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# Comparison of Spinal Block Characteristics Between Height and Weight Based Dosage to Addition of Fentanyl in 0.5% Hyperbaric Intrathecal Bupivacaine for Elective Cesarean Section

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## ABSTRACT

Introduction: Association of low dose of bupivacaine with fentanyl can reduce hemodynamic adverse events and improve the quality of analgesia reducing intraoperative incidence. The study evaluates the effect of fentanyl as adjuvant intrathecally to dose calculated by Harten's chart to determine hemodynamic effects and quality of analgesia undergoing cesarean section.

Objectives: To evaluate the improvement of quality of intraoperative anesthesia and controlling postoperative pain without adverse effects on mother and neonate.

Methodology: Hundred term parturients were enrolled in each group using randomised sampling technique, undergoing elective cesarean section under spinal anesthesia in this cross-sectional study carried out in Dhulikhel Hospital, Kavre district, Nepal. Group N received only total dose of 0.5% hyperbaric Bupivacaine calculated by Harten's chart and Group F received total dose of 0.5% hyperbaric Bupivacaine calculated by Harten's chart with addition of 10 mcg Fentanyl intrathecally as adjuvant. Hemodynamic parameters, onset of sensory block at T6 level with motor blockade, intraoperative analgesic requirement with adverse effect were studied and compared.

Results: Hypotensive episodes were more in Group F (26.4%) but lesser adverse effect like nausea, vomiting and bradycardia (1.9%) than in Group N ($p<0.001$). Intraoperative analgesic requirement was significantly higher with Group N (68.1%) with $p<0.001$. The time of achieving sensory block to T6 level and motor blockade to Grade III was early in Group F than in Group N $p=0.05$.

Conclusion: Addition of intrathecal fentanyl (low dose as 10 mcg) results early onset of sensory blockade, gives synergistic effect providing better intraoperative and postoperative analgesia and less complication like nausea, vomiting and shivering with good fetal outcome.

## INTRODUCTION

Spinal anesthesia is a form of regional anesthesia which involves injection of local anesthesia in subarachnoid space. The commonly used drug in subarachnoid block is hyperbaric 0.5% Bupivacaine which is a local anesthetic drug belonging to amino amide group with duration of action of 90-120 minutes .[1]

Cesarean section pain is of somatic origin due to surgical incision and visceral origin due to exteriorization of uterus and transmitted through thoracic, lumbar and sacral spinal segments: 4$^{th}$ thoracic vertebra to 5$^{th}$ sacral spine segment (T4-S5).[2] A T6 level of sensory blockade is usually significant for cesarean section.[3] Autonomic block level is few segments higher than sensory block and is associated with maternal hypotension. In addition, sometime Bupivacaine may also fail to prevent visceralgia and induce pain

during traction of peritoneum.[4]

The most common problem associated with spinal anesthesia is rapid onset of hypotension with incidence over 50% with associate adverse effect to both mother and baby.[5] Maternal hypotension following spinal anesthesia may cause major problem associated with unpleasant symptoms like dizziness, nausea, vomiting. In severe cases, may cause unconsciousness, apnea or even cardiac arrest in parturient, which may impair placental perfusion and compromise fetal outcome.[6]

Number of strategies for preventing hypotension includes lateral uterine displacement, intravenous (IV) fluid preload, gravity (Trendelenburg or leg raising), compression devices on the legs, and prophylactic vasopressors.[7-9] Reducing dose of anesthetic agent in these patient results in reduction in block level and consequently less hypotension.

To compensate for this shortcoming, adjusted dose of hyperbaric bupivacaine to patient's weight and height has shown to limit the spinal segment block spread by using Harten's chart.[10] Addition of small portion of opioids to local anesthetics is widely used clinically as a more effective method to reduce hemodynamic changes, improve the quality of intra-operative anesthesia and control the post-operative pain.[11]

Among many opioids, fentanyl has more rapid onset and short duration of action than morphine, which has become one of the most commonly used neuraxial opioid. It is a liposoluble opioid known to have less side effects and to be effective for maintaining the proper depth of anesthesia and controlling the post-operative pain.[12] This study was conducted to study the clinical effects of adding 10 mcg fentanyl to hyperbaric bupivacaine to that of control group that was without any opioid.

## METHODOLOGY

This cross-sectional study was carried out at the Department of Anesthesiology and Intensive Care at tertiary center of Kavre District, Nepal from March 2023 to March 2024. After approval of the study by the Institutional Review Committee (IRC), with reference number 9/23 and obtaining a written informed consent from the patients, all term parturients from 37- 41 weeks of gestation weighing 50-110 kg and height 140-180 cm (according to Harten's chart) with ASA II undergoing elective Cesarean section requiring spinal anesthesia were enrolled in this study. Patient refusal, parturient with preterm gestation age (<37 weeks of gestation), undergoing general anesthesia, emergency Cesarean section, parturient with uncontrolled morbidities (eg. diabetes mellitus, hypertension, heart disease etc), any disproportion of spine or previous spine surgeries were excluded from the study.

The patients were divided into two groups Group F and Group N using randomized sampling technique, having 100 patients in each group. Even numbers of study group were in Group F receiving total dose of 0.5% hyperbaric bupivacaine calculated by Harten's chart with addition of 10 mcg fentanyl as adjuvant whereas odd numbers of study group were in Group N receiving only total dose of 0.5% hyperbaric bupivacaine calculated by Harten's chart (Table 1). After spinal anesthesia, hemodynamic changes, time and level of T6 sensory block, grade of motor block at T6 sensory block, intraoperative requirement of supplementary analgesia and postoperative control of pain were noted. The degree of sedation was monitored using Modified Ramsay Sedation Scale. The data were recruited serially until the required sample size were reached.

**Table 1:** Adjusted dose regimen for hyperbaric bupivacaine 0.5 % for caesarean section under spinal anesthesia (values are in milliliters)[10]

| Patient weight (kg) | Patient's Height (cm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 |
| 50 | 1.5 | 1.7 | 1.8 | 1.9 | | | | | |
| 55 | 1.5 | 1.6 | 1.8 | 1.9 | 2 | | | | |
| 60 | 1.4 | 1.6 | 1.7 | 1.8 | 2 | 2.1 | | | |
| 65 | 1.4 | 1.5 | 1.7 | 1.8 | 1.9 | 2.1 | 2.2 | | |
| 70 | 1.3 | 1.5 | 1.6 | 1.8 | 1.9 | 2 | 2.2 | 2.3 | |
| 75 | | 1.4 | 1.6 | 1.7 | 1.9 | 2 | 2.1 | 2.3 | 2.4 |
| 80 | | 1.4 | 1.5 | 1.7 | 1.8 | 2 | 2.1 | 2.2 | 2.4 |
| 85 | | | 1.5 | 1.6 | 1.8 | 1.9 | 2.1 | 2.2 | 2.3 |
| 90 | | | 1.4 | 1.6 | 1.7 | 1.9 | 2 | 2.2 | 2.3 |
| 95 | | | | 1.5 | 1.7 | 1.8 | 2 | 2.1 | 2.3 |
| 100 | | | | 1.5 | 1.7 | 1.8 | 1.9 | 2.1 | 2.2 |
| 105 | | | | | 1.6 | 1.7 | 1.9 | 2 | 2.2 |
| 110 | | | | | | 1.7 | 1.8 | 2 | 2.2 |

All the patients were premedicated with intravenous Ranitidine 50 mg and Metoclopramide 10 mg 20 minutes before surgery. Standard monitoring was attached to the patient and baseline hemodynamic values were noted. Preloading with crystalloid Ringer lactate 10ml/kg via 18 Gauge (G) intravenous cannula were infused 15 minutes before performance of spinal anesthesia. Ringer's lactate solution was also used as maintenance fluid throughout the surgery. Under aseptic technique, 1 ml of 2% plain lidocaine was infiltrated in 3$^{rd}$ and 4$^{th}$ or 4$^{th}$ and 5$^{th}$ lumber intervertebral space in sitting position. Intrathecal injection was given by 25G Whitacre needle after free flow of cerebrospinal fluid (CSF) from all four at 0.2ml per seconds. Patient were kept in supine position with left lateral tilt with small sandbag beneath the right pelvic region.

The sensory (assessed by pin prick with blunt bevel needle in midclavicular line) and motor (assessed by modified Bromage Scale) assessments were done after 1 min of subarachnoid block (SAB) and every minute till T6 level of sensory block was achieved.[13] If the sensory blockade was inadequate 10 min after the insertion of the spinal anesthesia, the patient was positioned in a 10° head-down tilt and repositioned back to horizontal after achievement of T6 sensory block. The surgery was allowed to commence after attaining T6 sensory block and grade 3 motor blocks. If the desire level of sensory block was not achieved even after 20 minutes, patients were converted to general anesthesia with endotracheal intubation and was noted. After intrathecal injection hemodynamic values; systolic blood pressure, mean arterial pressure and heart rate were recorded at 3 minutes

interval for 20 minutes and every 5 minutes interval till the end of surgery.

**Table 2:** Modified Bromage Scale[13]

| Grade | Criteria | Degree of block |
|---|---|---|
| I | Free movement of legs and feet | Nil (0%) |
| II | Just able to flex knees with free movement of feet | Partial (33%) |
| III | Unable to flex knees with free movement of feet | Almost complete (66%) |
| IV | Unable to move legs or feet | Complete (100%) |

Any time between intrathecal injection and the end of surgery, if systolic blood pressure (SBP) fell below 20% of the baseline value, it was considered as hypotension and treated with intravenous Mephentermine (6 mg). Bradycardia [Heart rate (HR) < 50 beats per minute (bpm)] was treated with intravenous atropine (0.6 mg).[14,15]

Intraoperative pain was assessed with 10 cm linear visual analogue scale (VAS)[16] where, 0 represented 'no pain' and 10 represented 'most severe pain'. Patient with pain scale of VAS 3-7 were treated with 0.25mg/kg intravenous dose of ketamine. If pain scale before delivery of baby was VAS ≥ 7, then patient was converted to general anesthesia with endotracheal intubation and were also noted and excluded from the study. The quality of intraoperative anesthesia was graded as "excellent" if the patient had no pain during surgery, "good" if there was minimal pain (VAS 0-3) but required no supplementary analgesia, "fair" when VAS>3 and needed intravenous ketamine 0.25 mg/kg and if the pain persist after delivery of fetus, patient sedated with intravenous Midazolam 0.03mg/kg and Fentanyl 0.5 mcg/kg and "poor" if conversion to general anesthesia was required.

After the delivery of the baby, 3 International Unit (IU) of oxytocin was given intravenously as slow bolus and as an infusion of 3 IU of Oxytocin per 100 ml of intravenous fluid.[17] Apgar score at 1 min and 5 min by the pediatrician were allocated. Any complication was managed according to standard hospital protocols.

Data was analyzed using SPSS 27. Descriptive statistics were calculated for both qualitative and quantitative variables. Frequencies and percentages were calculated for variables by Chi square test between the groups. P value <0.05 was considered statistically significant and p value <0.001 as statistically highly significant.

## RESULTS

A total of two hundred parturient with 100 paturient in adjusted dose according to Harten's chart (Group N) and 100 parturient in adjusted dose according to Harten's chart with 10mcg Fentanyl as adjuvant (Group F) were analyzed. Only one patient (0.8%) from group N, converted into general anesthesia with rapid sequence induction due to inadequate block.

Demographic profile (Table 3) shows there are no difference in age, weight, height and gestational age. The duration of surgery was also similar in both the groups. The mean volume of drugs in group N patients received 1.74 ± 0.16 ml which was statistically not significant as compared with the group F of 1.95 ± 0.144 (p= 0.57).

**Table 3:** Demographic Variables

| Variables | Group N | Group F | p Value |
|---|---|---|---|
| Age (years) | 29.16 ± 4.14 | 29.62 ± 4.70 | 0.35 |
| Weight (kg) | 70.70 ± 10.80 | 71.15 ± 8.93 | 0.15 |
| Height (cm) | 154.6 ± 6.34 | 154.70 ± 6.19 | 0.17 |
| Gestational Age (WOG) | 38.28 ± 1.15 | 38.39 ± 1.00 | 0.78 |
| Duration of Surgery (min) | 45.91 ± 14.24 | 52.85 ± 13.54 | 0.94 |
| Total amount of administration (ml) | 1.74 ± 0.16 | 1.95 ± 0.14 | 0.57 |

Quality of sensory block was assessed with pin pricks. The time taken to achieve T6 sensory block between 2 groups was significant p= 0.05 (3 min versus 5 min). However, Bromage score for motor block during T6 sensory block and after 2 hours of spinal anesthesia was similar in both the groups. The degree of sedation was no difference in both the groups as shown in Table 4.

**Table 4:** Assessment of Quality of Anesthesia between two groups

| | Group N | Group F | p Value |
|---|---|---|---|
| Sensory Block T6 (min) | 3.48 ± 1.11 | 3.78 ± 1.23 | 0.05 |
| Bromage Score at T6 | 2.85 ± 0.43 | 2.94 ± 0.24 | 0.62 |
| Bromage after 2 hours | 1.96 ± 0.8 | 2.15 ± 0.56 | 0.87 |
| Degree of sedation | 1.87 ± 0.37 | 1.95 ± 0.54 | 0.15 |

Hemodynamic value as systolic blood pressure (SBP), heart rate (HR) and mean arterial pressure (MAP) when compared between two groups, and found statistically significant. When SBP compared between two groups, there were statistically significant during 5 min p= 0.00 and during 20 min with p= 0.00 as shown in Table 5 and Figure 1.

**Table 5:** Hemodynamic Variables of Systolic blood Pressure between two groups

| SBP | Group N | Group F | P Value |
|---|---|---|---|
| Baseline | 124.77 ± 13.98 | 123.13 ± 12.95 | 0.16 |
| 2 min | 114.08 ± 15.83 | 114.20 ± 13.24 | 0.03 |
| 5 min | 111.74 ± 17.28 | 109.44 ± 15.66 | 0.00 |
| 8 min | 113.42 ± 18.56 | 110.19 ± 16.56 | 0.12 |
| 11 min | 115.56 ± 16.75 | 111.34 ± 13.92 | 0.88 |
| 14 min | 115.99 ± 17.82 | 114.68 ± 14.35 | 0.55 |
| 17 min | 115.31 ± 18.41 | 112.24 ± 14.36 | 0.32 |
| 20 min | 114.88 ± 15.37 | 113.31 ± 13.94 | 0.00 |

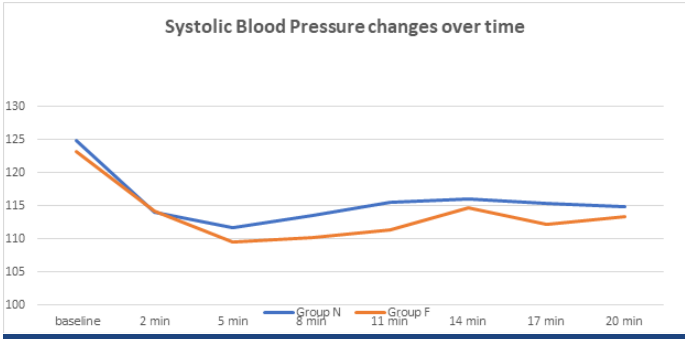


**Fig 1:** Systolic Blood Pressure changes between the two groups

With HR, when compared between two groups, there were statistically significant during 5 min with p=0.56 and 20 min with p= 0.02 and with MAP, during 5 min and 20min with p=0.01 and 0.01 respectively. Demographic profile shown in Table 6 and Figure 2 for HR and Table 7 and Figure 3 for MAP respectively.

**Table 6:** Hemodynamic Variables of Heart rate between two groups

| HR | Group N | Group F | P Value |
|---|---|---|---|
| Baseline | 92.79 ± 12.08 | 97.60 ± 15.82 | 0.61 |
| 2 min | 90.91 ± 14.58 | 98.88 ± 17.65 | 0.02 |
| 5 min | 86.52 ± 16.58 | 95.79 ± 18.05 | 0.56 |
| 8 min | 86.82 ± 16.15 | 93.83 ± 15.74 | 0.06 |
| 11 min | 87.61 ± 14.51 | 90.92 ± 15.5 | 0.82 |
| 14 min | 88.52 ± 13.52 | 91.80 ± 15.7 | 0.07 |
| 17 min | 92.25 ± 11.72 | 93.49 ± 13.98 | 0.33 |
| 20 min | 89.50 ± 14.65 | 93.56 ± 13.38 | 0.02 |

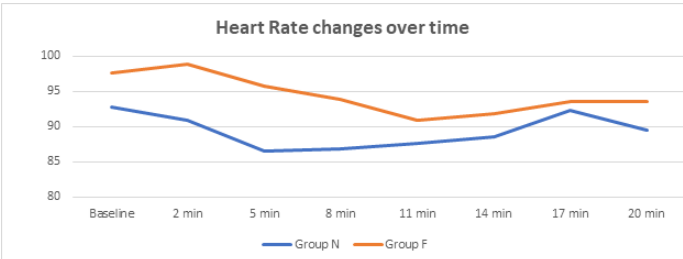


**Fig 2:** Heart Rate changes between the two groups

**Table 7:** Hemodynamic Variables of Mean Arterial Pressure between two groups

| MAP | Group N | Group F | P Value |
|---|---|---|---|
| Baseline | 96.38 ±11.76 | 93.86 ± 11.15 | 0.71 |
| 2 min | 86.76 ± 13.05 | 85.19 ± 11.57 | 0.47 |
| 5 min | 83.74 ± 14 | 81.74 ± 14.15 | 0.01 |
| 8 min | 83.74 ± 14.75 | 82.31 ± 13.8 | 0.85 |
| 11 min | 87.89 ± 15.79 | 82 ± 12.89 | 0.66 |
| 14 min | 87.43 ± 16.22 | 83.45 ± 12.98 | 0.91 |

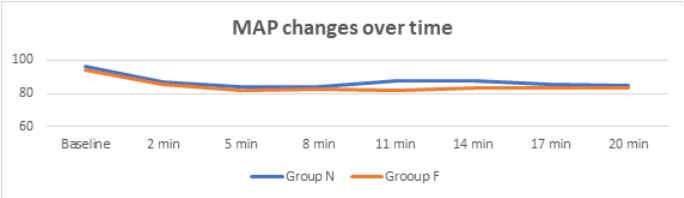


**Fig 3:** Mean Arterial Pressure changes between the two groups

Vasopressor requirement was more in Group F with 28 parturient (26.4%) than in Group N with 11 parturient (10.4%) who developed hypotension which was highly significant with p <0.001. Incidence of nausea was noted in 12 parturient in group N in which 2 had nausea and vomiting whereas only 6 parturient complained of nausea in group F. None of the patients from group F had bradycardia intraoperatively. Two patient (1.9%) from group N developed bradycardia (lasted <10 seconds). The intraoperative analgesic effect between two groups, there were statistically highly significant having p value <0.001. In Group N, forty-seven patient (68.1%) required analgesia in which patient complained of epigastric pain and discomfort; and pain during manipulation of uterus especially during delivery of the fetus. Intravenous Ketamine 0.25 mg/kg was given and if the pain persists after delivery of fetus, patient was sedated with intravenous Midazolam 0.03mg/kg and Fentanyl 0.5 mcg/kg. In group F none complained of epigastric pain but six patients did complain of discomfort during manipulation of uterus where no analgesic requirement was needed. Apgar Score were similar in two groups at 1 minute and 5 minutes. None of the patient experienced shivering.

## DISCUSSION

In our study, dose adjustment of intrathecal heavy bupivacaine on the basis of Harten's chart significantly reduced bupivacaine requirement for cesarean section. The quality of anesthesia was differed between the two groups but the outcome of the baby was similar.

A T6 level of sensory blockade is usually significant for cesarean section.[3] Our observation was delayed in mean time of sensory block on adjustment bupivacaine than to the adjustment bupivacaine with adjuvant. Shende et al and Ahmed NU et al study was similar to this present study. [18,19] The finding of faster onset in Group F may be due to use of fentanyl as an adjuvant which has rapid onset and its synergistic effect with local anesthetics. Bogra et al also got similar results.[20] The motor blockade when T6 level of sensory blockade was achieved, both the group were similar with grade 3.

In hemodynamic stability, SBP and MAP value was reducing within 3 minutes interval, till 20 minutes of recording from the baseline in both the groups. In comparing two groups, there was decrease of SBP and MAP value statistically highly significantly with Group F (p=0.001) in 5 and 20 minutes which concluded Group F had more hypotensive episode than in Group N. In the studies by Abate SM et al and Brie AM et al reviewed fewer episode of hypotension with low dose bupivacaine with fentanyl when compared with conventional dose of bupivacaine.[21,22] Adjusted dose of hyperbaric bupivacaine based on Harten et

al study showed reduction on hypotensive episode of 50.0% and lesser use of vasopressor due to restricted spinal block segments and extend of sympathetic block.[10] This trend was not consistent with present study. Hypotensive episodes were noted in 26.4% of Group F and 10.4% in Group N in our study, the distribution was statistically highly significant p=0.001. However, hypotensive episodes were noted higher in 71.7% and 45% of fixed doses in Harten et al[10], and KC KK et al[23] studies respectively. The parturient have wide variability in spread of intrathecal hyperbaric Bupivacaine, ranging from high block to inadequate block depending on the individual spinal anatomy, changes in lumbar lordosis and in volume and density of CSF.[3] Bogra et al found that blood pressure declined with increasing dose of bupivacaine and fentanyl.[20] Increasing dose with fentanyl may have increased the hypotensive incidence though the volume between two groups were statistically insignificant.

Bradycardia lasting less than 10 seconds in two patients and vomiting in two patients was noted in Group N. The incidence of nausea was higher in Group N than in Group F (12 vs 6 patients) mainly related to peritoneal traction, exteriorization and reposition of the uterus.[24] Fentanyl improves synergistic effect of surgical quality with bupivacaine. Similar to the findings of Randalls et al and Singh H et al.[25, 26] There was no any incidence of itching or shivering in either group of the study.

Analgesic requirement was statistically high in Group N (68.1%) which were requested mainly due to rectus muscle traction or epigastric pain during uterine manipulation especially during delivery of the fetus. The effect of opioid additives showed significantly reduced intraoperative pain which was comparable to the study done by Jung Hang Lee et al and Nagraj A et al.[27,28] A meta-analysis from Uppal V et al showed patient receiving only bupivacaine required systemic anesthetic adjunct medication compared to patient receiving intrathecal fentanyl with bupivacaine.[29] Choi et al demonstrated that patient with low dose bupivacaine intrathecally reported intraoperative pain, while patients who received same dose of intrathecal bupivacaine with addition of intrathecal fentanyl 10 mcg reported no intraoperative pain which was similar to our study.[30] The postoperative analgesia lasted for 2 hours in Group F as fentanyl has short duration of action. However, postoperative analgesia couldn't be assessed in Group N as many patients received intraoperative analgesia and sedation due to pain intraoperatively. Only one patient from Group N was converted to general anesthesia due to inadequate block which is different from the study of Subedi et al[31] in which conversion to general anesthesia was nil. It might be due to low volume of local anesthesia, failure to spread and drug action on the nerves of the patient. Multivariate analysis by Brewer A et al reported increase in odds of conversion to general anesthesia in the patient who did not receive intrathecal fentanyl than who received fentanyl with bupivacaine intrathecally. [32]

## CONCLUSION

Dose adjustment of heavy bupivacaine based on Harten's chart do reduce the requirement of bupivacaine for the cesarean section but the volume might not be adequate in our subset of population in associate with visceral pain. While addition of intrathecal fentanyl (low dose as 10 mcg) results early onset of sensory, gives synergistic effect providing better intraoperative and postoperative analgesia and less complication like nausea, vomiting and shivering with good fetal outcome.

## LIMITATION

This study had several limitations: intraoperative VAS scores could not be assessed due to patient anxiety, the quality of surgical anesthesia and umbilical blood gas analysis were not evaluated, and sensory and motor block regressions were not recorded. Additionally, the highest sensory level beyond T6 after spinal anesthesia and postoperative analgesia were not assessed due to intraoperative analgesia and sedation use.

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## CONFLICT OF INTEREST None

## FINALCIAL DISCLOSURE None

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