

Management of hypotension in patients undergoing surgery for inguinal hernia under spinal anesthesia: Comparison between intravenous phenylephrine and ephedrine

Muhit MS^a, Mustafa SJ^b, Alam KP^c, Sharmin F^d, Afza A^e, Rubel GM^f

Abstract

Background: Hemodynamic instability after spinal anesthesia (sub arachnoid block) is one of most common complications that anesthesiologist has to deal with clinical practice. Ephedrine and phenylephrine are the two potent drugs to manage hypotension during spinal anesthesia.

Objective: To compare the effectiveness of ephedrine and phenylephrine on hypotension and heart rate after spinal anesthesia

Methods: This randomized control study was conducted on 100 male patients scheduled for surgery for inguinal hernia in a medical college hospital. Patients were selected according to inclusion criteria. They were divided equally into two groups where group A (n=50) patients received intravenous ephedrine 5mg bolus and group B (n=50) received intravenous phenylephrine 50 microgram bolus dose. The hemodynamic parameters were compared at a regular interval. The main outcome variables were systolic arterial pressure (SAP), diastolic arterial pressure (DAP) and Heart rate (HR).

Results: This study showed that phenylephrine and ephedrine both are equally potent in managing hypotension. Moreover, phenylephrine has shown significantly higher systolic and diastolic arterial pressure from 12 to 30 minutes ($p < 0.05$) after anesthesia and ephedrine showed considerably higher heart rate from 12 to 18 minutes ($p < 0.05$) in study participants.

Conclusion: During hypotension induced by spinal anesthesia, phenylephrine has better control over systolic and diastolic arterial pressure whereas ephedrine shows increased heart rate compared to phenylephrine.

Keywords: Regional anesthesia, ephedrine, phenylephrine.

Introduction:

Herniotomy for indirect inguinal hernia is one of the common surgeries performed in Bangladesh Medical College Hospital. Hypotension while performing surgery under spinal anesthesia should be treated properly to prevent

any kind of untoward complications. The administration of bolus crystalloid fluid may be effective to prevent hypotension after anesthesia.¹ But, anesthesiologist should be careful in fluid management when they deal with patient with cardiovascular and renal diseases. Elderly patients are also vulnerable for fluid overload and pose the risk for further decreases of systemic vascular resistance and cardiac output.² Thus, anesthesiologists use several drugs along with the fluid administration to combat hypotension during anesthesia. Ephedrine is the drug of choice as vasopressor for spinal anesthesia throughout the world.³ It has direct effects on alpha and beta receptors. Ephedrine causes increase in systolic and diastolic arterial pressure and heart rate.⁴ Phenylephrine is another alpha adrenergic agonist, with no effect on beta receptor. It causes direct arteriolar constriction resulting an increase arterial pressure.⁵ Unlike ephedrine, phenylephrine is less likely cause of tachyphylaxis and supraventricular tachycardia.⁶

- Dr. Md. Shahriar Muhit; FCPS, MBBS
Assistant Professor, Department of Anesthesiology
Bangladesh Medical College Hospital
- Dr. Sadia Jabeen Mustafa; FCPS, MBBS
Associate Consultant, Department of Endocrinology
Ibrahim General Hospital, Dhaka
- Dr. Kazi Parves Alam; MBBS
Junior Consultant, Department of Anesthesiology
Bangladesh Medical College Hospital
- Dr. Fatema Sharmin; DA, MBBS
Junior Consultant, Department of Anesthesiology
Bangladesh Medical College Hospital
- Dr. Ambia Afza; DA, MBBS
Junior Consultant, Department of Anesthesiology
Bangladesh Medical College Hospital
- Dr. G M Rubel; DA, MBBS
Junior Consultant, Department of Anesthesiology
Bangladesh Medical College Hospital

Correspondence to:

Dr. Md. Shahriar Muhit; FCPS, MBBS
Assistant Professor, Department of Anesthesiology
Bangladesh Medical College Hospital
Email: drmdsmuhit@gmail.com

Materials & Methods:

This was a prospective randomized double-blind study, conducted in a medical college hospital on male patients undergoing surgery for inguinal hernia during the period of 1 year.

Inclusion criteria were- 1. Patients giving informed consent; 2.

Male patients undergoing herniotomy surgery; 3. ASA physical status I and II patients; 4. Age between 18–65 years. Exclusion criteria were-1. ASA III and IV; 2. Patients above below 18 and above 65 years; 3. Patients with hypertension, diabetes mellitus, bronchial asthma, and ischemic heart disease; 4. Morbidly obese patients; 5. Patients with any history to local anesthetic drug, ephedrine, and phenylephrine; 6. Patients having contraindication of subarachnoid block (spinal anesthesia)

In the study 100 patients, aged 18 to 65 years, who met the inclusion criteria were scheduled for elective surgery for inguinal hernia under spinal anesthesia, were selected by prospective randomized double-blind selection. All the patients were divided into two groups; Group A received ephedrine and group B was allocated phenylephrine. A proper pre-anesthetic evaluation was followed to assess the physical condition of the patients and suitability for the study. A proper fasting protocol has been following since the night before surgery for the patients in both groups.⁷ After entering in the operating room, patients were applied ECG, noninvasive blood pressure, heart rate and oxygen saturation of blood with pulse oxymeter. An 18G intravenous line was introduced on each of the patients and preloaded with Ringer's lactate solution at a rate of 15ml/kg within half-life.⁸ Spinal anesthesia was administered at Lumber 3-4 or 4-5 interspace with 25G needle. Heart rate, systolic and diastolic arterial pressure were monitored and recorded regularly on every patient. After confirming the level of block to T5 level, surgery was started.^{9,10}

When the systolic BP less than 90 mm Hg or decrease in systolic BP more than 20% of base line whichever is lower. The patients were randomly provided two types of vasopressor drugs whenever needed. Group-A was given 5mg of intravenous bolus of ephedrine while Group-B was received 0.5ml (50 microgram) intravenous bolus of phenylephrine.^{11,12} The study drugs were prepared and labeled by an anesthesiologist who did not take part in the process of data collection.

Statistical Analysis

All the patients were monitored, and systolic arterial pressure, diastolic arterial pressure and heart rate have been recorded at a regular interval up to 90 minutes after anesthesia. The data were analyzed by SPSS Windows version 20.

Results:

Table 1: Demographic characteristics of patients (N=100)

	Group A (Mean±SD)	Group B (Mean±SD)	p value
Age(years)	57.86±6.54	54.48±7.05	0.82
Height(cm)	169.08±3.91	169.72±4.16	0.14
Weight(kg)	72.78±4.39	70.50±5.48	0.55

Table 1 shows the demographic characteristics of the study patients, it was observed that mean age was found in

57.86±6.54 years in group A and 54.48±7.05 years in group B. The mean (SD) height of the study patients were found 169.08±3.91 cm in group A and 169.72±4.16 cm in group B. The mean weight of the study patients was 72.78±4.39 kg in group A and 70.50±5.48 kg in group B. The difference was not found statistically significant ($p > 0.05$)

Table 2: Pre-operative assessment of patient (ASA grading)

	Group-A Number (%)	Group-B Number (%)	p value
ASA Grade I	73	80	0.26
ASA Grade II	27	20	0.35

Table 2 shows pre-operative assessment of the study patients. The ASA grade I was 73 (%) in group A and 80 (%) in group B. The ASA grade II was 27 (%) in group A and 20 (%) in group B. The difference was not statistically significant ($p > 0.05$) between two groups.

Table 3: Comparison of systolic arterial pressure (SAP) in mmHg among the two groups

Interval	Group A (Mean ± SD)	Group B (Mean ± SD)	p value
Base line	126.92±4.65	127.30±5.57	0.43
3 min	120.76±6.34	121.26±5.90	0.45
6 min	117.45±4.54	115.68±6.54	0.35
9 min	108.93±8.35	110.25±6.45	0.52
12 min	112.16±9.14	118.27±11.4	0.032
15 min	114.96±7.15	121.56±5.34	0.027
18 min	110.68±6.23	118.73±7.23	0.018
21 min	115.38±8.17	122.84±6.73	0.023
24 min	112.46±9.34	121.65±8.52	0.036
27 min	109.17±7.54	118.64±7.82	0.031
30 min	117.73±8.15	115.55±8.12	0.21
35 min	115.63±7.83	117.53±9.38	0.38
40 min	118.89±8.41	116.81±7.54	0.26
45 min	117.67±9.14	119.73±8.52	0.17
50 min	115.53±7.64	116.81±6.87	0.21
60 min	113.51±8.53	114.78±7.92	0.33
70 min	117.87±7.93	116.75±8.34	0.37
80 min	116.56±8.56	118.48±6.51	0.27
90 min	118.89±7.23	120.41±6.83	0.23

Table 3 shows Systolic arterial pressure (SAP) changes were not significant between the groups up to 9 minutes after anesthesia. On the other hand, SAP were significantly lower in group I than group II from 12 to 27 min after anesthesia and those values were statistically significant as p value < 0.05 . Though, 30 min after anesthesia SAP were not significantly different in both groups up to 90 min of operation time.

Table 4: Comparison of diastolic arterial pressure (DAP) in mmHg among the two groups

Interval	Group A (Mean ± SD)	Group B (Mean ± SD)	p value
Base line	81.14±4.67	81.72±4.54	0.74
3 min	68.59±6.80	69.47±5.90	0.43
6 min	64.73±7.84	65.71±8.52	0.38
9 min	61.84±6.39	60.85±7.44	0.47
12 min	68.26±7.18	80.86±5.61	0.026
15 min	72.96±6.25	79.43±7.44	0.032
18 min	67.85±8.43	75.34±6.58	0.034
21 min	73.45±6.64	79.32±7.54	0.025
24 min	71.46±9.34	77.14±8.61	0.028
27 min	67.37±8.53	74.34±7.62	0.036
30 min	69.62±7.61	72.83±6.26	0.026
35 min	70.31±8.17	71.63±7.25	0.28
40 min	68.58±6.43	69.73±8.14	0.35
45 min	67.82±7.27	69.45±8.39	0.24
50 min	70.18±8.46	71.28±6.54	0.38
60 min	72.80±6.18	73.74±6.62	0.27
70 min	72.57±7.82	72.17±7.93	0.31
80 min	74.81±8.51	73.67±7.15	0.26
90 min	74.18±6.39	74.83±8.79	0.38

Table 4 shows that Diastolic arterial pressure (DAP) changes were not significant between the groups up to 9 minutes after anesthesia. On the other hand, DAP were significantly lower in group I than group II from 12 to 30 min after anesthesia and those values were statistically significant as p value <0.05. Though, 30 min after anesthesia DAP were not significantly different in both groups up to 90 min of operation time.

Table 5: Comparison of Heart Rate (beats per minute) of the patients among the two groups

Interval	Group A (Mean ± SD)	Group B (Mean ± SD)	P value
Base line	84.46±11.59	82.64±9.48	0.64
3 min	89.15±10.47	90.41±11.19	0.56
6 min	92.37±9.38	93.74±10.26	0.48
9 min	93.64±10.18	93.15±11.71	0.64
12 min	92.64±11.42	79.53±12.82	0.018
15 min	90.73±9.81	81.63±11.54	0.037
18 min	88.74±10.74	85.26±9.42	0.028
21 min	89.26±9.37	87.43±11.61	0.23
24 min	87.72±10.31	88.72±11.75	0.14
27 min	85.14±11.14	86.64±10.41	0.21
30 min	87.51±10.24	86.11±10.63	0.37
35 min	88.27±11.26	87.51±11.41	0.23
40 min	89.63±10.36	87.42±10.24	0.18
45 min	88.76±11.42	86.82±11.63	0.23
50 min	87.42±10.63	88.73±9.42	0.31
60 min	86.54±9.26	87.32±10.42	0.24
70 min	87.32±11.72	88.54±10.26	0.35
80 min	86.63±10.25	87.52±9.64	0.41
90 min	85.41±11.78	86.41±10.82	0.32

Table 5 shows comparison of baseline heart rate of patients in both group showed no statistical difference. From 12 to 18 min mean heart rate in group II was significantly lower from group I as p value were <0.05. From 21 to 90 min intraoperative heart rate in both groups showed no significant difference.

Discussion:

Regional anesthesia has some great advantages over general anesthesia. Among the regional anesthesia, spinal anesthesia is the most common form that has been widely used for different surgical procedures. However, management of hypotension is the main challenge that the anesthesiologist must overcome during surgical procedure under spinal anesthesia. Although perioperative fluid replacement can prevent hypotension induced by spinal anesthesia, in many cases anesthesiologist must be cautious about fluid overload specially in elderly patients. In this scenario, vasopressors like ephedrine or phenylephrine may be a good option over fluid replacement to control the hypotension.

In the study, demographic data and ASA grading were comparable in two group. The baseline arterial pressure, both systolic and diastolic, did not have any significant difference in both groups. Even there was no considerable difference (p <0.05) in mean systolic and mean diastolic arterial pressure in both groups from the administration of anesthesia to 9 min of operation timeline. The study showed a statistically significant difference in systolic and diastolic pressure in group A and group B from 12 to 30 min of operation time, where phenylephrine group demonstrated considerable higher mean systolic and diastolic arterial pressure from 12 to 30 min. This findings have the similarity with the study conducted by Abbasivash R et al.¹³

When we measured the baseline heart rate in the both groups there was no significant difference. However, after introduction of anesthesia from 12 to 18 min, group A showed significantly higher mean heart rate than group B, that was similar with the findings of study conducted by Naghibi et al.¹⁴ However, in the study conducted by Lee A et al.¹⁵ showed higher incidence of bradycardia in the group where phenylephrine was used but in our study there was no patient who developed bradycardia in the study time. Miodrag Žunić et al¹⁶ in their study observed that the higher heart in ephedrine group is beneficial for elderly patients to maintain the cardiac output, simultaneously increase myocardial oxygen demand. However, Hedge J et al¹⁷ in their study showed that patients with cardiac risk factors like ischemia should be carefully monitored and drugs must be chosen meticulously where hypotension can be prevented with minimal increase of heart rate to mitigate the myocardial oxygen demand.

Conclusion:

After administration of anesthesia in this study, phenylephrine and ephedrine both showed considerable similarities in terms of managing hypotension. However, it has been observed that ephedrine showed a significantly higher heart rate after few minutes under anesthesia. This increased heart rate may have no untoward effect in healthy individuals but may jeopardize the cardiovascular function especially in elderly patients with co-morbidities. Thus, phenylephrine can be an attractive alternative to ephedrine in the management of hypotension in spinal anesthesia.

References:

1. Walter Williamson et al, Effects of timing of fluid bolus on reduction of spinal-induced hypotension in patients undergoing elective cesarean delivery; *AANA J*. 2009 Apr;77(2):130-6
2. Cunningham C, Tapking C, Salter M, Seeton R, Kramer GC, Prough DS, Sheffield-Moore M, Kinsky MP. The physiologic responses to a fluid bolus administration in old and young healthy adults. *Perioper Med (Lond)*. 2022 Aug 16;11(1):30. doi: 10.1186/s13741-022-00266-z. PMID: 35971161; PMCID: PMC9380305.
3. Kol IO, Kaygusuz K, Gursoy S, Cetin A, Kahramanoglu Z, Ozkan F, Mimaroglu C. The effects of intravenous ephedrine during spinal anesthesia for cesarean delivery: a randomized controlled trial. *J Korean Med Sci*. 2009 Oct;24(5):883-8. doi: 10.3346/jkms.2009.24.5.883. Epub 2009 Sep 23. PMID: 19794988; PMCID: PMC2752773.
4. Uemura Y, Kinoshita M, Sakai Y, Tanaka K. Hemodynamic impact of ephedrine on hypotension during general anesthesia: a prospective cohort study on middle-aged and older patients. *BMC Anesthesiol*. 2023 Aug 22;23(1):283. doi: 10.1186/s12871-023-02244-4. PMID: 37608253; PMCID: PMC10464275.
5. Tang W, Liu H, Zhang Z, Lyu W, Wei P, Zhou H, Zhou J, Li J. Effect of phenylephrine rescue injection on hypotension after spinal anaesthesia for caesarean delivery when guided by both heart rate and SBP during an early warning window: A randomised controlled trial. *Eur J Anaesthesiol*. 2024 Jun 1;41(6):421-429. doi: 10.1097/EJA.0000000000001977. Epub 2024 Feb 28. PMID: 38420866.
6. Yoon HJ, Cho HJ, Lee IH, Jee YS, Kim SM. Comparison of hemodynamic changes between phenylephrine and combined phenylephrine and glycopyrrolate groups after spinal anesthesia for cesarean delivery. *Korean J Anesthesiol*. 2012 Jan;62(1):35-9. doi: 10.4097/kjae.2012.62.1.35. Epub 2012 Jan 25. PMID: 22323952; PMCID: PMC3272527.
7. Dongare PA, Bhaskar SB, Harsoor SS, Garg R, Kannan S, Goneppanavar U, Ali Z, Gopinath R, Sood J, Mani K, Bhatia P, Rohatgi P, Das R, Ghosh S, Mahankali SS, Singh Bajwa SJ, Gupta S, Pandya ST, Keshavan VH, Joshi M, Malhotra N. Perioperative fasting and feeding in adults, obstetric, paediatric and bariatric population: Practice Guidelines from the Indian Society of Anaesthesiologists. *Indian J Anaesth*. 2020 Jul;64(7):556-584. doi: 10.4103/ija.IJA_735_20. Epub 2020 Jul 1. PMID: 32792733; PMCID: PMC7413358.
8. Gousheh MR, Akhondzade R, Asl Aghahoseini H, Olapour A, Rashidi M. The Effects of Pre-Spinal Anesthesia Administration of Crystalloid and Colloid Solutions on Hypotension in Elective Cesarean Section. *Anesth Pain Med*. 2018 Aug 8;8(4): e69446. doi: 10.5812/aapm.69446. PMID: 30250818; PMCID: PMC6139530.
9. Zhang N, He L, Ni JX. Level of sensory block after spinal anesthesia as a predictor of hypotension in parturient. *Medicine (Baltimore)*. 2017 Jun;96(25): e7184. doi: 10.1097/MD.0000000000007184. PMID: 28640100; PMCID: PMC5484208.
10. Ousley R, Egan C, Dowling K, Cyna AM. Assessment of block height for satisfactory spinal anaesthesia for caesarean section. *Anaesthesia*. 2012 Dec;67(12): 1356-63. doi: 10.1111/anae.12034. Epub 2012 Oct 12. PMID: 23061397.
11. Vercauteren MP, Coppejans HC, Hoffmann VH, Mertens E, Adriaensen HA. Prevention of hypotension by a single 5-mg dose of ephedrine during small-dose spinal anesthesia in prehydrated cesarean delivery patients. *Anesth Analg*. 2000 Feb;90(2):324-7. doi: 10.1097/00005539-200002000-00016. PMID: 10648315.
12. Moran DH, Perillo M, LaPorta RF, Bader AM, Datta S. Phenylephrine in the prevention of hypotension following spinal anesthesia for cesarean delivery. *J Clin Anesth*. 1991 Jul-Aug;3(4):301-5. doi: 10.1016/0952-8180(91)90224-b. PMID: 1910798.
13. Abbasivash R, Sane S, Golmohammadi M, Shokuhi S, Toosi FD. Comparing prophylactic effect of phenylephrine and ephedrine on hypotension during spinal anesthesia for hip fracture surgery. *Adv Biomed Res*. 2016 Oct 26; 5:167. doi: 10.4103/2277-9175.190943. PMID: 27995106; PMCID: PMC5137231.
14. Naghibi K, Rahimi M, Mashayekhi Z. A Comparison of Intravenous Ephedrine or Phenylephrine, for Prevention of Postspinal Hypotension during Elective Lower Abdominal Surgery: A Randomized, Double-blind Case-control Study. *Adv Biomed Res*. 2017 May 29; 6:60. doi: 10.4103/2277-9175.207147. PMID: 28603701; PMCID: PMC5458406.
15. Lee A, Ngan Kee WD, Gin T. A quantitative, systematic review of randomized controlled trials of ephedrine versus phenylephrine for the management of hypotension during spinal anesthesia for cesarean

- delivery. *Anesth Analg.* 2002 Apr;94(4):920-6, table of contents. doi: 10.1097/00000539-200204000-00028. PMID: 11916798.
16. Žunić M, Krčevski Škvarč N, Kamenik M. The influence of the infusion of ephedrine and phenylephrine on the hemodynamic stability after subarachnoid anesthesia in senior adults - a controlled randomized trial. *BMC Anesthesiol.* 2019 Nov 11;19(1):207. doi: 10.1186/s12871-019-0878-4. PMID: 31711417; PMCID: PMC6849197.
17. Hedge J, Balajibabu PR, Sivaraman T. The patient with ischaemic heart disease undergoing non cardiac surgery. *Indian J Anaesth.* 2017 Sep;61(9):705-711. doi: 10.4103/ija.IJA_384_17. PMID: 28970628; PMCID: PMC5613595.