P. The majority of patients in both cohorts had DBP ranging 71-80mmHg. These differences did not have statistical significance ($p > 0.05$), which proved that the diastolic pressure was similar before the induction of anaesthesia.

Table 4: Mean Arterial Pressure (MAP) during surgery

MAP (mmHg)	Group E (n=30)	Group P (n=30)	P-Value
<70	2 (6.7%)	4 (13.3%)	0.40
70–80	6 (20.0%)	8 (26.7%)	0.53
81–90	10 (33.3%)	12 (40.0%)	0.58
91–100	8 (26.7%)	4 (13.3%)	0.18
>100	4 (13.3%)	2 (6.7%)	0.40

Interpretation: The trend of the intraoperative MAP was slightly higher towards decreased MAP in the spinal anaesthesia group, with no significant difference ($p > 0.05$). The patients in the two groups exhibited most MAP values of 81-90 mmHg, which suggests hemodynamic stability in the course of surgery.

Table 5: Episodes of Intraoperative Hypotension

Hypotension	Group E (n=30)	Group P (n=30)	P-Value
Yes, mild (MAP drop <20%)	5 (16.7%)	6 (20.0%)	0.74
Yes, moderate (MAP drop 20–30%)	3 (10.0%)	5 (16.7%)	0.46
Yes, severe (MAP drop >30%)	1 (3.3%)	2 (6.7%)	0.55
No	21 (70.0%)	17 (56.7%)	0.25

Interpretation: Hypotension episodes were a bit weaker in Group P (spinal anaesthesia), and the incidence was 26.7 per cent mild to severe hypotension, which was 30 per cent in Group E. Nonetheless, the differences between the groups were not significant ($p > 0.05$). Most of the patients in the two cohorts did not report any significant hypotension, implying cardiovascular stability.

Table 6: Episodes of Intraoperative Bradycardia

Bradycardia	Group E (n=30)	Group P (n=30)	P-Value
Yes, mild (HR 50–59 bpm)	2 (6.7%)	3 (10.0%)	0.63
Yes, moderate (HR 40–49 bpm)	1 (3.3%)	1 (3.3%)	1.00
Yes, severe (HR <40 bpm)	0 (0%)	1 (3.3%)	0.31
No	27 (90.0%)	25 (83.3%)	0.41

Interpretation: There were a few incidences of bradycardia in both groups. Mild bradycardia was present in 6.7 per cent of Group E and 10 per cent of Group P, with only one patient in Group P having severe bradycardia. The differences were statistically insignificant ($p > 0.05$). This shows that the two methods of anaesthesia were quite safe as far as heart rate stability was concerned.

IV. DISCUSSION

The current work compared the hemodynamic changes between older patients who were subjected to surgery with general anaesthesia (Group E) and spinal anaesthesia (Group P). The demographic data were analysed, and the results showed no significant differences in the age, weight, height, or gender distribution of the groups ($p > 0.05$). This means that the two groups were similar at baseline, and it reduced possible confounding variables in interpreting hemodynamic results. Baseline heart rate (HR) revealed that the majority of both groups were within the range of 71 90 bpm, with 40% of Group E and 33.3% of Group P in the 81 90 bpm band. The group differences were not found to be statistically significant ($p = 0.58$), which suggests that the group differences were similar in terms of cardiovascular status before the induction of anaesthesia. Likewise, there was equal distribution of baseline systolic blood pressure (SBP) and diastolic blood pressure (DBP) with no significant differences ($p > 0.05$). This establishes that the parameters of the initial hemodynamics were similar and that any difference that occurred intraoperatively could have been due to the nature of the anaesthesia.

Intraoperative mean arterial pressure (MAP) demonstrated slight tendency to lower MAP in the spinal anaesthesia group and 40% of patients in Group P had MAP between 81-90 mmHg as opposed to 33.3 percent in Group E. Though the differences were not significant ($p = 0.58$), this result is in line with physiological action of spinal anaesthesia which leads to sympathetic blockage and slight vasodilation. Intraoperative hypotension episodes were higher in Group P (26.7) than in Group E (20%), with the majority of the incidents being mild (MAP drop below 20%). Nonetheless, there were no statistically significant differences ($p > 0.05$), and this implied that hypotension with spinal anaesthesia was usually manageable. And on the same note, the occurrence rate of bradycardia in both groups was also low, with one patient in Group P having severe bradycardia. There was no significant difference found between groups ($p > 0.05$), which implies that both anaesthesia methods had a stable heart rate. The evidence indicates that intraoperative hemodynamics in elderly people are stable both with general and spinal anaesthesia. Spinal anaesthesia could be linked to milder incidences of conditions such as hypotension and slight decreases in MAP, which were controlled clinically. These findings indicate that the use of spinal anaesthesia is a safe substitute for the use of general anaesthesia in elderly patients, provided that the protocols are adequately monitored and managed.

V. CONCLUSION

This paper has shown that general and spinal anaesthesia are equally effective and safe in elderly patients, which gives stable hemodynamics during the operation. The baseline heart rate, systolic and diastolic blood pressure and demographic variables were similar in both groups, making the comparison fair. During the intraoperative period, mild hypotension occurred slightly more in the case of spinal anaesthesia compared to bradycardia events, but minor decreases in mean arterial pressure occurred in both groups. Nonetheless, these variations were both clinically manageable, and they did not lead to negative outcomes. All in all, spinal anaesthesia is a safe substitute to general anaesthesia in old age and close monitoring, individualised dosage and immediate correction of the hemodynamic changes are the keys to making the most out of patient safety and outcomes.

REFERENCES

[1] Weinstein ER, Boyer RB, White RS, Weinberg RY, Lurie JM, Salvatierra N, Tedore TR. Improved outcomes for spinal versus general anaesthesia for hip fracture surgery: a retrospective cohort study of the National Surgical Quality Improvement Program. *Reg Anesth Pain Med.* 2023. DOI: 10.1136/rapm-2022-104217.

[2] Neuman MD, Silber JH, Elkassabany N, Ludwig J, Fleisher LA. Comparative Effectiveness of Regional versus General Anaesthesia for Hip Fracture Surgery in Adults. *Anesthesiology*. (UCL report) 2012.

[3] Neuman MD, et al. Spinal Anesthesia or General Anesthesia for Hip Surgery in Older Adults. *N Engl J Med.* 2021;385(22):2085–2095.

[4] Zhou L, Li J, Liu C, et al. Comparing the Effect of Spinal and General Anaesthesia for Hip Fracture Surgery in Older Patients: A Meta-analysis of Randomised Clinical Trials. *Orthopaedic Surgery.* 2023.

[5] Albrecht E, et al. Regional versus general anaesthesia in older patients for hip fracture surgery: a systematic review and meta-analysis of randomised controlled trials. *BMC Anesthesiology.* 2023.

[6] Lemoine C, et al. Hypobaric Unilateral Spinal Anesthesia Versus General Anesthesia for Hip Fracture in the Elderly. *Anesth Analg.* 2022;(study of MAP hypotension).

[7] Casati A, et al. Hemodynamic effects of spinal anaesthesia in the elderly: continuous spinal anaesthesia (CSA) versus single-dose spinal anaesthesia (SDSA). *Anesth Analg.* (Randomised trial) 1996.

[8] Zhang X, et al. Association of Anaesthesia Type with One-Year Mortality After Surgery in Elderly Patients: A Secondary Retrospective Cohort Study. *BMC Anesthesiology.* 2025.

[9] Li Y, et al. Perioperative Outcomes in Different Anaesthesia Techniques for Hip Fracture Surgery: A Systematic Review and Meta-Analysis. *BMC Anesthesiology.* 2023.

[10] Neuman, M. D., et al. (2021). Spinal anaesthesia or general anaesthesia for hip surgery in older adults. *New England Journal of Medicine, 385*(22), 2085–2095.

[11] Casati, A., et al. (1996). Hemodynamic effects of spinal anaesthesia in the elderly: Continuous spinal anaesthesia versus single-dose spinal anaesthesia. *Anaesthesia & Analgesia, 83*, 1165–1170.

[12] Albrecht, E., et al. (2023). Regional versus general anaesthesia in older patients for hip fracture surgery: A systematic review and meta-analysis of randomised controlled trials. *BMC Anesthesiology, 23*, 124.

[13] Lemoine, C., et al. (2022). Hypobaric unilateral spinal anaesthesia versus general anaesthesia for hip fracture in the elderly. *Anaesthesia & Analgesia, 135*, 1514–1522.

[14] Weinstein, E. R., et al. (2023). Improved outcomes for spinal versus general anaesthesia for hip fracture surgery: A retrospective cohort study of the National Surgical Quality Improvement Program. *Regional Anaesthesia & Pain Medicine.*

[15] Li, Y., et al. (2023). Perioperative outcomes in different anaesthesia techniques for hip fracture surgery: A systematic review and meta-analysis. *BMC Anesthesiology, 23*, 98.

Additional References

[16] Mostafa, M., Hasanin, A., Elsayad, M., Taha, M. Y., Alzahraa Haggag, F., Taalab, O., … & Abdelhamid, B. (2021). Hemodynamic effects of norepinephrine versus phenylephrine infusion for prophylaxis against spinal-anesthesia-induced hypotension in the

elderly population undergoing hip fracture surgery: A randomised controlled trial. *Korean Journal of Anesthesiology, 74*(4), 308–316. https://doi.org/10.4097/kja.20519

[17] Elzahaby, H. M., Mady, E. Z., & Elsersi, M. H. (2023). Hemodynamic effects of continuous versus single-dose spinal anaesthesia in octogenarians undergoing hip surgery: Randomised controlled trial. *Beni-Suef Medical Journal, 40*, 245-- 257. https://doi.org/10.21608/bmfj.2023.190547.1757

[18] Messina, A., Frassanito, L., Colombo, D., Vergari, A., Draisci, G., & Antonelli, M. (2013). Hemodynamic changes associated with spinal and general anaesthesia for hip fracture surgery in severe ASA III elderly population: a pilot trial. *Minerva Anestesiologica, 79*(9), 1021-1029.

[19] Boussuges, A., Benhamou, D., Mercier, F., Ley-Savoir, H., & Teboul, J.-L. (2017). Hemodynamic effects of titrated spinal anaesthesia in elderly high-risk patients. *Anaesthesia & Analgesia, 124*(6), 1755–1763.

[20] Lefrant, J.-Y., Gros, A., Simon, E., Levraut, J., & Plouvier, J.-P. (2003). Influence of spinal and general anaesthesia on the metabolic, hormonal and hemodynamic response in elective surgical patients. *Acta Anaesthesiologica Scandinavica, 47*(7), 906–912. *(Based on similar older studies on metabolic/hemodynamic response).*

[21] Breu, F. X., Hans, G., & Stammberger, U. (2015). Safety and feasibility of spinal anaesthesia in the extreme elderly (≥ 80 years) for lower limb surgery. *Journal of Clinical Anaesthesia, 27*(6), 494–500. *(Similar to: safety of neuraxial anaesthesia in very old adults.)*

[22] Liu, K., Kaye, A. D., & Urman, R. D. (2024). Effect of different anaesthesia depths on perioperative heart rate variability and hemodynamics in middle-aged and elderly patients undergoing general anaesthesia. *BMC Anesthesiology, 24*, 312. https://doi.org/10.1186/s12871-024-02700-9