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Original Research Article

Intrathecal Butorphanol as Adjuvant to 0.5% Hyperbaric Bupivacaine to Enhance the Duration of Subarachnoid Blockade with Postoperative Analgesia during Orthopaedic Surgeries-A Randomized Study

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Abstract

Background: There are various anaesthesia techniques used considering the health of the patient and type of the surgery. The current study will focus on Neuraxial anaesthesia that is provided during the lower orthopaedics surgery of the patients. This is helping in blocking nociceptive impulse from the operative site of the patient and minimizes the loss of the blood. Moreover, it is helping in minimizing the incidence of deep vein thrombosis and instability. The utilization of this approach is having a significant impact on the reduction in the dosage of both drugs and support in reducing the side effects and helps in improving the perioperative analgesia particularly in comparatively prolonged orthopaedic procedures. In fact, sometimes in cases of unplanned extended surgical duration we were able to avoid conversion of regional anaesthesia to general anaesthesia due to intrathecal additive Butorphanol. According to analysis, the butorphanol is considered as synthetic lipophilic opioid analgesic that is applied for balancing the anaesthesia approach for managing the perioperative health of the patient and maintaining the stability.

Aim: To compare the efficacy and safety of intrathecal butorphanol as adjuvants to 0.5% hyperbaric bupivacaine in patients scheduled for orthopaedic surgeries.

Method: Ninety-four adult consented patients of both gender of ASA physical status I and II scheduled for elective orthopaedic surgeries under subarachnoid blockade, were analysed. All enrolled patients were divided into two groups of 47 patients each to receive either 3 ml of 0.5% hyperbaric bupivacaine (Group A) or a similar amount of bupivacaine with 0.1 ml/ 0.1 mg of butorphanol (Group B). Patients were compared for duration of sensory and motor blockade, intraoperative hemodynamic changes, time to first rescue analgesia and side effects by using Analysis of variance (ANOVA), Mann Whitney U test and chi-square test.

Results: The mean age of group A and B was 58.6 and 57.9 years and gender ratio was 28:19 and 26:21 respectively. Further, the duration of the surgery for A and B group was 149.68 mins

and 158.89 mins respectively. Noticeably the time taken for total regression of sensory block at S1(min) was higher in Group B (322.8 ± 33.75 mins) than Group A (221.7 ± 19.6 mins) and statistically significant. In addition to this, the duration of motor block was 201.36 mins for group A and it was comparatively low against the group B which was 299.58 mins and statistically significant. Moreover, the VAS>3 was also observed significantly earlier among the patients of group A. The mean time for motor block up focusing on the bromage scale 3 was 14.13 mins for the patient of group A and 13.18 mins for the group B. There was no significant difference identified among these variables.

Conclusion: Butorphanol is a useful adjuvant to intrathecal hyperbaric bupivacaine and can be considered as a standard practice for subarachnoid blockade during orthopaedic surgeries.

Keywords: Bupivacaine, Butorphanol, Orthopaedic Surgery, Subarachnoid Blockade

Background

There are different types of processes and procedures used by the health care professionals during the surgery[1]. For maintaining the good health and pain relief during surgery, the professionals are giving different types of anaesthesia to patient[2]. There are various anaesthesia used by the care staff considering the health of the patient and type of the surgery[3]. Neuraxial anaesthesia is commonly used during the lower limb orthopaedic surgery of the patients[4]. This helps in blocking nociceptive impulse from the operative site of the patient and minimizes the loss of the blood[5]. Moreover, it also helps in minimizing the incidence of deep vein thrombosis and instability. The local anaesthesia helps to increase the quality of spinal anaesthesia[6]. The conclusion and outcome of this clinical study will be helpful for recommending the butorphanol as a standard additive to regional anaesthesia[7].

The spinal anaesthesia is having small mass of drugs that helping in systematic pharmacologic effects to minimize the instability and blocking of impedes effects for safe surgery[8]. According to clinical research, the effects are proportional to the level of sympathetic blockade and helping in intrathecal adjuvants, opioids. The utilization of this approach is having a significant impact on the reduction in the dosage of both drugs and support in reducing the side effects and helps in improving the perioperative analgesia[9]. According to analysis, the butorphanol is considered as synthetic lipophilic opioid analgesic that applied for balancing the anaesthetic approach for managing the health of the patient and maintaining the stability[10]. There were various studies done on this topic, but the limited information is provided related to the clinical characteristics of butorphanol[11]. Therefore, consideration of current study will be helpful for understanding the efficiency and safety of butorphanol and comparing the outcome with the 0.05% hyperbaric bupivacaine used on different types of patients during the orthopaedic surgeries[12].

Aim

To compare the efficacy and safety of intrathecal butorphanol as adjuvants to 0.5% hyperbaric bupivacaine in patients scheduled for orthopaedic surgeries.

Method and material

The present study was a randomised controlled trial conducted in a tertiary care hospital, after approval of the ethical committee and collecting the consent from a total of 94 ASA 1 & 2 patients aged

between 18 to 65 years, of both genders and scheduled for various orthopaedic surgeries under spinal anaesthesia. Patients with cardio-respiratory disease, hepatic or renal disease, CNS or endocrine disorder, and pregnancy were excluded. For conducting the study, the patients were categorised in two different groups based on a computer-generated randomisation table. Group A received 3 ml 0.5% hyperbaric bupivacaine and Group B received 0.1ml (0.1 mg) butorphanol with 3 ml 0.5% hyperbaric bupivacaine. An anaesthesiologist performed the subarachnoid blocks and participated in the data collection. Another anaesthesiologist who didn't participate in performing subarachnoid blocks and data collection was asked to prepare drugs under all aseptic precautions.

All patients scheduled for surgery were evaluated and those fulfilling the inclusion criteria were included and kept 6 hours fasting. During pre-anaesthetic evaluation all patients were explained about the 11-point Visual Analogue Scale (VAS) scoring system for assessment of postoperative pain. After arrival of the patient into the operation theatre, routine monitoring was conducted that involved blood pressure, heart rate, ECG and oxygen level. In addition to this, a crystalloid solution in a dose of 10 ml/kg was started. Under all aseptic conditions, subarachnoid blocks were performed at the L3-L4 intervertebral disc space with 25 G quincke's spinal needle. After subarachnoid block patients were placed in supine position immediately with a pillow under head. Onset of sensory block was defined as the time from intrathecal injection to the occurrence of sensory block at the T10 dermatome level. The maximal cephalic level of sensory blockade and the time taken to attain, was also noted. The highest level of sensory blockade was determined in the midclavicular line by checking the insensitivity to cold alcohol swabs every two minutes till the maximum height was achieved. Sensory testing was performed at every 15 minutes interval till two segment regression of sensory block during intraoperative period.

The onset of motor blockade of the lower extremities was evaluated by observing toes movements and modified Bromage scale (0-3), if possible, at every two minutes. Definition of motor blockade according to the modified Bromage scale[13] is, 0- able to flex the whole lower limb at the hip (full motor activity), 1- able to flex the knee but unable to raise the leg at the hip, 2- able to plantar flex the ankle but unable to flex the knee, 3- no movement of lower limb (no toes movements).The onset of motor block was defined as the time from intrathecal injection to the absence of toes activity. The surgical anaesthesia was considered effective when T10 dermatome was anesthetized.

Intraoperative hemodynamic parameters of heart rate and blood pressure were recorded at every 5 min in the first hour and thereafter every 10 min until the patient was transferred to the post anaesthesia room. For the present study, hypotension was defined as a fall in systolic blood pressure of more than 25% of base line or less than 100 mm Hg and was treated with additional crystalloid solution and incremental dosages of mephenteramine 6 mg if needed. Bradycardia (heart rate <40 beats/min) was to be treated with intravenous atropine. Supplemental oxygen was administered throughout the surgery. Side effects of pruritus, nausea, vomiting, respiratory depression (respiratory rate <10 breaths/min or peripheral oxygen saturation <90%) on air or shivering was observed and managed symptomatically.

Postoperatively the sensory and motor block levels were assessed at 15 min intervals until normal sensations returned. The Time taken for total regression of sensory block at S1 level is calculated from onset of sensory block at T10 level to the return of sharp sensation from the stimulus of a blunted 18-gauge needle. Duration of analgesia was taken from onset of onset of sensory block at T10 level to time of administration of first rescue analgesic,

assessed using a 0-10 linear visual analogue scale (VAS). Rescue analgesia was given with inj. Diclofenac sodium 75 mg intravascularly when (VAS > 3).

Statistical Analysis

The results obtained at the end of study are tabulated as Mean ± SD and analysed using StatGraphics Centurion (version16.2). The demographic data for categorical variables Both groups were comparable with regards to age, weight, gender distribution, ASA grade and duration of surgery and there was no statistically significant difference between them (Table 1).

The mean values of HR, SBP (MAP would be more significant) at different time intervals were comparable among the groups and there was no significant statistical difference (table 2). Compared to baseline all patients have low HR and systolic BP but the magnitude of decrease was not significant for either group. There was no incident of hypoxia in any patient. Mean time to achieve sensory analgesia at T10 dermatome level was 4.2 mins for patients of group A and 3.6 mins for group B. The mean time for reaching the highest level of the sensory blockade has shown no statistically significant difference. The mean time for motor blockade (bromage scale 3) was 12.23 mins for patients in group A and 11.8 mins for group B. There was no significant difference among these variables.

Noticeably the time taken for total regression of sensory block at S1(min) was higher in Group B (322.8 ± 33.75 mins) than Group A (221.7 ± 19.6 mins) and statistically significant. In addition to this the duration of the motor block was 198.7 mins for group A & it was significantly low against group B which was 295.26 mins. Moreover, the VAS>3 was achieved significantly earlier among the patients of group A (Table 3).

There was no difference in incidences of pruritus, shivering, nausea and vomiting among the two groups of patients. Apart from this, four patients in Group A were needed to convert to general anaesthesia, although the incidences were not statistically significant.

Result

was compared using chi-square test and statistical significance in mean difference was done by using analysis of variance (ANOVA). The spinal blockade characteristics were compared using Mann Whitney U test. A p value of <0.05 was considered to indicate statistical significance.

Table 1: Demographic profile of patients

Parameters	Group A (Bupivacaine)	Group B (Bupivacaine + Butorphanol)
Age (years)	58.6 ± 2.8	57.9 ±4.2
Weight (kg)	66.56 ± 8.37	67.36 ±7.54
Gender M:F	28:19	26:21
ASA Grade I/II	25/22	26/21
Duration of surgery	149.68 ± 23.74	158.89 ± 26.22

Table 2: Hemodynamic parameters of heart rate and systolic blood pressure

Parameters	Heart rate (beats/min)		SBP (mm Hg)	
Groups	Group A	Group B	Group A	Group B
Preoperative	89.3 ± 8.16	92.5 ± 3.95	134.2 ± 1.92	138.5 ± 3.97
5min after SA	78.7 ± 6.34	75.3 ± 4.78	118.5 ± 2.72	117.2 ± 4.78
10 min	70.8 ± 7.21	70.5 ± 2.43	115.6 ± 3.71	117.3 ± 2.75
15 min	71.4 ± 4.28	70.2 ± 3.45	110.4 ± 2.64	114.4 ± 4.70
20 min	71.5 ± 3.45	68.6 ± 1.98	112.3 ± 1.68	112.7 ± 3.76

25 min	73.2 ± 4.67	72.4 ± 1.76	106.8 ± 1.60	111.9 ± 2.74
30 min	69.8 ± 2.38	69.7 ± 2.57	103.7 ± 3.60	107.3 ± 4.73
40 min	73.1 ± 3.47	70.2 ± 5.21	113.3 ± 4.61	109.2 ± 5.67
60 min	80.3 ± 7.61	79.6 ± 3.89	118.9 ± 2.93	108.4 ± 6.62
80 min	81.4 ± 6.36	72.4 ± 6.38	124.4 ± 1.65	110.7 ± 3.68
100 min	88.7 ± 4.93	71.3 ± 4.78	126.5 ± 1.76	110.1 ± 8.72
120	90.9 ± 5.69	74.9 ± 7.18	129.3 ± 2.67	112.5 ± 9.75
140	93.7 ± 4.93	81.4 ± 6.36	129.3 ± 2.67	122.5 ± 9.75
Postoperative	95.7 ± 4.93	91.4 ± 6.36	139.3 ± 2.67	128.4 ± 9.75

Table 3: Sensory and motor blockade profile

Parameters	Group A	Group B	P value
Onset time of Sensory block at T 10 level (min)	3.12 ± 1.7	3.25 ± 2.2	0.14
Median cephalic sensory level	T6 (T6-T8)	T6 (T6-T8)	0.88
Time taken to achieve sensory blockade at most cephalic level (min)	9.4 ± 2.7	7.43 ± 3.8	0.069
Time taken to achieve complete motor block (min)	14.13 ± 3.9	13.18 ± 2.3	0.46
Time taken for total regression of sensory block at S1(min)	221.7 ± 19.6	322.8 ± 33.75	0.001**
Duration of motor block (min)	201.36 ± 38.05	299.58 ± 41.42	0.035*
Time to administer first rescue analgesia (min)	169.7 ± 30.6	265.6 ± 19.9	0.000**

Discussion

Neuraxial anaesthesia is used during the lower limb orthopaedic surgery of the patients as it helps in blocking nociceptive impulse from the operative site of the patient and minimizes the loss of the blood. Moreover, it helps in minimizing the incidence of deep vein thrombosis and instability. The local anaesthesia helps to increase the quality of spinal anaesthesia. The butorphanol is considered as synthetic lipophilic opioid analgesic that is applied for balancing the anaesthetic approach for managing the health of the patient and maintaining the stability. Use of butorphanol as intrathecal additive to subarachnoid blocks is yet not widely studied and also the concerned literature is limited. Moreover, many times orthopaedic procedures are of longer duration requiring either epidural or general anaesthesia due to regression of subarachnoid block.

Time taken for total regression of sensory block at S1

There was a significant difference in time taken for total regression of sensory block at S1 between the two groups in the present study. It was significantly higher for group B. It was 221.7 mins for group A and 322.8 mins for group B ($p<.05$). Similar results were obtained from the studies of Singh et al (2006)[14] (25 µg of butorphanol), Kumar (2001)[15] (25 µg of butorphanol), Chari et al. (2013)[16] (25mgof butorphanol), and Basunai et al (2020)[17] (250µg of butorphanol). In all the above stated studies, time taken for total regression of sensory block at S1 was significantly higher for the butorphanol group ($p<.05$). In case of Basunai et al (2020)[17], it was 81.23 for group A and

109.83 for group B (p<.05). For Kumar et al. (2011)[15] it was 156.0 for group A and 167.0 for study group B (p<.05). For Singh et al. (2013)[14] it was 135.0 for group I and 158.0 for group II (p<.05). For Chari et al. (2013)[16] it was 104.03 for control group and 112.43 for study group (p<.05). This clearly shows that with the introduction of butorphanol, one can significantly increase the time required for a patient to have complete return of a sharp sensation from the stimulus of an 18-gauge needle. In this study, this time was higher as compared to previous studies because in the present case, a higher quantity of butorphanol was injected in the patients.

Duration of motor block

In the present study, the duration of motor block was significantly higher for the butorphanol group. It was 299.58 mins for group B and 201.36 mins for group A (p<.05). However, results of Kaur (2011)[18] (25 μg of butorphanol) were contradicted by the present study as they found no significant difference in duration of motor block between the groups (p>.05). This clearly shows that with the introduction of butorphanol, one can significantly increase the time from t = 0 until the first postoperative measurement where total motor score had returned to zero. In this study, this time was higher as compared to previous studies because in the present case, a higher quantity of butorphanol was injected in the patients.

Time to administer first rescue analgesia

It was 169.7 mins for group A and 265.6 mins for group B, showing that time to administer first rescue analgesia was significantly higher for group B (p<.05). Similar results were obtained by Kaur et al. (2011)[18[Chari et al. (2013)[16], and Basunai et al (2020)[17]. All the three studies found that time to administer first rescue analgesia was significantly higher for the butorphanol group (p<.05). This clearly shows that introduction of butorphanol significantly reduces the chances of converting the patients to GA in orthopaedic surgeries which are of longer duration as compared to other surgeries.

Onset time of Sensory block at T10 level

As per the present study, the Onset time of Sensory block at T 10 level was 3.12 mins for group A and 3.25 minutes for group B. The results showed no significant difference between the two groups in terms of Onset time of Sensory block at T 10 level (p>.05). Similar results were obtained by Basunai et al. (2020)[17] and Kaur (2011)[18]. In study by Basunai et al (2020)[17], Onset time of Sensory block at T 10 level was 3.08 for group A and 3.15 for group B (p>.05).

Highest Sensory Level

In present study, the highest sensory level was T6 for both the groups, which is similar to the studies of Basunai et al. (2020)[17] and Kumar et al (2011)[15], but different from Singh et al. (2006)[14]. In the study of Singh et al (2006)[14], the highest sensory level was T8 for the butorphanol group.

Time to Sensory Block

As per the results of the current study, group B took less time (7.43 mins) to achieve sensory block as compared to group A (9.4 mins). However, this difference was not significant (p>.05). Similar results were obtained by Singh et al (2006)[14] and Kumar (2011)[15]. For Singh et al (2006)[14] and Kumar (2001)[15], sensory block was achieved in 7.0 mins and 8.6 mins respectively for the butorphanol group.

Time to Complete Motor Block

Time to complete motor block was achieved earlier in group B as compared to group A. It was 14.13 mins in group A and 13.18 mins in group B. However, not much significant difference has been established between the two groups. Although, Chari et al. (2013)[16] also found no significant

difference in complete motor block between the two groups, in their study, complete motor block was achieved in 4.4 mins in control group and 4.3 mins in study group.

Hemodynamic Characteristics

The outcome related to the hemodynamic characteristics focusing on the preoperative of heart and systolic blood pressure and intraoperative hemodynamic variations of heart rate considering the different time intervals. According to the outcome of the data analysis, all patients have low heart rate and mean blood pressure considering the baseline values. However, the magnitude of the decrease was not significant for the patient of the butorphanol group compared to the control group. Moreover, there was no incident of hypoxia occurring in any patient. Finally, 3 patients in both the groups reported shivering and 4 patients in group A were converted to GA. Munoz et al[19] found that 74% of patients who presented with drowsiness (due to benzodiazepine premedication) and anaesthetic level above T7 had desaturation compared to only 7% of those who were awake and had lower level ($P < 0.0005$). In this study as all the cases in both the groups, the extent of block was between T10 to T8, the effect of high spinal block on respiratory system and hence on arterial oxygen saturation has been avoided.

Limitations of the Study

This study included patients undergoing orthopaedic surgeries only; gynaecology, general surgery and urological procedures were not included. The inclusion of patients from different surgical specialties would have given better comparison. Second and most important, there is no literature on standard doses of intrathecal butorphanol.

Conclusion

The main finding of the study was that the addition of 100 μg butorphanol as adjuvant to hyperbaric bupivacaine 3 mL in intrathecal route for orthopaedic surgeries provided prolonged, effective and relatively safe anaesthesia and analgesia with haemodynamic stability. Butorphanol is an easily available opioid and has a low abuse potential compared to other opioids. Thus, butorphanol may be useful as an adjuvant to intrathecal hyperbaric bupivacaine and can be considered as a standard practice for subarachnoid blockade particularly during orthopaedic surgeries.

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