Randomized Controlled Trial on the Effects of Fixed Dose Versus Height Adjusted Dose of Hyperbaric Bupivacaine Used in Spinal Anesthesia for Cesarean Section

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Abstract

Background: Post spinal anesthesia hypotension is more common in pregnant scheduled for ceserean section and associated with adverse effect on mother and fetus. **Objective:** The following non-blinded randomized controlled trial sought to find out whether a height-adjusted dose of hyperbaric bupivacaine provides effective spinal anesthesia without the use of preloading substances and with the least associated complications during cesarean section. **Method:** patients with ASA classification II who were scheduled for cesarean section under spinal anesthesia in Duhok hospitals were selected and divided based on their height groups. Patients with heights between 150-159 were randomly allocated into Group F (who were given a fixed 11 mg dose of 0.5% hyperbaric bupivacaine intrathecally) and Group H1 (who received a height-adjusted dose of 0.5% intrathecal hyperbaric bupivacaine based on a minimum height-adjusted dose of 0.065 mg/cm height). Each group was then evaluated based on a set of predetermined parameters (Sensory level, Brombage scale, Atropine, etc..), most importantly the extent and incidence of hypotension. **Results:** The findings indicate that a height-adjusted dose provides an adequate block with minimal associated complications and is more effective than a fixed dose in preventing post-spinal-anesthesia hypotension. **Conclusion:** Using of height adjusted dose of 0.5% hyperbaric bupivacaine was sufficient to achieve efficient sensory and motor block with minimal complications during ceserean section under spinal anesthesia.

Keywords: Height-adjusted, Cesarean Section, Hyperbaric Bupivacaine, Post-spinal-anesthesia Hypotension.

Introduction

Post Spinal Anesthesia Hypotension (PSAH) is defined as the decrease of systolic blood pressure less than 100 mmHg,[1] and mean arterial pressure less than 65 mmHg[2] (Obstetric Regional Anesthesia) and it is an ongoing problem that occurs mainly in parturients. 52% of patients who undergo cesarean section (CS) experience PSH.[3] The main cause of post-spinal-anesthesia hypotension is high block which reaches T4 level and blocks cardioaccelerator fibers. However, block at T6 and above is considered satisfactory for cesarean section pain.[4] There is a greater risk of hypotension among parturients because a more extensive block (at the T4 level) is needed for the cesarean section. Furthermore, Increased intraabdominal pressure in full-term parturients lowers the volume of cerebrospinal fluid due to greater compression of the epidural space by the excess weight, engorging of epidural space vessels, and deposit of fat in the epidural space added to that aortocaval compression.[5] This hypotension leads to reduced blood flow to the uterine, and even reduced oxygenation for the fetus, and can have adverse effects on both of them.[6,7] There is an ongoing debate about the effective prevention of spinal-induced hypotension, more specifically, about the strategies that are currently used. One of the most common strategies used to prevent PSAH is called Preload. This technique involves intravenous fluid administration to optimize the blood volume before the procedure.[6] However, in recent years the effectiveness of this technique has been questioned. According to Ferré *et al.*[8], the practice of preloading is ineffective in preventing hypotension after spinal anesthesia when compared to co-loading vasoconstrictors. Vasoconstrictors are also

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commonly used to prevent PSAH; however, experts in the field have conflicted opinions about their usage too. Although NICE recommended the use of prophylactic vasopressors,[9] others have suggested not to use preventive doses of vasoconstrictors because vasopressors will decrease uterine blood flow.[10]

The scientific community is searching for a solution for PSAH. In recent years, many studies have suggested using lower doses of bupivacaine to prevent hypotension. However, since lower doses may not be sufficient, some suggest adding intrathecal fentanyl which is associated with complications like delayed respiratory depression and pruritus.[11,12] Other studies have suggested matching the dosage to the height and weight of the patient. In 2017, a study predicted intrathecal hyperbaric bupivacaine dosage using a regression equation with measuring abdominal girth and vertebral column length. However, this method is complicated and time-consuming.[13] More recently, Saring *et al.*[14] has used 0.6 mg of 5% heavy bupivacaine for each 1 cm height to reach block T6 sensory dermatome with minimal hypotension but his method includes a long dose table according to patient height as well as many difficult volume calculations.

In this study, a different approach was taken. We hypothesize that adjusting bupivacaine dose according to height is more effective in preventing post-spinal-anesthesia hypotension than a fixed dose during caesarean section. To test this hypothesis, we depended on 0.065 mg\cm dose of 0.5% heavy bupivacaine and suggested one dose for the 10 cm range for the height-adjusted group. Finally, for individuals with heights less than 160 cm, a comparison was made between the two groups (height-adjusted dose and fixed-dose group who received 11 mg of 0.5% intrathecal heavy bupivacaine) in terms of effectiveness and spinal anesthesia-related complications.

Methodology

Study Design

The study utilized a parallel study design. Approval of the ethical committee of Duhok Health directory on 5, October, 2023 (approval number: 26072023-6-13 R1). as well as Informed consent of the patients was obtained beforehand. The study was randomised but not blinded.

Sample Characteristics and Inclusion Criteria

The sample size for this study consisted of 273 patients with ASA classification II who were scheduled for CS under spinal anesthesia in Duhok hospitals. Due to the lack of population data and statistics in our locality, we were not able to calculate the sample size using any specific mechanisms for this study. The participants were recruited within 6 months and they are exclusively composed of ASA status II full-term pregnant women who were scheduled for CS under spinal anesthesia. Patients were excluded if they exceeded class II on the ASA classification, had absolute contraindications to neuraxial anesthesia, had a history of three or more CSs. Furthermore, all patients with any known cardiovascular comorbidity were also excluded (e.g., primary hypertension, pregnancy-induced hypertension, any form of arrhythmia), as well as women in active labor, with intrauterine growth retardation (IUGR), known fetal abnormalities, or increased risk of postpartum hemorrhage (e.g., placenta accreta).

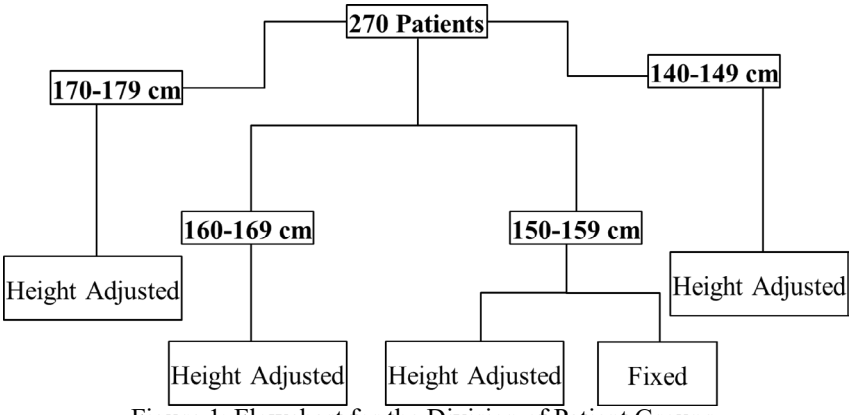

Figure 1: Flowchart for the Division of Patient Groups.

Source: Prepared by researcher.

As shown in Figure 1, the patients who fit the selection criteria and consented to their participation in the study were initially categorized into four groups based on their height, specifically within the ranges of 140-149 cm, 150-159 cm, 160-169 cm, and 170-179 cm. Those with heights between 150-159 cm were randomly subdivided using a simple randomisation technique into two groups: the height-adjusted dose group (H-group), and the fixed-dose group (F-group). The F-Group received a fixed 11 mg dose of 0.5% bupivacaine intrathecally while the H-Group received a height-adjusted dose of 0.5% heavy bupivacaine, as detailed in Table 1, based on a minimum height-adjusted dose of 0.065 mg/cm height. 1:1 random allocation ratio was achieved between these groups. It is worth mentioning that Hung B et el arranged height-adjusted doses of isobaric 0.5% bupivacaine for spinal anesthesia into 10 groups.[15] However, the present study uses only 5 doses according to patient height which is more simplified for anesthesiologists.

Table 1: Height-adjusted Bupivacaine Doses Used in Adjusted-dose Group H.

Height (cm)	Dose	
	mg	ml
140-149	9	1.8
150-159	10	2
160 -169	11	2.2
170- 179	12	2.4
180-189	12.5	2.5

Source: Prepared by researcher

Intervention Method

Patients did not receive any preloading intravenous fluids nor prophylactic vasopressors. Spinal Anesthesia was performed in the sitting position at L3-L4 interspace with cutting spinal needle gauge 25, according to their height. The dermatomal sensory block was assessed using a pin prick while the motor block was assessed using the Brombage scale. Noninvasive blood pressure and heart rate were monitored every 5 min post spinal anesthesia. Bradycardia, nausea, vomiting, transferred to general anesthesia, and the need for sedation intraoperatively had been monitored. Hypotension was defined as a decrease of mean arterial pressure (MAP) less than 65 mmHg, and it was treated with intravenous ephedrine while bradycardia was treated with intravenous atropine.

Statistical Analysis and Methods

IBM SPSS v26 software was used to perform the statistical analysis. The chi-square test was used to check for the association between any two categorical variables. Assuming normality, the independent-samples t-test should suffice for examining the difference between the two groups in ephedrine; if not, a non-parametric counterpart of the t-test should be used, namely the Mann-Whitney test. The typical test for the difference in 'change' (pre-post change) between two groups is mixed ANOVA, assuming normality. If normality is violated, the Mann-Whitney test may be applied to the change variables. The change variable is created by subtracting the pre-value from the post-value (e.g., the post-MAP minus the pre-MAP), and then the Mann-Whitney test is used to compare the two groups in terms of this 'change' variable. It is worth noting that all tests were conducted under a 0.05 level of significance. Table 2 shows three variables: Ephedrine, MAP change, and HR (Heart Rate). According to this, Ephedrine has a significant non-normal distribution (p-value < .05), and thus the Mann-Whitney test was used to compare the two groups in their ephedrine. MAP Change also exhibited a significantly non-normal distribution in both groups (P-values < .05), and therefore the Mann-Whitney test was used to compare the MAP change between the two groups. On the other hand, HR change does not exhibit a significant level of non-normal distribution in either group (P-values > .05), and therefore the Mixed ANOVA test was used.

Table 2: Tests of Normality.

Variable	Group	P-value of Shapiro-Wilk's Test
Ephedrine	F	0.000
	H1	0.000
MAP change	F	0.000
	H1	0.038
HR change	F	0.123
	H1	0.106

Source: Prepared by researcher using IBM SPSS v26 software.

Results

About the Sample

The initial sample had a size of N=273, 4 patients were lost and the rest were seprated into their respective groups. Figure 3 shows the flow of participants and the boxplot below (Figure 2) shows distribution of their heights. The figure shows that group F has a height range of roughly 150–159 cm, while group H has a wider range of heights (roughly 145–175 cm). To validate the comparison between the two groups in this analysis, we should try to achieve an approximate similarity in the height range between the two groups. In other words, to prove that the dose used should be based on height (as in group H), group F should have a similar height. For this reason, we will restrict the comparison to patients with a height range between 150–159 cm. Doing this, the total sample size becomes N=152 (75 in group-F and 77 in group-H1).

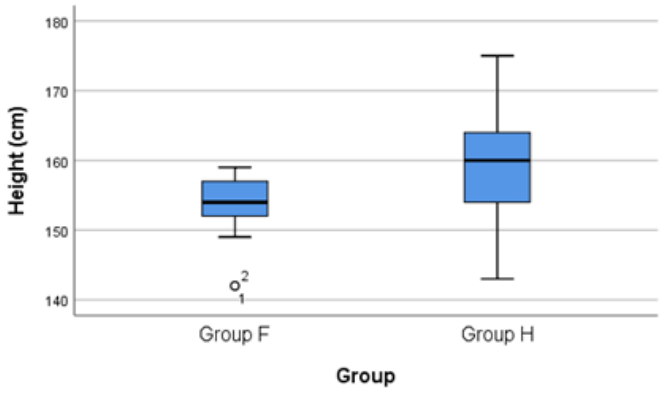

Figure 2: Boxplot for the Distribution of Height.
Source: Prepared by researcher using IBM SPSS v26 software.

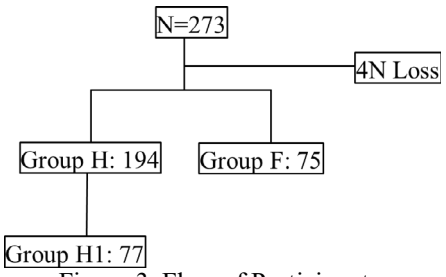

Figure 3: Flow of Participants.
Source: Prepared by researcher.

Sample Characteristics

As seen in Table 3, the two groups are not significantly different in terms of age, weight, and height, since the three corresponding P-values for the difference are > .05. Both groups have an average weight of 83 kg and average height of 155 cm. The average age is 30 in group F and 29 in group H1 (both are very close). The similarity between the two groups in these three characteristics gives more validity to the comparison between them in terms of the effectiveness of the treatment.

Table 3: Sample Characteristics.

Variable	Group	Mean ± SD	P-value
Age	F	29.72 ± 5.82	0.500
	H1	29.1 ± 5.42	
Weight (kg)	F	83.22 ± 13.74	0.947
	H1	83.36 ± 11.7	
Height hft7y(cm)	F	154.59 ± 2.89	0.951
	H1	154.56 ± 2.73	

Source: Prepared by researcher using IBM SPSS v26 software.

Comparison between Group-F and Group-H1 Comparison in Terms of Ephedrine, MAP and HR

According to Table 4, we may conclude the following:

- The two groups (F and H1) are significantly different in their ephedrine since the P-value is < .05. The table shows that group-F have generally higher ephedrine (M = 18.61, SD = 8.32), as compared to group-H1 (M = 2.92, SD = 4.08).
- The two groups (F and H1) are significantly different in their HR change since the P-value is < .05. The table shows group F has a generally increased HR (M = 7.08, SD = 21.28), while group H1 has generally a slightly decreased HR (M = -1.43, SD = 18.95).
- The two groups (F and H1) are insignificantly different in their MAP changes within 5 phases since the P-value is > .05.

However, One might argue that the P-value is not overly large in the case of MAP changes (it is 0.074, and only slightly above 0.05); it is due to use of higher dose of ephedrine in F group to treat post spinal hypotension which lead to higher MAP at 15mand 20 min post spinal anesthesia, and it could be significant if a larger sample size was used. However, if we assume that the difference between the two groups is true, it can be seen that both groups have dropped in MAP (because their mean MAP change is negative), however, group F has a deeper reduction (M = -10.33, SD = 12.19) in comparison with group H (M = -6.1, SD = 11.22).

Table 4: Comparison in Terms of Ephedrine, MAP and HR.

Variable	Group-F		Group-H1		P-value
	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)	
Ephedrine	18.61 ± 8.32	20 (10 to 25)	2.92 ± 4.08	0 (0 to 5)	0.000
MAP change	-10.33 ± 12.19	-8.3 (-16 to -1)	-6.1 ± 11.22	-4 (-10 to 1)	0.074
HR change	7.08 ± 21.28	9.5 (-8 to 23)	-1.43 ± 18.95	-1 (-14.5 to 9)	0.028

Source: Prepared by researcher using IBM SPSS v26 software.
*Note. Mann-Whitney test was applied for the ephedrine and HR-change comparisons, while Mixed ANOVA test was applied for the HR-change comparison

Comparison in Terms of the Number of Low-MAP's in the Five Phases

As seen in Table 5, the number of low-MAP readings in (in the five phases) is significantly associated with group type (F or H1), where the chi-square's P-value is < .05. In Group F, a higher proportion of women tends to experience a greater number of low-MAPs compared to Group H1. Specifically, 68.6% (N=48) of individuals in Group F have 2-4 low-MAP instances, with only 5.1% (N=3) in Group H1. Conversely, in Group H1, 94.5% (N=56) of women have 0 or 1 low-MAP instances, in contrast to 31.4% (N=22) in Group F.

Table 5: Comparing Group F and Group H1 in Terms of the Number of Low-MAP's in the Five Phases (Chi-Square Test).

Group	Number of Low-MAP's in the Five Phases					P-value
	0	1	2	3	4	
F	12 (17.1%)	10 (14.3%)	20 (28.6%)	21 (30%)	7 (10%)	0.000
H1	42 (71.2%)	14 (23.7%)	3 (5.1%)	0 (0%)	0 (0%)	

Source: Prepared by researcher using IBM SPSS v26 software.

Comparison in Terms of Having Bradycardia, Nausea and Vomiting

Table 6 shows that there is no significant association between being in a certain group (F or H1) and having bradycardia or nausea, where the P-value is > .05 for all the variables. Group type, however, has a significant association with vomiting, where the P-value is < .05. It can be seen from the table that group H1 has a relatively higher incidence of vomiting (22.1%), as compared to group F (8.3%).

Table 6: Comparison in Terms of Having Bradycardia, Nausea and Vomiting (Chi-Square Test).

Problem	Group	n (%)		P-value
		Yes	No	
Bradycardia	F	15 (20.8%)	57 (79.2%)	0.388
	H1	11 (14.3%)	66 (85.7%)	
Nausea	F	14 (19.4%)	58 (80.6%)	0.132
	H1	24 (31.2%)	53 (68.8%)	
Vomiting	F	6 (8.3%)	66 (91.7%)	0.024
	H1	17 (22.1%)	60 (77.9%)	

Source: Prepared by researcher using IBM SPSS v26 software.

Descriptive Comparisons

Detailed Change from Phase 1 to Phase 5 in MAP, SBP, and HR for Both Groups

The pattern of change in MAP across the five phases in Figure 4 show that both groups drop in average MAP after phase 1, with the F-group having steeper drop. both groups start with similar average MAPs at phase 1, with 89.4 and 83.7 mmHg in groups H1 and F respectively. This is followed by a decrease in phase 2 which continues until phase 3, which is the lowest point for both groups. However, this drop is steeper in Group F, which drops by 20.7 mmHg from Phase 1 to 2, while Group H only drops by 9.2 mmHg. Phases 4 and 5 see an increase in average MAP for both groups, however, the average MAP at phase 5 was still lower than the initial one of phase 1 for both groups. Finally, it is worth mentioning that in group H1, the average MAP never went below 65 mmHg, however, Group F went down to 63 and 61.7 mmHg during phases 2 and 3.

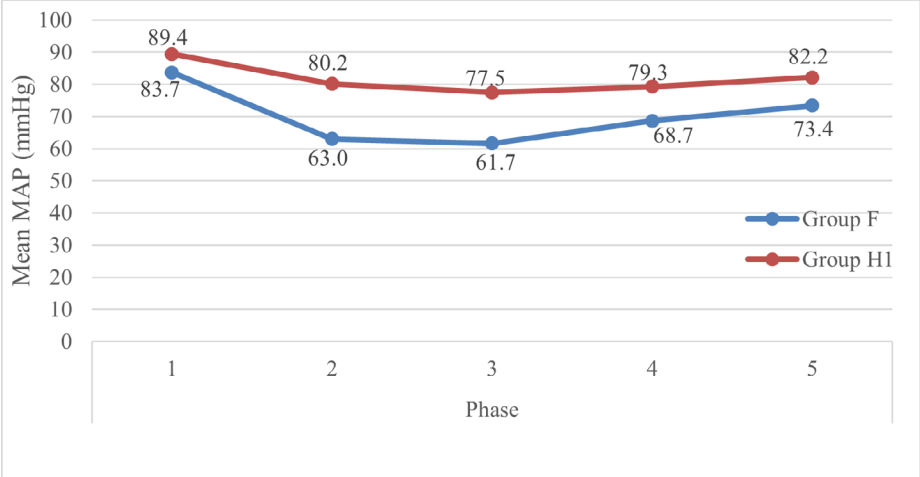

Figure 4: Change in Average MAP across the Five Phases.

Source: Prepared by researcher using IBM SPSS v26 software.

The pattern of average Systolic Blood Pressure (SBP) across the five phases in Figure 5 is similar to that explained for MAP, except that in group H1, there is a sudden considerable hike in average SBP. The average SBP for the H1 group starts at 121.9 mmHg in phase 1, and then it hikes up to 152.7 mmHg in phase 2, after which it drops down to 112.9 mmHg in phase 3, which is its lowest point. It is worth mentioning that a similar dip was observable in MAP during phase 3. After phase 3, the average SBP for group H slowly increases, reaching heights of 117.2 and 118.6 mmHg in phases 4 and 5 respectively. In contrast to group H1, group F starts from 116.7 mmHg in phase 1 and then experiences a slight dip to 99.4 in phase 2. However, group F also reaches its lowest point (95.5 mmHg) in phase 3, after which it proceeds to rise to 103.5 and 113.8 mmHg in phases 4 and 5 respectively. Finally, it is worth mentioning that The average SBP never went below 120 mmHg (after phase 1) for group H1, while it was below 120 in all phases for group F, and specifically below 100 in phases 2 to 4.

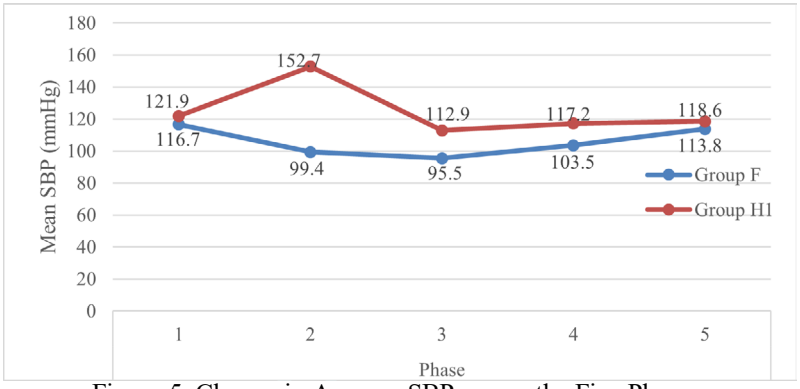

Figure 5: Change in Average SBP across the Five Phases.

Source: Prepared by researcher using IBM SPSS v26 software.

As seen in Figure 6, for group H1, the average HR is 97.1 at phase 1, and then it starts to decrease, reaching its lowest point at phase 3 (88.9 BPM). After this it starts to increase, reaching its maximum at phase 5 (100.1 BPM). Group F exhibits a similar pattern, except that the lowest point is at phase 2 (87.3 BPM). Group F has a slightly higher HR in Phase 5 than in Phase 1, while Group H1 has a slight decrease.

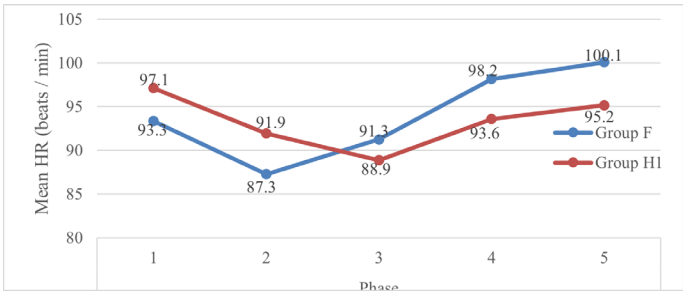

Figure 6: Change in Average HR across the Five Phases.

Source: Prepared by researcher using IBM SPSS v26 software.

Descriptive Statistics for Several Variables in the Two Groups

Group F and Group H1 are compared in terms of certain variables such as Ephedrine dose, Atropine, Brombage score, amount of patients transferred to General Anesthesia (GA), etc.. in Table 7. According to this table, the average ephedrine dose in Group F is 18.6 mg (SD = 8.3), while it's 2.9 mg (SD = 4.1) in Group H1. In addition, the sensory level of T6 is prevalent in both groups, but more dominant in Group F; 94.4% (N=68) in Group F and 80.5% (N=62) in Group H1. The Brombage score is 1 in all cases of Group F, and nearly all cases of Group H1 (N=74, 96.1%). Atropine was given to 13 cases (18.1%) in Group F, and to 8 cases (10.4%) in Group H1. For most cases in both groups, the onset of the block occurred at 60 seconds. This pattern was more prevalent in Group F, with 88.9% of cases (N=64), compared to 75.3% (N=58) in Group H1. None of the cases of Group H1 were transferred to GA, and only a few cases (N=3, 4%) in Group F were transferred. on the other hand, none of the cases in Group F received head-down positioning while only a few cases (N=3, 3.9%) in Group H1 received it. Finally, almost none of the cases (N=1, 1.4%) in Group F received sedation, and only some of the cases (N=12, 14.6%) in Group H1 received it.

Table 7: Comparison in Terms of Having Bradycardia, Nausea and Vomiting (Chi-Square Test).

Variable	Categories	Group-F		Group-H1	
		Frequency (N=75)[1]	%	Frequency (N=77)[1]	%
Ephedrine Group-F: *M ± SD: 18.6 ± 8.3* *Mdn (IQR): 20 (10-25)* Group-H: *M ± SD: 2.9 ± 4.1* *Mdn (IQR): 0 (0-5)*	0	4	5.6	48	62.3
	5	0	0	13	16.9
	10	16	22.2	16	20.8
	15	6	8.3	0	0
	20	27	37.5	0	0
	25	6	8.3	0	0
	30	11	15.3	0	0
	35	2	2.8	0	0
Sensory level	T4	2	2.8	1	1.3
	T6	68	94.4	62	80.5
	T8	2	2.8	14	18.2
Brombage	1	72	100.0	74	96.1
	2	0	0.0	3	3.9
Atropine	Yes	13	18.1	8	10.4
	No	59	81.9	69	89.6
Onset of block (sec)	60	64	88.9	58	75.3
	90	4	5.6	11	14.3
	> 90	4	5.6	8	10.4
Transfer to GA	Yes	3	4.0	0	0
	No	72	96.0	77	100.0
Head down	Yes	0	0	3	3.9
	No	72	100.0	74	96.1
Sedation	Yes	1	1.4	12	15.6
	No	70	98.6	65	84.4

Source: Prepared by researcher using IBM SPSS v26 software

[1] Any total less than 75 in group-F or less than 77 in group-H1 is due to missing values / info

Sample Characteristics

Table 8 shows the mean age, bupivacaine dosage, weight (Kg), height (cm), and Ephedrine dose. Firstly, the mean age of the sample is 29.4 years (SD = 5.7), and the mean weight is 83.2 Kg (SD = 15). Furthermore, the majority of the sample (N=175, 90.2%) have taken 10 or 11 mg doses of bupivacaine, which is because 90.2% of the sample (N=175) have heights between 150 and 169.9 cm. Finally, Ephedrine was given to 39.2% (N=76) of the cases (mostly 10 mg dose).

Table 8: Sample Characteristics.

Variable	Categories	Frequency (N=194)	%
Age *M±SD: 29.4±5.7* *Mdn (IQR): 29 (25-33)*	< 20	5	2.6
	20-29	94	48.5
	30-39	86	44.3
	40-49	9	4.6
Bupivacaine dose *M±SD: 10.5±0.7* *Mdn (IQR): 11 (10-11)*	9	13	6.7
	10	77	39.7
	11	98	50.5
	12	6	3.1
Weight (kg) *M±SD: 83.2±15* *Mdn (IQR): 81 (75-91.1)*	50-59.9	2	1.0
	60-59.9	29	14.9
	70-79.9	52	26.8
	80-89.9	55	28.4
	90-99.9	35	18.0
	100+	21	10.8
Height (cm) *M±SD: 158.9±6.7* *Mdn (IQR): 160 (154-164.3)*	140-149.9	13	6.7
	150-159.9	77	39.7
	160-169.9	98	50.5
	170-179.9	6	3.1
Ephedrine does *M±SD: 4.2±5.9* *Mdn (IQR): 0 (0-10)*	0	118	60.8
	5	14	7.2
	10	47	24.2
	15	6	3.1
	20	9	4.6

Source: Prepared by researcher using IBM SPSS v26 software.

Summary of Main Measurements of H Group

Table 9 shows that the mean and SD for the main measurements in H group were as follows: 120.3 mmHg (SD = 11.8) for SBP; 65.3 mmHg (SD = 9.9) for DBP; 80.9 mmHg (SD = 9.6) for MAP; 95.5 (SD = 15.2) for HR. For MAP specifically, cases could be summarized according to the 65 mmHg threshold: 4 (2.44%) had MAP < 65, while 160 (SD = 97.56%) had MAP >= 65—see Figure 7.

Table 9: Mean (SD) and Median (IQR) for SBP, DBP, MAP and HR.

Variable	Mean ± SD	Median (IQR)
SBP	120.3 ± 11.8	119 (114-126)
DBP	65.3 ± 9.9	64 (59-72)
MAP	80.9 ± 9.6	80 (74.25-86)
HR	95.5 ± 15.2	93 (85-102)

Source: Prepared by researcher using IBM SPSS v26 software.

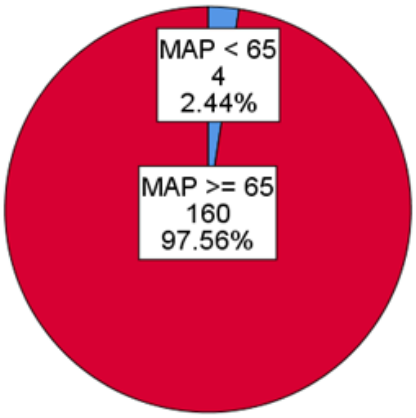

Figure 7: Presence of Low-MAP's in H Group.

Source: Prepared by researcher using IBM SPSS v26 software.

Some Important Descriptives

As seen in Table 10, in Group H(patients with different heights received height adjusted dose of intrathecal bupivacaine), some cases had the following problems:

13 (6.8%) cases had bradycardia, 52 (27.1%) had nausea, and 26 (86.5%) had vomiting. In addition, the sensory level was T6 for the majority of the cases (N=172, 89.6%) and the Brombage score was 1 for the majority of the cases (N=180, 93.8%). Atropine was given for only 10 cases (5.2%). The onset of the block was 60 sec for the majority of the cases (N=162, 84.4%). Lastly, only 2 cases (1%) needed to be transferred to GA, while head-down positioning was applied for 3 cases (1.5%) and sedation was used for 21 cases (10.9%).

Table 10: N (%) for Various Categorical Variables in Group H.

Variable	Categories	Frequency (N=194)[1]	%
Bradycardia	Yes	13	6.8
	No	179	93.2
Nausea	Yes	52	27.1
	No	140	72.9
Vomiting	Yes	26	13.5
	No	166	86.5
Sensory level	T4	1	0.5
	T6	172	89.6
	T8	19	9.9
Brombage	1	180	93.8
	2	12	6.3
Atropine	Yes	10	5.2
	No	182	94.8
Onset of block (sec)	60	162	84.4
	90	19	9.9
	> 90	11	5.7
Transfer to GA	Yes	2	1.0
	No	192	99.0
Head down	Yes	3	1.5
	No	191	98.5
Sedation	Yes	21	10.9
	No	171	89.1

Source: Prepared by researcher using IBM SPSS v26 software.

[1] Any total that's slightly less than 194 is just due to missing values (or info)

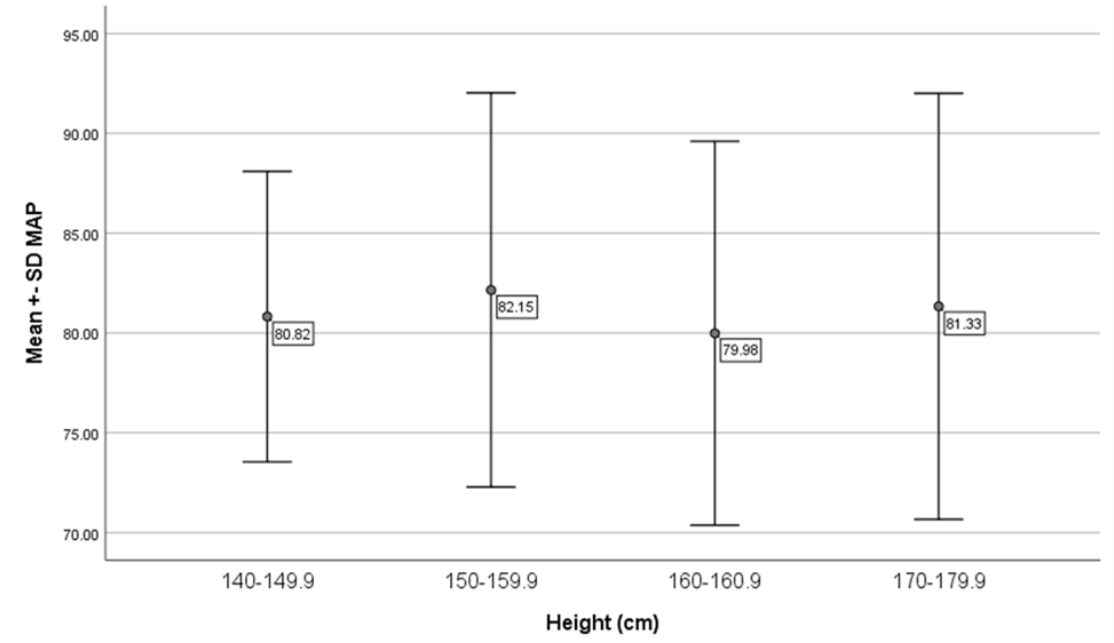

Table 11: MAP Changes in Group H.

Source: Prepared by researcher using IBM SPSS v26 software.

Discussion

The present study investigates whether a height-adjusted dose provides effective spinal anesthesia with the least associated complications during cesarean section. In

group H, 192 patients received a height-adjusted dose of intrathecal 0.5% heavy bupivacaine according to their height group. 90% of them reached the target sensory block level T6 and above, and 93% of them reached Brombage score I. Meanwhile, only 3 patients needed head-down repositioning, and just 2 patients needed to be transferred for general anesthesia due to a failed block. This reflects efficient sensory and motor block in the majority of the patients who received a height-adjusted dose.

Spinal anesthesia-related complications in the H-group included a 2.44% incidence of hypotension which was predefined as MAP<65. The correlated need to use of ephedrine was zero in 60.8%, however, the majority of the cases that did require ephedrine only used up to 10 mg. In other words, Group H either did not require a vasopressor or required a minimal dose of it. Furthermore, the incidence of bradycardia was only 13 patients, of which only 10 of them needed atropine as treatment. The incidence of nausea was 27.1% while vomiting was 13.5%. Although the incidence of nausea and vomiting was higher in Group H, this was not correlated to the incidence of hypotension, rather these effects are due to other contributing factors such as uterotonic agents and surgical manipulation as explained by Balki and Carvalho[16]. Overall however, the incidence of intraoperative nausea and vomiting in the H1 Group is less than previous studies. [16]

For heights between (150-159 cm), we compared Group H1 to Group F who received 11 mg of hyperbaric bupivacaine as a fixed dose. As indicated in Table 4**,** the incidence of hypotension is significantly higher in Group F than in Group H1 within 20 minutes post spinal anesthesia. Furthermore, there was no incidence of hypotension in Group H1 within 15 minutes or 20 min post spinal anesthesia which reflects stable hemodynamics. This shows that using a height-adjusted dose decreased the incidence of hypotension. These findings are unlike previous studies such as Białowolska *et al.*[11] which used similar height-adjusted doses of hyperbaric bupivacaine in addition to fentanyl, which showed a 50% incidence of hypotension in the height-adjusted group and failed to indicate a significant difference in terms of the incidence of hypotension when compared to the fixed-dose group. However it is important to note that this study did not use fentanyl or any other preloading substances, therefore the results may vary.

A significant difference (p-value = 0.000) was found between the two groups in terms of ephedrine use; when compared to Group F (18.61 ± 8.32 mg), fewer doses of ephedrine were used in Group H1 (2.92 ± 4.08 mg). This is yet another indication of a lower incidence of hypotension in Group H1, and the effectiveness of using a height-adjusted dose of bupivacaine to reduce post-spinal-anesthesia hypotension. Although the average changes in MAP within 20 min did not have a significant difference (p-value = 0.074) between the groups, due to use of higher doses of ephedrine in F group, even so the average MAP change in the H1 group never reached 65 mmHg, while the lowest point in the F group was 61 mmHg. In other words, Group F experienced a steeper decline in MAP. Furthermore, mean heart rate changes within 20 min were also more stable in the H1 Group with fewer fluctuations, while Group F had higher incidences of tachycardia at min 20 post-spinal due to using ephedrine in high doses. Both the steeper decline of MAP and the higher frequency of fluctuations in the mean heart rate changes in the F Group are indications of unstable hemodynamics in this group when compared to the H1 Group.

A higher need for sedation was noted in Group H1 (15.6%) as compared with Group F (1.4%). Sedation was given as anxiolytics or according to the patient's request, not due to pain, and consisted only of 2 mg intravenous of midazolam. This means that the higher use of sedation in Group H1 does not indicate an inefficient block. Finally, although the need for sedation was higher in the H1 Group than the F group, there was no transfer to GA in H1 group and was still considerably low in H group , with only 1% of the Group needing transfer GA. It is worth noting here that Saring *et al.*[14] also yielded higher percentage of transfer to GA (2%) incidence in the height-adjusted group.

Limitations

This study was limited in terms of its sample size and its exclusion of weight as part of the calculations that are involved in determining an adjusted dose of Bupivacaine. The sample size was 273 people, which is reasonable but not entirely representative. In other words, since the sample size was small, it is not representative of the entire population, therefore studies with bigger sample sizes are recommended for the future. Furthermore this study based its adjusted Bupivacaine dose entirely on height and did not make weight part of its dose calculations for the sake of simplicity. However, weight is a strong determinant of dosage specifically patients with BMI > 35 were included in this study. It is also worth mentioning that one of the other problems that were faced during this study was that certain patients required sedation in order to relieve anxiety. This intervened with the data on patient sedation in each group as well. Due to these limitations the findings of this study may not hold external validity. Athough the findings are meaningful and they contribute to the pool of literature surrounding this subject, the applicability of these findings are limited and more research is needed.

Biases

No potential sources of bias were identified during this study.

Funding

No external sources of funding were used for this study.

Conclusion

In conclusion, our findings indicate that using a height-adjusted dose of 0.5% hyperbaric bupivacaine based on a minimum height-adjusted dose of 0.065 mg/cm height was sufficient for achieving efficient sensory and motor block with minimal complications during cesarean section without

using any preloading intravenous fluids nor prophylactic vasopressors. It was also more effective in preventing post-spinal-anesthesia hypotension than a fixed dose.

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