Original Article

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Comparison of Dexmedetomidine and Fentanyl as Intrathecal Adjuvants to 0.5% Hyperbaric Bupivacaine for Lower Abdominal Surgery Under Subarachnoid Block

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Abstract

Background: Adjuvants to spinal anesthesia can improve anesthesia and reduce pain intra- as well postoperatively. The present study compared the efficacy of dexmedetomidine and fentanyl added to intrathecal bupivacaine in lower abdominal surgeries. **Subjects and Methods:** Patients, aged 20 to 60 years in American Society of Anesthesiologists Grade 1 and 2, scheduled to undergo lower abdominal surgeries randomly received either 0.5 ml of 5 mcg Dexmedetomidine with 2.5 ml (12.5 mg) of Bupivacaine 0.5% heavy (Group D) or 0.5 ml of 25 mcg Fentanyl with 2.5 ml (12.5 mg) of Bupivacaine 0.5% heavy (Group F). Various intra-operative parameters were noted. **Results:** Highest sensory level achieved was significantly higher for Group F as compared to that for Group D (level 8 vs level 6; p-value <0.001). Time for two-segment regression, time of sensory regression to S1, regression to Bromage 0 and time to rescue analgesia was significantly higher for Group D as compared to Group F. Time for highest sensory level and the onset of Bromage 3 were not significantly different between the two study groups. Among the hemodynamic parameters, only heart rate was found to be significantly higher in Group F 20 minutes onwards during the procedure. Other than this none of the hemodynamic parameters was significantly different between the two study groups. Also, the proportion of patients with adverse effects were similarly distributed between the two study groups. **Conclusions :** Our results indicate that Dexmedetomidine may be used as an alternative to fentanyl for intrathecal adjuvant with hyperbaric bupivacaine.

Keywords: Subarachnoid block, Intrathecal adjuvant, Dexmedetomidine, Fentanyl.

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Introduction

There are various techniques for regional anaesthesia for lower abdominal procedures, among which the subarachnoid block is a common one. It is easy to conduct, the onset of action is quicker, and additionally relaxes the muscles while maintaining an optimal situation for performing the surgery. Not only it is more economical but has fewer failure rates as well. Some agents are employed as adjuvants along with spinal anesthesia which can help in controlling pain not only during the procedure but also after the procedure.[1] Different types of adjuvants have been used in the past, for example, dexmedetomidine, clonidine, ketamine and fentanyl. Clonidine and dexmedetomidine have α_2 agonistic action, which they affect through α_2 receptors which are present both pre-synaptic as well post-synaptic.[2] Dexmedetomidine is commonly used both as anesthesia and for relieving pain. It has sedative, anxiety-relieving and pain-relieving actions, which can help spare anaesthetic agents.[3] Fentanyl is prepared synthetically from opioids and has an action on the central nervous system. It is also known for its analgesic action. It is for this reason that fentanyl is used intrathecally in addition to other local anesthetic agents, so as to prolong anesthesia as well as analgesia. Both the agents, dexmedetomidine and fentanyl are employed as adjuvants in various types of surgical procedures, in the hope that it would provide improved analgesic action, with a prolonged duration as well. The present study compared the efficacy of dexmedetomidine and fentanyl when it is added to bupivacaine intrathecally in patients who are scheduled to undergo lower abdominal surgeries.

Subjects and Methods

This randomized controlled study was performed in the Department of Anesthesia, of a tertiary care hospital over a period of one year. We included patients, from the age group of 20 till 60 years, who were scheduled for surgery and procedures of the lower abdomen. These patients were not suffering from any heart disease or respiratory ailment. Their pre-operative assessment revealed that they were in the American Society of Anesthesiologists Grade 1 and 2. We excluded patients who had known contraindications for spinal anesthesia, in hemodynamic instability, on anti-hypertensive or anti-depressants or refused consent to participate in the study. Using data from previous studies, type I error at 5% and type II error at 20%, the minimum sample size required was calculated as 28 in each study group, Group D receiving 0.5 ml of 5 mcg Dexmedetomidine with 2.5 ml (12.5 mg) of Bupivacaine 0.5% heavy or Group F 0.5 ml of 25 mcg Fentanyl with 2.5 ml (12.5 mg) of Bupivacaine 0.5% heavy. The study was approved by the Institutional Ethics Committee. The patients were requested to sign a consent form, separate from that for the surgical procedure.

The patients were examined and evaluated one day before the day of the surgery. Routine and specific investigations were ordered as deemed necessary for declaring the patient fit for surgery. On the day of surgery, hemodynamic parameters were monitored were noted. Using strict aseptic precautions, spinal anesthesia was administered in a sitting position. Lumbar puncture was done in L3-L4 space and the drug, blinded to the anaesthetist was administered. Intra-operative monitoring of the following parameters was done:

1. Vitals signs
2. Sensory block onset was calculated as the time from the administration of the anaesthetic agent till pin-prick sensation was lost at the location of the incision, tested with a 23G sterile hypodermic needle every minute until the highest level was stabilized by repeated testing.
3. Level of maximal sensory blockade: The maximum level of a sensory block obtained in the dermatomes.
4. Time of two-segment regression: Time required for regression of two segments after obtaining maximal sensory blockade.
5. Time of two-segment regression to S1: Time which was required for regression to S1 sacral segments after obtaining maximal sensory blockade.
6. The onset of Bromage 3: Motor blockade onset is the time interval between administration of the drug to the inability to raise the extended legs, flex knees, ankle and move toes.
7. Regression to Bromage 0: Indicates the duration of motor blockade. It was noted as the time interval from the time when motor paralysis sets in (according to modified Bromage scale) to the time the patient can flex the feet (great toe movement).
8. Adverse effects: like nausea, vomiting, hypotension, decrease in oxygen saturation and pruritus.

Motor block was evaluated using the modified Bromage scale;[4] Bromage 0: at this level, the patient can move the hip, knee and ankle, Bromage 1: at this level, the patient is unable to move the hip, however, the knee and ankle can be moved, Bromage 2: the patient is unable to move the hip and knee, however ankle can be moved, Bromage 3: the patient cannot move the hip, knee, and ankle. After the surgery, the pain was evaluated using the Visual Analogue Scale (VAS). Injection tramadol 50 mg intravenously was used in cases who experienced pain. The patients were transferred to the indoor ward after they recovered from the sensory and motor blocks.

Data were compiled in an excel sheet and analysed using SPSS software. Quantitative data were described as means and standard deviation and qualitative data as frequency distributions. Means were compared using student's t-test and proportions were compared using chi-squared or Fisher's exact test. A p-value less than 0.5 was considered statistically significant.

Results

The characteristics of the patients are described in [Table 1]. The mean age of patients in Group D and Group F was 34.9 ± 9.57 and 38.5 ± 8.40 years respectively. The mean weight of the patients in Group D and F were 63.1 ± 6.9 and 59.0 ± 6.93 kg respectively. The mean height of the patients in Group D and F were 165.1 ± 7.2 and 156.0 ± 11.01 cm respectively. None of these variables were significantly different between the two study groups. The comparison of block characteristics between the two study groups is described in [Table 2]. The highest sensory level achieved was significantly higher for Group F as compared to that for Group D (level 8 vs level 6; p-value <0.001). Time for two-segment regression was significantly higher for Group D as compared to Group F (110.3 ± 11.54 vs 81.5 ± 15.67 minutes; p-value <0.001). Similarly, the time of sensory regression to S1 was significantly more for Group D as compared to Group F (453.67 ± 23.26 vs 180.70 ± 18.23 minutes; p-value <0.001). Regression to Bromage 0 and time to rescue analgesia was also found to be significantly higher among patients in Group D as compared to Group F (p-value <0.001). Time for the highest sensory level and the onset of Bromage 3 were not significantly different between the two study groups. Figure 1 compares the hemodynamic parameters of the patients during the operative period. Only heart rate was found to be significantly higher in Group F 20 minutes onwards during the procedure. Other than this none of the

hemodynamic parameters was significantly different between the two study groups. In addition, the proportion of patients with adverse effects were similarly distributed between the two study groups.

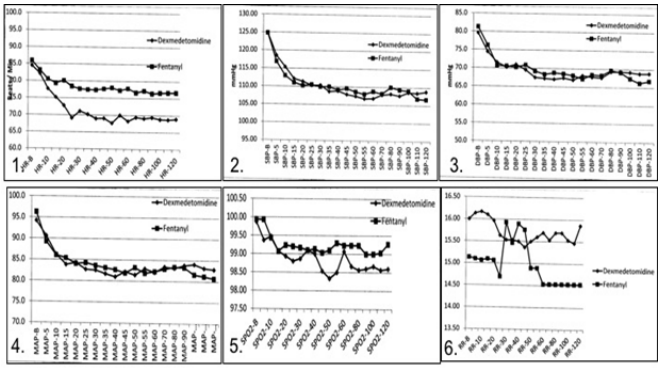

Figure 1: Comparing intra-operative hemodynamic parameters between patients receiving Dexmedetomidine and Fentanyl

1. Heart Rate (HR); 2. Systolic Blood Pressure (SBP); 3. Diastolic Blood Pressure (DBP); 4. Mean Arterial Pressure (MAP); 5. Oxygen Saturation; 6. Respiratory Rate

Discussion

Dexmedetomidine has more specific action for the α_2 receptor as compared to the α_1 receptor (200:1 for clonidine vs 1600:1 for dexmedetomidine). Its mechanism of action involves reducing the release of norepinephrine and subsequently decreased sympathetic tone through presynaptic activation of the α_2 adrenoceptors. It also helps with sedation and analgesia by attenuating the hemodynamic and neuroendocrine responses to surgical procedures.[5] On the other hand, Fentanyl is an opioid, which is lipid-soluble and acts through its agonistic action for the μ-receptor. It affects the opioid receptors which are located in the dorsal horn and also travel supraspinally.[6]

The present study compared the role of Dexmedetomidine and Fentanyl as an adjuvant to Bupivacaine in patients undergoing surgery of the lower abdomen. We included 30 patients in each of the two study groups. At baseline, patients in both the study groups were similar. Among the block characteristics, we observed that time of two-segment regression, time of sensory regression to S_1, regression time to reach Bromage 0 and time till rescue analgesia were significantly higher in patients who received dexmedetomidine as compared to those who recieved Fentanyl. Among 102 patients undergoing surgery of the lower limbs, Bajwa and colleagues compared dexmedetomidine with fentanyl. In their study, the authors observed that dexmedetomidine as an adjuvant for epidural anaesthesia as compared to fentanyl without compromising the hemodynamic characteristics of the patients. In addition, there was a quicker onset of sensory block, longer duration of postoperative analgesia, the lower requirement of local anaesthetic for epidural analgesia in the postoperative period, and much better sedation control of the patients.[7] Al-Ghanem and colleagues investigated the role of adding dexmedetomidine (5 μg) or fentanyl (25 μg) intrathecally to isobaric bupivacaine (10mg) in patients who underwent a hysterectomy and observed a longer duration of sensory and motor block with the use of dexmedetomidine as compared to fentanyl.[8] Similar observations were made by Yektas et al and Ravipati et al who observed quicker onset of the motor block with the use of dexmedetomidine as compared to fentanyl.[9,10] However, contrary to our results, Mahendru et al observed no significant differences in motor block onset between patients who received dexmedetomidine and fentanyl as adjuvants.[11] In addition, we observed the highest sensory level at T_8 in the fentanyl group and T6 in the dexmedetomidine group. Another study observed the highest sensory level at T_5 dermatome and Mahendru et al observed the highest level at the T_6 dermatome level with the use of these drugs.[10,11] Another study found that for dexmedetomidine T5 dermatome is the highest sensory level, while in the patients who received fentanyl the highest level was at T6.[12]

Intrathecal local anesthetics have been shown to decrease the mean arterial pressure and the sympathetic effect. It has been hypothesised that this happens due to the reduced flow of axonal impulses traveling through the spinal nerves.[13] Throughout the intraoperative period, we observed that the hemodynamic parameters were similar among the patients in the two study groups. Rahimzade et al comparing the addition of Dexmedetomidine and Fentanyl to intrathecal bupivacaine in lower limb orthopaedic procedures observed that changes in blood pressures and heart rate in the Fentanyl group was higher than Dexmedetomidine and saline (control) groups.[14] Ibrahim and colleagues reported a rise in the incidence of hemodynamic abnormalities, such as low pulse rate and low blood pressure in the dexmedetomidine group.[15]

The distribution of adverse effects among patients in the two groups was similar in our patient population. Intrathecal fentanyl has been known to cause pruritus, though Gupta et al did not found it to be significantly associated with fentanyl.[16] Talke et al demonstrated anti-shivering characteristics of the α_2 adrenergic agents.[17] However, we did not find any observed case of shivering in our study. Ravipati et al found pruritus in the fentanyl group, while the patients in the dexmedetomidine group reported nausea and vomiting, however the difference was not statistically significant.[10]

Table 1: Baseline characteristics of the patients included in the study

Variable	Group D	Group F	p-value
Age (in years)	34.9 ± 9.57	38.5 ± 8.40	0.08
Weight (in kg)	63.1 ± 6.9	59.0 ± 6.93	0.12
Height (in cm)	165.1 ± 7.2	156.0 ± 11.01	0.17
Gender distribution			
Females	14	17	0.14
Males	16	13	

Table 2: Comparing block characteristics among patients in the two groups

Variable	Group D	Group F	p-value
Time for highest sensory level (minutes)	6.37 ± 1.06	6.52 ± 1.90	0.70
Highest sensory level achieved	6 (range 4-8)	8 (range 6-10)	<0.001
Time of two-segment regression (minutes)	110.3 ± 11.54	81.5 ± 15.67	<0.001
Time of sensory regression to S_1 (minutes)	453.67 ± 23.26	180.70 ± 18.23	<0.001
The onset of Bromage 3 (minutes)	5.71 ± 1.36	5.50 ± 2.35	0.69
Regression to Bromage 0 (minutes)	407.53 ± 18.91	149.37 ± 12.49	<0.001
Time to rescue analgesia (minutes)	231.93 ± 17.83	160.13 ± 15.51	<0.001

Table 3: Comparing the occurrence of adverse effects in the two study groups

Adverse effect	Group D (n=30)	Group F (n=30)	p-value
Nausea	01	02	1.00
Vomiting	04	01	0.35
Pruritus	00	03	0.23
Bradycardia	02	03	1.00
Hypotension	05	09	0.22
The decrease in oxygen saturation	00	00	NA
Shivering	01	00	1.00

Conclusion

Our results suggest that dexmedetomidine results in a higher quality of sensory block when it comes to the level of sensory block achieved, two-segment regression and time of regression to S1. In addition, a longer motor block was obtained as well. The patients were observed to be hemodynamically stable and the adverse effect profile of patients in either of the drug groups was comparable. Looking at the encouraging results, it appears Dexmedetomidine can be employed instead of fentanyl as an adjuvant to be used intrathecally with hyperbaric bupivacaine.

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