Comparison between intrathecal isobaric ropivacaine-fentanyl and bupivacaine-fentanyl in elective infraumbilical orthopedic surgery: A randomized controlled study

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Abstract

Background and Aims: We aimed to evaluate and compare the block characteristics and duration of analgesia of intrathecal isobaric ropivacaine-fentanyl and bupivacaine-fentanyl combination in adult patients undergoing lower limb orthopedic surgery.

Material and Methods: Seventy-four American Society of Anesthesiologists’ I and II adult patients undergoing lower limb orthopedic surgery under subarachnoid block were randomized to receive either 3 ml 0.5% isobaric ropivacaine and 25 mcg fentanyl (Group R) or 3 ml 0.5% isobaric bupivacaine and 25 mcg fentanyl (Group B). The hemodynamic profiles, maximum upper level of sensory block height, time to reach peak block height, two dermatome regression time, and duration of motor block were recorded.

Results: There was no statistically significant difference regarding the hemodynamic parameters between the groups. The median (range) peak sensory block height was T7 (T4-T9) in Group R and T7 (T4-T10) in Group B. Time to reach peak block height (13.2 ± 2.3 min in Group R vs. 13.7 ± 2.2 min in Group B; P = 0.385) was similar between the groups. Two dermatome regression time in sensory block (median 120 min vs. 85 min; P < 0.001) and duration of motor block (median 245 min vs. 150 min; P < 0.001) was significantly higher in Group B. The duration of analgesia (median 360 min vs. 245 min; P < 0.001) was significantly higher in the bupivacaine group.

Conclusion: Intrathecal isobaric bupivacaine-fentanyl combination produces a significantly longer duration of analgesia, sensory block and motor block than isobaric ropivacaine-fentanyl combination. As ropivacaine has a shorter duration of sensory and motor block, it may be preferred in day care surgery.

Key words: Bupivacaine, intrathecal bupivacaine, orthopedic surgery, ropivacaine

Introduction

Subarachnoid block is the most commonly used regional anesthesia technique in contemporary anesthesia practice. Motor block from subarachnoid anesthesia beyond the duration of surgery is undesirable, particularly in ambulatory setting, and this is the most important reason why subarachnoid block is not preferred in ambulatory setting. Various local anesthetic agents have been used in spinal anesthesia since their introduction. Among them, ropivacaine, which was first used clinically in 1992, [1] provides shorter duration of sensory and motor block than bupivacaine, and may be of particular use in the day-case setting. [2] Ropivacaine has been shown to be effective in providing surgical anesthesia for patients undergoing total hip replacement, [3] transurethral resection of the prostate, [4] lower abdominal or limb surgery [5,6] and cesarean section. [7] Various studies have compared the efficacy and side effect profile of equipotent doses of intrathecal bupivacaine and ropivacaine in different surgeries. [4,8,9] However, there are very few studies comparing intrathecal use of equal volume of isobaric ropivacaine and bupivacaine and their effect on perioperative hemodynamics and duration of analgesia. [10,11] and even fewer studies have used fentanyl as an adjuvant. [8] In this prospective randomized study, intrathecal 0.5% isobaric ropivacaine and fentanyl was compared with 0.5% isobaric bupivacaine and fentanyl in terms of block characteristics and hemodynamic effects in adult patients undergoing elective orthopedic surgery.
Material and Methods

After obtaining institutional ethics committee permission and written informed consent from the patients, 74 adult patients of American Society of Anesthesiologists Physical Status (ASA PS) I and II and aged between 18 and 60 years scheduled to undergo elective orthopedic surgery under subarachnoid block during the period of March 2011 to February 2012 were included in the prospective randomized trial. Patients refusing to participate, with known allergy to any study drug, having any contraindication to spinal anesthesia, and pregnant women were excluded from the study. Patients having the level of sensory block below T10 after 15 min of subarachnoid block or having visual analogue scale (VAS) pain score <40 at any point of time during intraoperative period were offered general anesthesia for the rest of the procedure. This subset of patients were planned to regard as “incomplete block” category and planned to exclude from the final data analysis.

A computer-generated randomization table (Microsoft® Excel 2007 software, Microsoft Corp., Redmond, WA) was used to assign each patient into either Group “R” (patients receiving ropivacaine and fentanyl) or Group “B” (patient receiving bupivacaine and fentanyl). For ensuring blinding, randomly allocated coded syringes of drugs were prepared by an anesthesiologist who did not perform subarachnoid block or record the outcome during intraoperative and postoperative periods. The investigator and the anesthesiologist performing subarachnoid block were blinded to the content of the drugs contained in the syringes. The solution intended for Group R contained 3 ml isobaric ropivacaine (0.5%) and 0.5 ml (25 μg) fentanyl, and solution intended for Group B contained 3 ml isobaric bupivacaine (0.5%) and 0.5 ml (25 μg) fentanyl.

A complete preanesthetic evaluation was performed in each patient and necessary written informed consent was taken. Standard ASA fasting guidelines were followed in each patient, and they did not receive any sedative premedication on the day of surgery until motor blockade regressed to sacral dermatome. These measurements were performed at 5, 10, and 15-min after intrathecal injection and then every 15-min after surgery until motor blockade regressed to sacral dermatome. Duration of motor block was calculated till modified Bromage score reached six for each patient.

Intraoperative HR and blood pressure were measured every 5 min for the first 30 min and then at 10-min interval till the end of surgery and hourly thereafter till rescue analgesia was required. Duration of sensory block was calculated with two dermatome regression from peak block height for each patient.

Intraoperative fluid management was done as per standard protocol. The blood losses up to the transfusion threshold were replaced with 3 ml of RL for each ml of blood loss. Hypotension, defined by decrease in blood pressure more than 30% below baseline or in normotensive patients, fall in systolic pressure below 90 mmHg, was treated with bolus of 200 ml of RL solution and if not responded, incremental doses of intravenous mephentermine was used. Bradycardia was defined as heart rate (HR) <50/min which was treated with intravenous atropine 0.5 mg. At the end of the surgery, the patients were shifted to the postoperative ward for clinical monitoring of vital signs, appropriate fluid therapy and another treatment.

Oxygen was given through bi-nasal cannula at 2 L/min. Height of sensory block (using loss of sensation to cold with an alcohol swab on each side of mid-axillary line) - measured every 5 min for the first 30 min and then at 15-min interval till the end of surgery and hourly thereafter till rescue analgesia was required. Duration of sensory block was calculated with two dermatome regression from peak block height for each patient.

Following parameters were assessed

- Motor block was assessed using a 6-point-modified Bromage scale.[12] These measurements were performed at 5, 10, and 15-min after intrathecal injection and then every 15-min after surgery until motor blockade regressed to sacral dermatome. Duration of motor block was calculated till modified Bromage score reached six for each patient.

- Intraoperative HR and blood pressure were measured every 5 min for the first 30 min and then at 10-min interval till the end of surgery and hourly thereafter till rescue analgesia was required.

- Duration of analgesia — defined from the time of institution of a successful intrathecal block to the time of request for first rescue analgesia or VAS pain score more than 40 whichever was earlier was also assessed.

- Side effects such as nausea and vomiting, pruritus, and respiratory depression were observed and managed accordingly in the intraoperative period and in the postoperative period till the requirement of rescue analgesic.
Rescue analgesia was administered postoperatively when VAS score was >40 or when patient requested for analgesia with diclofenac sodium 1 mg/kg bodyweight intramuscularly. The primary endpoint of the study was when the patients requested for first rescue analgesia or VAS >40 whichever was earlier.

Sample size estimation was done using PS Power and Sample Size Calculation software (version 3.0, 2009, Department of Biostatistics, Vanderbilt University School of Medicine, Nashville, TN). Based on clinical experience and review of literature, it was seen that 1 h difference in mean duration of analgesia between the two groups can be considered, being clinically significant. Within group, standard deviation was assumed to be 1.5 h. Using these data and assuming a study power of 80% and a 5% probability of type I error, a sample size of 74 patients was found to be required for this study. So, a total of 74 patients (n = 74) were incorporated in the study, who were distributed randomly into two equal study groups (n = 37).

All raw data of study parameters were entered into a Microsoft Excel spreadsheet and analyzed using SPSS software (SPSS version 22.0, Chicago, IL, USA). Results were summarized by descriptive statistics such as mean and standard deviation for numerical variables that are normally distributed and median and interquartile range for those that are skewed. Numerical variables were compared between groups by independent sample t-test if normally distributed and by Mann-Whitney U-test if skewed. Chi-square test and Fisher’s exact test were used to compare the frequency of adverse events and other categorical variables between groups. All statistical analysis was two-tailed, and a P < 0.05 was regarded as statistically significant.

**Results**

Both the groups were comparable with respect to the demographic parameters like age, sex, height, weight, ASA PS distribution, duration and type of surgeries with no statistically significant difference between them [Table 1].

There was no statistically significant difference between the two groups regarding intraoperative systolic, diastolic and mean arterial blood pressure. There was no incidence of significant hypotension in any group as defined by decrease in blood pressure more than 30% below baseline or in normotensive patients, fall in systolic pressure below 90 mmHg. None of the patients required vasopressor support or had any episode of bradycardia, which required administration of atropine.

Median (range) peak sensory block height in Group R was T7 (T4-T9) and in Group B it was T7 (T4–T10). The mean time to reach the peak sensory block height was similar in both the groups (13.2 ± 2.3 min in Group R and 13.7 ± 2.2 min in Group B; P = 0.385, independent sample t-test). The duration of motor block (median 245 min vs. 150 min; P = 0.00, Mann-Whitney U-test; Hodges-Lehman median difference 80 min, 95% confidence interval [CI]: 60, 120 min) and two dermatome regression time of sensory block (median 120 min vs. 85 min; P = 0.00, Mann-Whitney U-test; Hodges-Lehman median difference 35 min, 95% CI: 20, 45 min) was significantly higher in the Group B.

In the first 3 postoperative hours, VAS score was significantly lower in the Group B than in Group R (independent sample t-test P < 0.05) suggesting that the patients who received bupivacaine-fentanyl combination experienced much lower pain for a prolonged period of time than ropivacaine-fentanyl combination [Figure 1]. The duration of analgesia as defined above (median 360 min vs. 245 min; P < 0.001, Mann-Whitney U-test; Hodges-Lehman median difference 120 min, 95% CI: 90, 145 min) was significantly higher in

![Figure 1: A comparison of visual analogue scale in two groups](image)

### Table 1: Demographic profile of the patients in two groups (mean ± SD)

| Patients’ characteristics | Group R (n = 37) | Group B (n = 37) | Significance |
|---------------------------|------------------|------------------|--------------|
| Age (years)               | 43.57±11.01      | 42.16±11.03      | NS²          |
| Weight (kg)               | 58.43±5.95       | 58.35±6.54       | NS²          |
| Height (cm)               | 161.68±6.65      | 160.24±6.63      | NS²          |
| Sex (male/female)         | 20/17            | 18/19            | NS¹          |
| ASA PS (I/II)             | 25/12            | 25/12            | NS¹          |
| Site of spinal block (L2-L3/L3-L4) | 15/22          | 11/26            | NS¹          |
| Duration of surgery       | 79.19±17.85      | 78.92±18.68      | NS³          |

¹Independent sample t-test, ²Chi-square test. ASA PS = American Society of Anesthesiologists’ Physical Status, NS = Not significant, SD = Standard deviation
Group B. Summary of the block characteristics in either group has been furnished in Table 2.

Incidence of postoperative nausea and vomiting were equally distributed between the groups, and none of the patients from either group experienced any kind of pruritus or respiratory depression in intraoperative period and sedation in the postoperative period.

**Discussion**

The principal findings of our study are that the duration of motor block and two dermatome regression time of sensory block were higher with isobaric bupivacaine. Duration of postoperative analgesia is also higher with bupivacaine and patients who received bupivacaine experienced significantly less pain in 1st 3 h of postoperative period. However, peak height of sensory block and time to reach peak block height were similar to isobaric ropivacaine and bupivacaine.

As ropivacaine is less lipophilic than bupivacaine causes relatively less motor blockade. Ropivacaine has a greater degree of motor sensory differentiation, which may be desirable especially in day care surgery.

Mantouvalou et al. and Ogun et al. found a similar cephalad extent of sensory block after isobaric bupivacaine or ropivacaine subarachnoid anesthesia. Marret et al. who compared equal doses (10 mg) of isobaric bupivacaine with the isobaric ropivacaine also found a similar range of block height. But Malinovsky et al. found a lower cephalad extent (median dermatome level T9) of anesthesia associated with less intense anesthetic blockade in the ropivacaine group, resulting in requirement of supplemental analgesia to perform surgery. This difference can be explained by use of fentanyl as adjuvant in our study which improves the quality of the block as well as the increased drug volume could have led to a higher cephalad extent of the local anesthetic solution.

In our study, we did not found any incidence of bradycardia in any patient. Though McNamee et al. in their study found 2 patients among 32 in the ropivacaine group to have bradycardia and required atropine to treat the same; they had used a higher dose of ropivacaine that is, 3.5 ml 0.5%, total of 17.5 mg. The result of our study is comparable with a study done by Koltka et al., 2009, who also did not found statistically significant difference in HR and arterial blood pressure in their study. Though McNamee et al. found intraoperative hypotension requiring treatment with ephedrine in 12% patients in ropivacaine group and 26% patients in bupivacaine group, they had used a continuous intravenous infusion of 1% propofol after giving spinal anesthesia. They also later attributed the hypotension was due to propofol infusion rather than the institution of spinal anesthesia as the incidence of hypotension started only after starting the propofol infusion.

The two dermatome regression time of sensory block in our study was significantly higher in patients who received bupivacaine. McNamee et al. didn’t measure the two dermatome regression time, but the duration of sensory block at dermatome level T10, which was significantly higher in the bupivacaine group (median 3.5 h vs. 3 h). Malinovsky et al. also found that time for two segments regression to be higher in bupivacaine when pinprick was used to measure it, but it was similar when cold swab was used for sensory block assessment.

We noted a significantly higher time to request first rescue analgesic in patients received bupivacaine and up to 1st 3 h postoperatively, VAS score was significantly lower in the bupivacaine group than ropivacaine group, suggesting that the patients who received bupivacaine-fentanyl combination experienced much lower pain for a prolonged period of time than ropivacaine-fentanyl combination.

Our findings regarding duration of analgesia and study of postoperative VAS score between these two groups in this study qualitatively correlate well with the study done by Mantouvalou et al. who found that the duration of sensory analgesia was significantly shorter in the ropivacaine group. Similar finding was reported by McNamee et al. also. They noticed that the median time to first analgesic request was significantly shorter in the ropivacaine group than in the bupivacaine group. However, median time to first analgesic request is higher in our study than what reported by McNamee et al. probably because of fentanyl used in our study. There was no significant difference in the incidence of postoperative nausea vomiting between the two groups. None of the patients from either group experienced any kind of sedation, pruritus or respiratory depression in the postoperative period.

| Table 2: Characteristics of subarachnoid block in patients of two groups, median (range) |
|-----------------------------------------------|-----------------|-----------------|--------------------------|
| Block characteristics                        | Group R (n = 37)| Group B (n = 37)| Significance |
| Peak height of sensory block                 | T7 (T4-T9)      | T7 (T4-T10)     | —            |
| Two dermatome regression time of sensory block (in min) | 85 (55-145) | 120 (80-180) | P<0.001     |
| Duration of motor block (in min)             | 150 (100-220)   | 245 (155-320)  | P<0.001     |
| Duration of effective analgesia (in min)     | 245 (140-360)   | 360 (240-445)  | P<0.001     |

*Mann-Whitney U-test*
Conclusion

Intrathecal isobaric bupivacaine-fentanyl combination produces a significantly longer duration of analgesia, sensory block and motor block than isobaric ropivacaine-fentanyl combination. As ropivacaine has a shorter duration of sensory and motor block, it may be preferred in day care surgery.

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