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THE COMPARISON OF EFFECTIVENESS OF DIFFERENT DOSES OF FENTANYL ADDED TO HYPERBARIC BUPIVACAINE FOR SPINAL ANAESTHESIA IN EMERGENCY APPENDECTOMY

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ARTICLE INFO | **ABSTRACT** | **ORIGINAL RESEARCH ARTICLE**

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Introduction: General anaesthesia is associated with a greater risk from airway mishaps, gastric aspiration and higher postoperative morbidity and mortality. Spinal anaesthesia is similar to a nerve or plexus block method of eliminating pain sensation in a region of the body.

Objectives: To evaluate the effects of intrathecally administered fentanyl on the onset and duration of hyperbaric bupivacaine induced sensory and motor spinal block and to determine the most suitable dose combination of fentanyl to local anaesthesia.

Methodology: 120 patients who met the inclusion criteria were enrolled for the study and randomly divided into 4 groups after obtaining an informed written consent. Group A (3ml of 0.5% hyperbaric bupivacaine + 0.6ml of normal saline), Group B (3ml of 0.5% hyperbaric bupivacaine + 10µg of fentanyl (0.2ml) + 0.4ml of normal saline), Group C (3ml of 0.5% hyperbaric bupivacaine + 20µg of fentanyl (0.4ml) + 0.2ml of normal saline) and Group D (3ml of 0.5% hyperbaric bupivacaine + 30µg of fentanyl (0.6ml)). The patients were then assessed for onset and duration of sensory block, side effects (nausea, vomiting, shivering) along with post-operative pain.

Results: There was no significant difference in ASA and nausea/vomiting except in shivering, rescue analgesia and pain free period. The duration of pain free period was longer in Group D. Group A had the highest incidence of Nausea/vomiting. The Group C (2.22±2.11hrs) patients required longer duration for sensory regression of two dermatomes whereas Group A (1.49±0.01hrs) had shorter duration for sensory regression of two dermatomes.

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Conclusion: Addition of fentanyl 10µg, 20µg and 30µg to bupivacaine in spinal block for appendectomy provided excellent surgical anaesthesia, prolonged the duration of spinal anaesthesia with lesser incidences of side effects.

INTRODUCTION:

General anesthesia has been associated with greater risk of airway mishaps, gastric aspiration, and higher postoperative morbidity and mortality. Regional anesthesia has been considered safer in this prospect for abdominal surgeries. Spinal anesthesia, because of its simplicity of technique has supplanted epidural anesthesia along with rapid onset and dense neural blockade, and also with negligible risk of aspiration.[1,2]

The spinal anesthetic may affect not only the targeted nerve system but neighboring spinal nerves as well. For its purposes, spinal anesthesia can be a highly effective alternative to a general anesthetic for an emergency appendectomy. However, side effects like severe headaches, post-operative pain are not uncommon. Post-operative pain is also associated with several physiological responses. In addition to the distress and discomfort, acute pain elicits a consistent and well defined metabolic response involving the release of various neuroendocrine hormones that lead to a myriad of detrimental effects.[3] The stress hormones released in pain cause an increase in heart rate, respiratory rate, myocardial oxygen demand, hypertension, arrhythmias and may lead to myocardial ischaemia.[4] All these factors bear adverse prognosis in post-operative recovery and increase in morbidity and postoperative hospital stay.

Adequate postoperative analgesia is associated with less physiological derangement and better as well as quicker recovery and ambulation. Nowadays there are various drugs and devices available ranging from non-steroidal anti-inflammatory drugs (NSAID), opioids, epidural and spinal analgesia, patient-controlled analgesia, local anesthetics and regional or peripheral nerve blocks which can be used to manage post-operative pain effectively.[5]

Subarachnoid block is one of the popular modes of anesthesia for lower abdominal surgeries. The number of adjuvants has been added to prolong the effects of the spinal anesthesia by dense motor and sensory blockade with less hemodynamic changes and minimal side effects. Bupivacaine has satisfactory sensory and motor blockade but its duration of action is limited, so the use of an adjuvant is required. Fentanyl offers benefit in terms of faster onset of action, maximum sensory blockade and prolonged the duration of action.[6]

The objective of this study is to evaluate the effects of intrathecally administered fentanyl on the onset and duration of hyperbaric bupivacaine-induced sensory and motor spinal block, quality of intraoperative surgical anesthesia and the requirements of analgesia during the early postoperative period and to determine the most suitable dose combination of fentanyl to local anesthesia which would produce excellent surgical anesthesia, postoperative analgesia and minimal side effects to the patient.

MATERIALS AND METHODS:

120 adult patients of ASA physical status I and II undergoing emergency appendectomy under spinal anesthesia were enrolled for this study. A double-blind randomized control trial design was adopted for this study. Patients who refused for spinal anesthesia, had ASA III or more, unexpected or excessive bleeding leading to hemodynamic instability requiring transfusion, patients with cardiac disease, appendicular mass or lump, and impending appendicular perforation were excluded from the study. Informed consent was

obtained from the patients willing to participate in the study. The patients have then divided randomly into 4 groups with 30 patients each using a sealed envelope technique. **Group A (Control Group)** received 3ml of 0.5% hyperbaric bupivacaine + 0.6ml of normal saline. **Group B** received 3ml of 0.5% hyperbaric bupivacaine + 10µg of fentanyl (0.2ml) + 0.4ml of normal saline. **Group C** received 3ml of 0.5% hyperbaric bupivacaine + 20µg of fentanyl (0.4ml) + 0.2ml of normal saline. **Group D** received 3ml of 0.5% hyperbaric bupivacaine + 30µg of fentanyl (0.6ml)

Procedure:

After a thorough pre-operative check-up, the patient was shifted to the operating room and NIBP cuff, ECG leads and pulse oximetry probe was attached to the patient and baseline blood pressure (NIBP), respiratory rate (RR), heart rate and Spo2 were recorded. A peripheral vein on the dorsum of non-dominant hand was cannulated for administration of IV fluid with 16 G cannula and patients received IV pre-hydration with 15ml/kg ringer's lactate solution.

With the patient in lateral position under all aseptic precautions, a 25 Gauge Quincke's needle was inserted at L3-4 or L4-5 space and the study drugs were injected as per group of the patient. After noting the time of injection, the patient was placed immediately in a supine position. Systolic, diastolic, and mean arterial pressures, heart rate, SpO2, and respiratory rate were recorded at 2.5 minutes' interval for the first 15 minutes and 5 minutes' interval thereafter till the completion of the surgery. The onset and duration of sensory block were assessed by pinprick method and time taken from intrathecal injection to the highest level of sensory block and sensory regression of two dermatomes were recorded. The onset and duration of motor block were noted. Grading of motor block was done as per scale Bromage.[7] Pain was evaluated using a standard 10cm linear visual analog scale (VAS). The duration of complete analgesia (time from subarachnoid injection to first reports of pain) and effective analgesia (time from subarachnoid injection to the first dose of rescue analgesia) were recorded. On VAS score, if it is < 4, doesn't require analgesic, if it is 4 and above, inj. Diclofenac 75mg IM as rescue analgesia was given. The number of rescue analgesic require in the first 12 hours were noted.

Other side effects i.e. pruritus, nausea, vomiting, shivering, sweating, faintness, discomfort were noted. The surgeon score on 3 points scale was noted. Pruritus was assessed as mild, moderate and severe.[8] Nausea and vomiting was rated on a scale of 0 to 3.[9] Shivering was graded using a scale that was validated by Tsai and Chu.[10]

The data collected were entered into excel software and mean, percentages were calculated by analyzing on SPSS software version 10 for windows. The appropriate statistical tool and technique were used to identify the significance of the variables depending upon the nature of the data collected. Independent z- test for continuous variables and chi-square and proportion test for a discrete variable was used and the "p" value was calculated. The "p" value less than 0.05 was considered as statistically significant.

RESULTS:

The socio-demographic characteristics of the four groups are reported in Table 1.

Table 1: Socio-demographic characteristics

Variable	Groups mean ± SD				P-value
	A	B	C	D	
Age (yrs)	29.13± 9.864	29.97± 9.536	29.97± 8.512	31.47 ± 11.569	0.835
Female	18	19	13	18	0.394

Male	12	11	17	12	0.394
Weight (kg)	53.9±92 75	54.5 ± 10.52	59.77 ± 8.605	57.33 ± 7.984	0.053

The complications and physical status of patients during operation are reported in Table 2. 10 subjects of Group A had the incidence of Nausea/vomiting which was highest in number when compared with other groups. The duration of the pain-free period was longer in Group D when compared with other groups whereas the shorter duration of pain-free period was observed in Group A. There was no significant difference in ASA and nausea/vomiting except in shivering, rescue analgesia and pain-free period.

Table 2: Complications and physical status of patients during operation

Variable		Groups mean ± SD				P-value
		A	B	C	D	
ASA I		30	29	30	30	0.388
ASA II		0	1	0	0	
Nausea/Vomiting	No	20	24	26	28	0.049*
	Yes	10	6	4	2	
Shivering	No	18	24	26	28	0.009*
	Yes	12	6	4	2	
Rescue analgesia	1	0	0	19	30	<0.001*
	2	30	30	11	0	
Pain_free period in (hrs)		1.9157± 0.28312	3.7767 ± 0.3656	6.6883 ± 0.5156	9.974 ± 0.5898	0.000 *

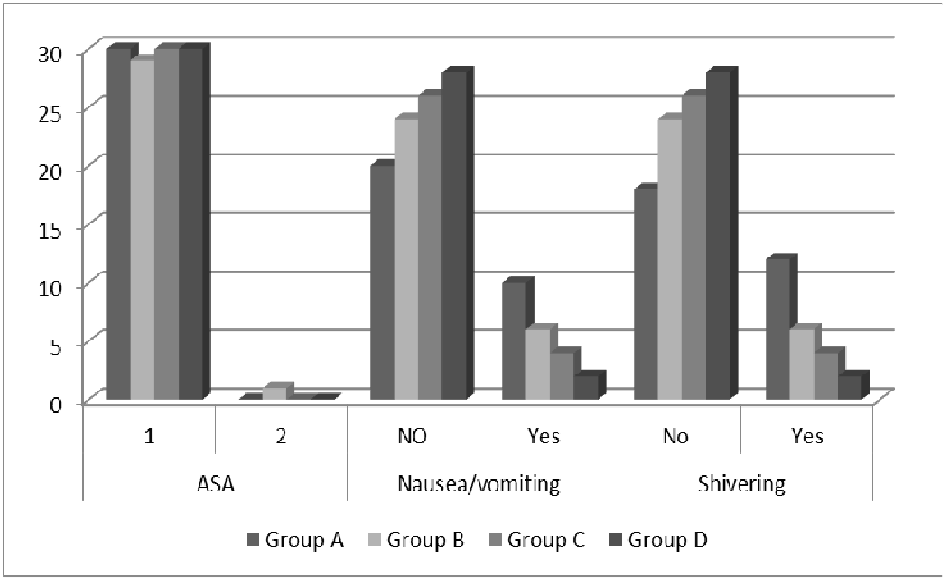

Fig 1: Graphical representation of physical status and complications

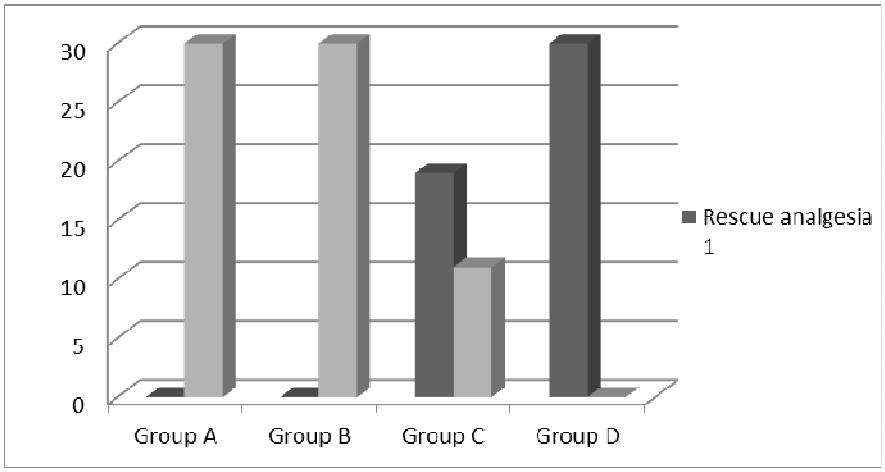

Fig 2: Comparison of rescue analgesia between groups

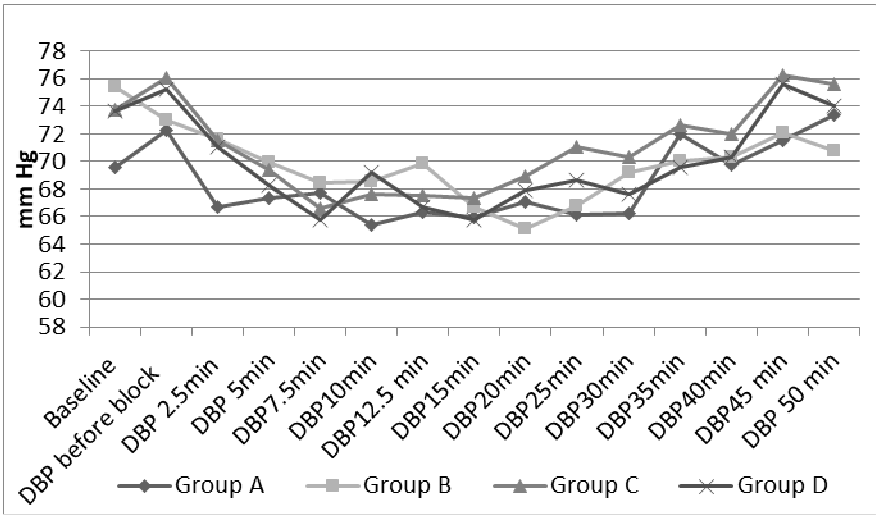

Fig 3: Graphical representation of DBP among groups all time intraoperative

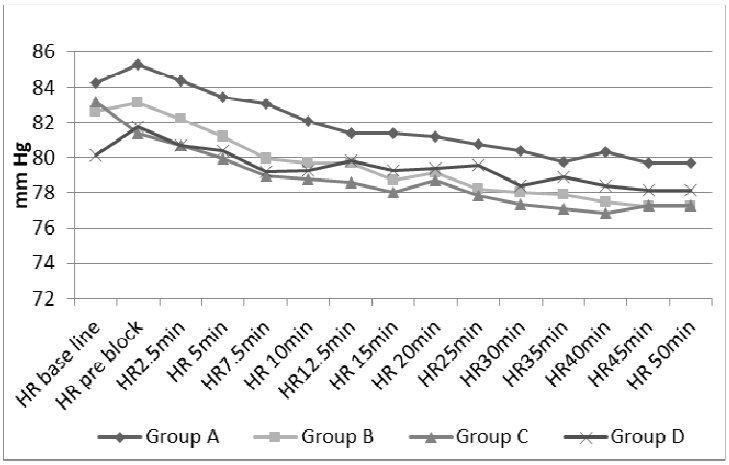

Fig 4: Graphical representation of heart rate among groups all time intraoperative

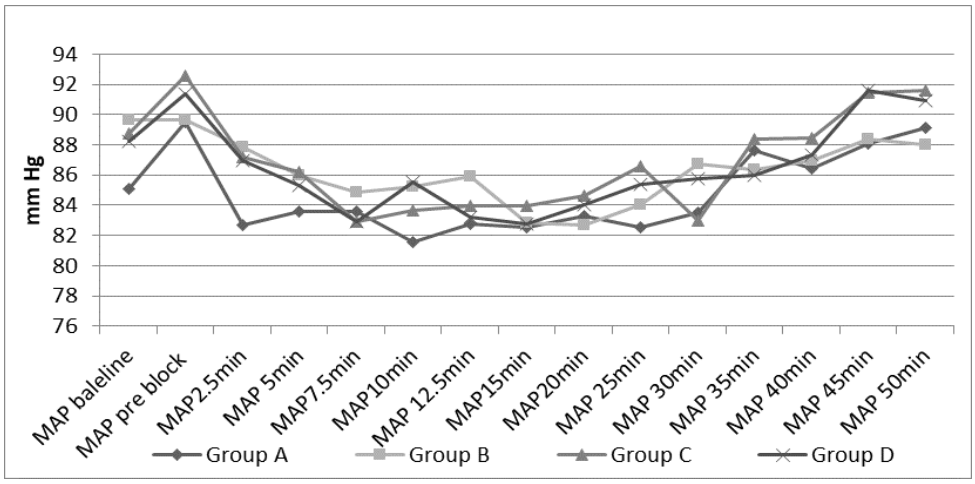

Fig 5: Graphical representation of MAP among groups all time intraoperative

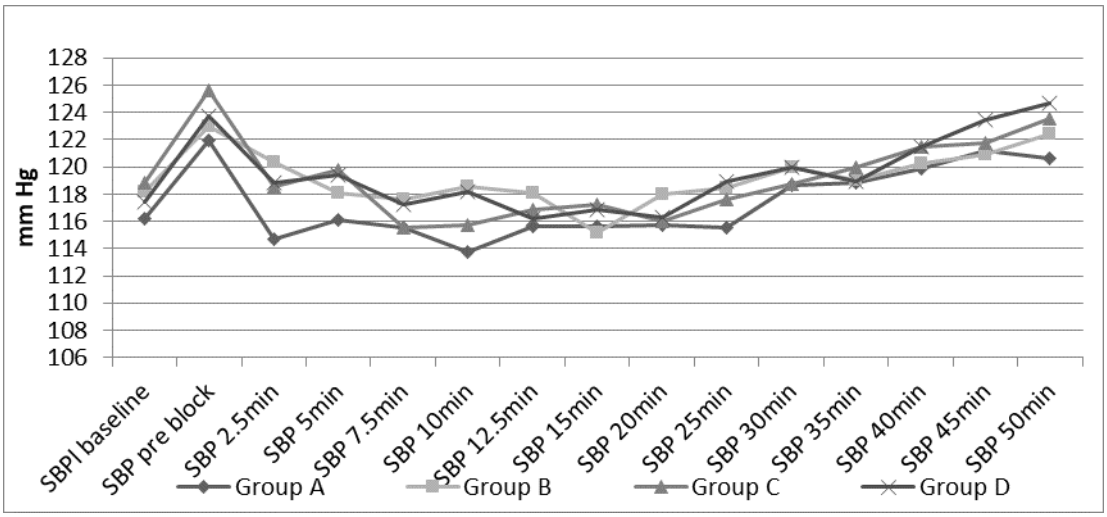

Fig 6: Graphical representation of SBP among groups all time intraoperative

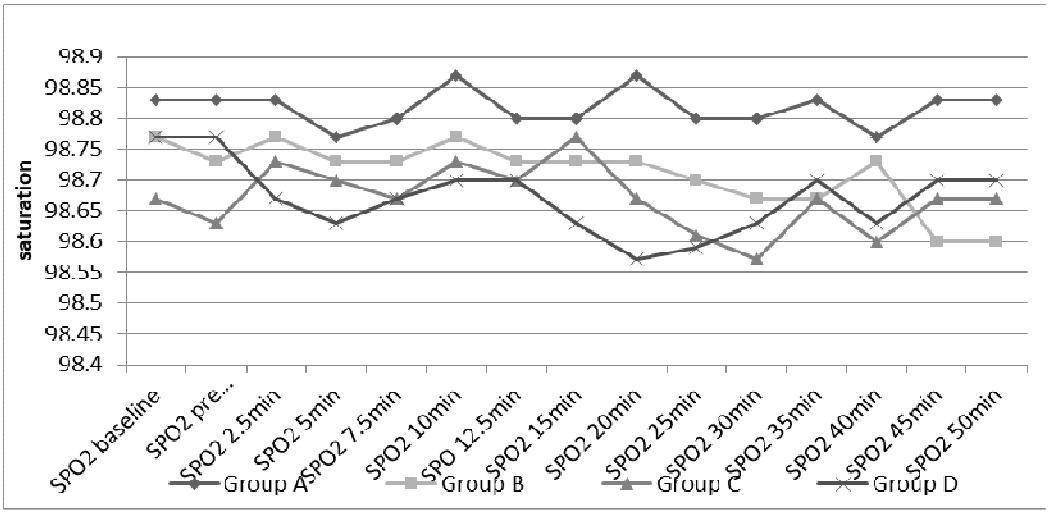

Fig 7: Graphical representation of SpO2 among groups all time intraoperative

The time taken for sensory regression of two dermatomes from the highest level of sensory block were 1.49±0.0137 hours, 1.74±0.26 hours, 2.22±2.11 hours and 2.21±0.038 hours in Group A, Group B, Group C and Group D respectively. The Group C (2.22±2.11hrs) patients required longer duration for sensory regression of two dermatomes whereas Group A (1.49±0.01hrs) had shorter duration for sensory regression of two dermatomes. There was significant difference in Time segment and VAS in all four groups (p=0.001). The quality of muscle relaxation produced during spinal anaesthesia was scaled as surgeon score, were 2.97±0.183, 2.97±0.183, 3.00±0.00 and 3.00±0.00 in Group A, Group B, Group C and Group D respectively which was statistically non-significant.

Variables	Groups mean ± SD				P-value
	A	B	C	D	
Surgeon _ score	2.97±0.183	2.97±0.183	3.00±0.00	3.00±0.00	0.574
2 segment regression time	1.49±0.0137	1.74±0.26	2.22±2.11	2.21±0.038	0.001*
VAS	5.00±0.00	5.03±0.18	5.40±0.49	5.70±0.46	0.001*

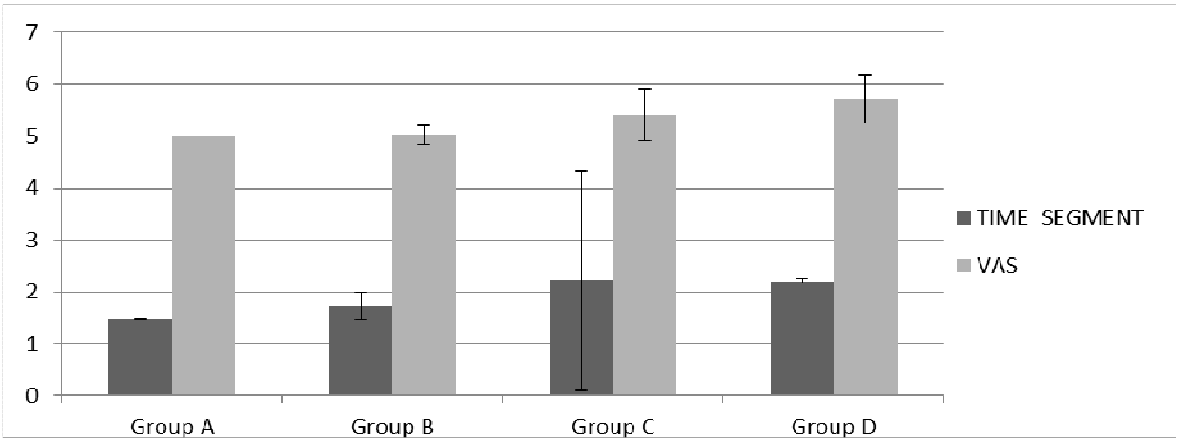

Fig 8: Graphical representation of a comparison of time segment and VAS between groups all time intraoperative

DISCUSSION

Due to its unpleasant nature and associated adverse consequences, post-operative pain has remained a concern for practicing clinicians despite development and advances in various newer techniques and modalities for its management.[3,4] Regional block has gained popularity due to their effectiveness and better patient satisfaction particularly in patients with pain due to trauma or surgeries involving lower extremities and abdomen.

In our study, the two-segment regression was significantly prolonged in fentanyl added groups than the non-fentanyl added group. Our finding was similar to the study carried by Anchalee Techanivate et al[11] in terms of prolonged time taken for two-segment regression. Although in his study the number segments regressed in fentanyl added groups were at 60 mins whereas in our fentanyl

added group it was approximately two hours. The most prolonged duration was observed in Group C (2.22±2.11hrs) and Group D patients (2.21±0.03hrs). The mechanism responsible for the longer duration of sensory blockade in fentanyl added groups might be co-administration of fentanyl and the local anesthetic synergistic inhibitory action of these two agents on A-gamma and C- fiber conduction.

Our study concluded that the time to first required postoperative analgesics was significantly prolonged in fentanyl added groups than the non-fentanyl added group. In a study conducted by Dr. B. N. Biswas et al[8,] the duration of first required postoperative analgesia was increased with the dose of intrathecal fentanyl 12.5µg (248±11.76mins). In our study group D (9.974±0.58hrs) patients showed that duration of effective analgesia was significantly more prolonged than other groups. As fentanyl is a lipophilic opioid that is more readily eliminated from the cerebrospinal fluid than hydrophilic opioids, such as morphine.[12,13] However, lipophilic opioids, have a short duration of action. The duration of action of fentanyl may be dose-dependent.[14,15] Hunt et al[16] reported that the addition of fentanyl ≥ 6.25µg (6.25, 12.5, 25, 37 and 50µg) to hyperbaric bupivacaine was shown to reduce intraoperative opioid supplement IV from 67% to 0% and provide postoperative analgesia of 3-4 hrs in patients who underwent cesarean delivery under spinal anesthesia.[16] Dahlgren et al[17] also reported that fentanyl 10µg added in hyperbaric bupivacaine spinal block produced complete analgesia and increased the duration of analgesia in the early postoperative period compared to placebo.[17] In our study, the addition of 30µg fentanyl to bupivacaine in the spinal block for appendectomy provided excellent surgical anesthesia. Improved perioperative analgesia following co-administration of fentanyl and bupivacaine could be explained by a synergistic inhibitory action of these two agents on A-gamma and C-fiber conduction.[18]

In this study, it was found that the incidence of nausea/vomiting was significantly reduced in fentanyl added groups. Similar results were reported by Jaishri Bogra et al[19], who conducted a study on 120 cesarean section parturients divided into six groups, wherein the incidence of nausea and shivering reduced significantly by the addition of fentanyl. A similar study was conducted by Hunt et al, who reported the significant increase of the incidence of nausea in those patients who received 6.25µg fentanyl intrathecally but Dahlgren et al, reported that even 60µg of fentanyl when given intrathecally for a cesarean section; reduced the need for intraoperative antiemetic medication. In our study, the incidence of nausea/vomiting did not increase by adding fentanyl. Despite an adequate dermatomal level of the block for surgery, patients may experience varying degrees of visceral discomfort and nausea/vomiting, particularly during traction on abdominal viscera due to its vagotonic effects. Fentanyl might have caused the vagal inhibition which could have led to the fewer incidences of nausea and vomiting.

Our study showed the incidence of shivering was significantly reduced in fentanyl added groups. Similar findings were reported by Anchalee Techanivate et al.[11] We found that the severity of intraoperative shivering was decreased when fentanyl was added to intrathecal bupivacaine. Alfousi et al.[20] reported that intravenous fentanyl 1.7µg/kg is about 77% effective in the treatment of postoperative shivering in patients who underwent abdominal or orthopedic surgery.[20] Wheelahan et al[21] reported that adding epidural fentanyl to epidural lidocaine decreases the shivering threshold compared with epidural lidocaine alone.[52] The spinal cord makes a major contribution to afferent thermal input and also it involves the integration of thermal input.[21] The reduction of shivering may be attributable to the effect of fentanyl that was

added into the subarachnoid space on the thermoregulator.

Surgeon's score for the quality of muscle relaxation produced during spinal anesthesia was 2.97±0.183, 2.97±0.183, 3.00±0.00 and 3.00±0.00 in Group A, Group B, Group C and Group D respectively, which were very much satisfied with the quality of muscle relaxation produced in all four groups.

CONCLUSION:

Thus, our study has shown that the addition of fentanyl 10µg, 20µg, and 30µg to bupivacaine in a spinal block for appendectomy provided excellent surgical anesthesia, prolonged the duration of spinal anesthesia, delayed the analgesics requirement in the early postoperative period and less incidence of side effects.

CONFLICT OF INTEREST:

The authors declare no financial support or potential conflict of interest.

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