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Original Article

Comparative Study between Ropivacaine and Ropivacaine Plus Fentanyl for Spinal Anesthesia

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Abstract

Introduction: Spinal anesthesia is preferred over general anesthesia due to the ease of administration, minimal systemic effects, and reduced post-operative morbidity. A number of anesthetic agents and adjuvants have been tried over the years, to achieve optimal effects. This study compares the efficacy of ropivacaine versus ropivacaine plus fentanyl as spinal anesthetics.

Materials and Methods: This study was carried out on 100 American Society of Anaesthesiologists Grades I and II patients, having no comorbidities and scheduled for surgery of up to 200 min. They were randomly divided into two Groups: Group I (Ropivacaine) and Group II (Ropivacaine and Fentanyl). Intraoperative and post-operative vitals, analgesic parameters, and side effects were monitored.

Results: The onset of both sensory and motor blockade was faster, and the duration of the blockade was longer with the addition of fentanyl to ropivacaine. Ropivacaine is a safe drug in terms of cardiorespiratory stability and other side effects. The addition of fentanyl did not alter the beneficial side effect profile of ropivacaine.

Conclusion: Ropivacaine is a safe anesthetic in terms of cardiorespiratory stability and side effects. The addition of fentanyl to ropivacaine significantly potentiates the block, both sensory and motor, without altering the beneficial effects of cardiorespiratory stability and side effect profile.

Key words: Fentanyl, Motor blockade, Pruritus, Ropivacaine, Sensory blockade, Spinal anesthesia, Two-segment regression

INTRODUCTION

Cerebrospinal fluid (CSF) was discovered by Demenico Cotugno in 1764 and its circulation was described F. Magendie in 1825.[1] J. Leonard Corning 1885, a neurologist injected cocaine in between two spinous processes and found to have sensory as well as motor blockade in the dog.[2]

Spinal anesthesia was introduced for the 1st time in clinical practice by German Surgeon August Karl Gustav Bier in 1898. He performed a lumbar puncture as described by Quincke (1891) and injected 3 cc of 0.5% cocaine into the spinal theca on himself. Tuffier in 1899 was the first one to try cocaine intrathecally to relieve the pain of the leg in the young man.[3] The first drug used for local anesthesia was cocaine in 1855.

Since then, a number of drugs have been tried in the zest to achieve optimal anesthesia. Identification of specific opiate receptors in the cord was a breakthrough. Yaksh and Rudy[4] were the first to report the intrathecal administration of morphine in 1976.

Spinal anesthesia has passed through phases of overly enthusiastic acceptance followed by phases of complete rejection; each phase frequently being based more on emotional reaction and clinical impression rather than on scientific observation. It is less frequently practiced in western countries due to the introduction of neuromuscular blocking agents and newer inhalation anesthetic agents. However, in our country, it is used commonly for many surgical procedures below the umbilicus. Particularly, in rural areas, it is preferable and economical to use spinal anesthesia as there is a lack of sophisticated anesthetic equipment, drugs, and compressed anesthetic gases to administer general anesthesia. Spinal anesthesia has maintained its

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popularity because it provides profound muscle relaxation, decreases operative blood loss, and causes minimal systemic effects if executed cautiously. At the same time, improvement in the technique and supportive management have lessened the incidence of complications.

The subarachnoid block requires minimal pre-operative preparation and is safe and satisfactory if performed with the knowledge of its physiological consequences. In many instances, a subarachnoid spinal block is the choice in the best interest of the patient and provides ideal operating conditions for the surgeon.

Solutions for spinal anesthesia can be classified as hyperbaric, isobaric, or hypobaric depending on their density in relation to CSF. Bupivacaine has been a standard agent for spinal anesthesia for a long time, which like all amide anesthetics has been associated with cardiotoxicity when used in high concentration or accidental intravascular injection. Ropivacaine is a long-acting regional anesthetic structurally related to bupivacaine developed for the purpose of reducing potential toxicity and improving relative sensory and motor block profiles.

In the present study, the efficacy of intrathecal isobaric ropivacaine was compared with ropivacaine with fentanyl for infraumbilical surgeries.

Aims and Objectives

The principal aim of this study was to determine the efficacy of 0.5% isobaric ropivacaine (17.5 mg) and compare it with 0.5% isobaric ropivacaine with fentanyl (15 mg + 10 mg) for subarachnoid block.

1. The speed of onset of sensory blockade.
2. The speed of onset of motor blockade.
3. Extent of sensory blockade.
4. Duration of action of motor blockade.
5. Two segment regression.
6. To compare the incidence of cardiorespiratory changes, if any.
7. To compare the incidence of side effects of both drugs if any.

MATERIALS AND METHODS

This study was undertaken after approval from the Hospital Ethical Committee. This was a randomized, double-blind, non-crossover type interventional study carried out in Padmashree Dr. D. Y. Patil Medical College, Hospital and Research Centre, Pune, on American Society of Anaesthesiologists (ASA) Grades I and II patients of 18–60 years of age, of either gender, weighing 40–80 kg, having height of 140–170 cm and scheduled for surgery of up to 200 min. However, the patients refusing to participate, having spine deformity, neurological deficiency, deranged coagulation profile, local skin infection, history of drug abuse, or opioid-tolerant patients were excluded from the study. A total of 100 patients (as per Figure 1) scheduled to undergo elective arthroscopy and anterior cruciate ligament (ACL) repair surgeries, lower abdominal surgeries as hernia, gynecology surgeries such as vaginal hysterectomy, total abdominal hysterectomy, and urological surgeries, were enrolled in this study. A written, informed, and signed consent was obtained from all the participants.

Detailed history, clinical examination, and relevant investigations were done. Patients were asked to remain nil by mouth overnight. Preoperatively pulse rate, blood pressure, respiratory rate, and SpO2 were recorded. No premedication was given. Preloading was done. Patients were randomly divided into two groups of 50 each:

- Group I: Received intrathecal 0.5% isobaric ropivacaine (17.5 mg).
- Group II: Received intrathecal 0.5% isobaric ropivacaine (15 mg) mixed with 10 mcg fentanyl.

Accordingly, spinal anesthesia was given. The adequate level of spinal anesthesia was achieved. Intraoperatively no sedation or analgesia was given to any of the patients.

During surgery, patients were monitored with basic monitoring devices electrocardiography, pulse oximeter, and NIBP monitor. Any episode of intraoperative hypotension was treated with fluid administration, head low position, and small bolus of injection ephedrine if required. Supplemental oxygen was given only if indicated. Any episode of bradycardia intraoperatively was treated with injection atropine.

Following parameters were assessed.

1. Pre-spinal hemodynamic baseline or 0 mins parameters.
   a. Heart rate
   b. Blood pressure
   c. Oxygen saturation
2. Intraoperative hemodynamic at 5, 10, 15, 30, 45, 60, 75, 90, 105, 120, and 150 min.
3. Post-operative hemodynamics up to 24 h.
4. Total duration of surgery.
5. Onset of sensory analgesia taken as loss of pin-prick sensation at dorsum of foot.
6. Level of the sensory blockade achieved in minutes.
7. Duration of motor blockade according to Bromage scale.
8. Two segments dermatomal regression level of sensory block.
9. Any adverse effects – neurological changes such as motor and sensory deficits, bowel and bladder dysfunction were checked before discharge.

Assessment of Motor Blockade

This was assessed by Bromage scale. The time interval between injection of the drug into subarachnoid space to the patient's inability to lift the straight extended leg was taken as onset time. Duration of motor block was recorded from onset time to time when the patient was able to lift the extended leg.

Bromage scale[5]

- 0 – Full flexion of knees and feet.
- 1 – Just able to flex knees, full flexion of feet.
- 2 – Unable to flex knees, but some flexion of feet possible.
- 3 – Unable to move legs or feet.

Bromage index for the degree of block

- I – no block (scale 0)
- II – partial block (scale 1)
- III – almost complete block (scale 2)
- IV – complete block (scale 3).

Statistical Analysis

Data were analyzed by SPSS. *P*-value was calculated using the Z-test. $P < 0.05$ was considered as significant.

RESULTS

Both the groups were comparable in terms of mean age, gender, mean height, mean weight, ASA grades, and duration of surgery as there was no statistically significant difference. The hemodynamics (heart rate, systolic, and diastolic BP), respiratory rate, and oxygen saturation (SpO2) were almost same throughout the study in both the groups (measured at 5 min interval till 15 min, 15 min interval till 120 min, 30 min interval till 270 min, and 60 min interval till 480 min) and there was no statistically significant difference ($P > 0.05$). The onset of sensory blockade was significantly earlier in Group II as compared to Group I. The peak sensory blockade was achieved much earlier in Group II than in Group I and this was statistically significant [Table 1]. Similarly, the motor blockade had a delayed start and a short lasting effect in Group I than in Group II, which was statistically significant [Table 2]. The two-segment regression time (sensory) was earlier in Group I than in Group II, and it was statistically significant [Table 3]. There was a single incidence of pruritus in Group II. However, it was not statistically significant ($P > 0.05$). No other side effects were observed.

Table 1: Comparison of onset and peak sensory blockade in the study groups

Sensory blockade (min)	Mean±SD (*n*=50)		*P*	Significance
	Group I	Group II		
Onset	3.84±0.47	3.27±0.52	<0.0001	Significant
Peak	6.15±0.59	3.92±0.49	<0.0001	Significant

SD: Standard deviation

Table 2: Comparison of onset and recovery of motor block in the study groups

Parameter	Mean±SD (*n*=50)		*P*	Significance
	Group I	Group II		
Onset motor (min)	5.22±0.52	3.61±0.47	<0.0001	Significant
Complete motor recovery (min)	134.6±10.39	165.4±11.30	<0.0001	Significant

SD: Standard deviation

Table 3: Comparison of two-segment regression time (sensory) in study groups

Parameter	Mean±SD (*n*=50)		*P*	Significance
	Group I	Group II		
Two-segment regression time (sensory) (min)	67.28±7.96	75.38±7.83	<0.0001	Significant

SD: Standard deviation

DISCUSSION

Spinal/regional anesthesia is preferred over general anesthesia,[6] as the adrenergic responses and the neuroendocrine changes occurring in response to surgical stress are minimal under spinal anesthesia. A survey of anesthetists in Scotland[7] suggested that many preferred intradural block in the presence of pulmonary or cardiovascular insufficiency or poor risk patients. The reason may be that it avoids the inhalation of potentially irritant vapors which may initiate coughing, laryngospasm, or bronchospasm in those who are susceptible. There is also no need for tracheal intubation which itself provides stimulation of bronchial reflexes.[8]

It is interesting to speculate on the reasons for the increased interest in spinal anesthesia. Many preferred to inject the solution extradurally, hoping thereby to avoid the common and sometimes distressing complication of spinal headache resulting from puncture of the dura mater as well as the rarer but catastrophic possibility of direct neural damage and permanent paralysis. There are now a number of reports of serious neurological complications following extradural block, showing that mere avoidance of dural puncture is no guarantee of safety, while the use of narrow gauge spinal needle has reduced the incidence of a spinal headache to acceptable levels.[8]

Various drugs such as procaine, etidocaine, tetracaine, lidocaine, and bupivacaine have been tried for spinal anesthesia. Etidocaine is twice as toxic as lidocaine,

CONSORT
TRANSPARENT REPORTING of TRIALS

CONSORT 2010 Flow Diagram

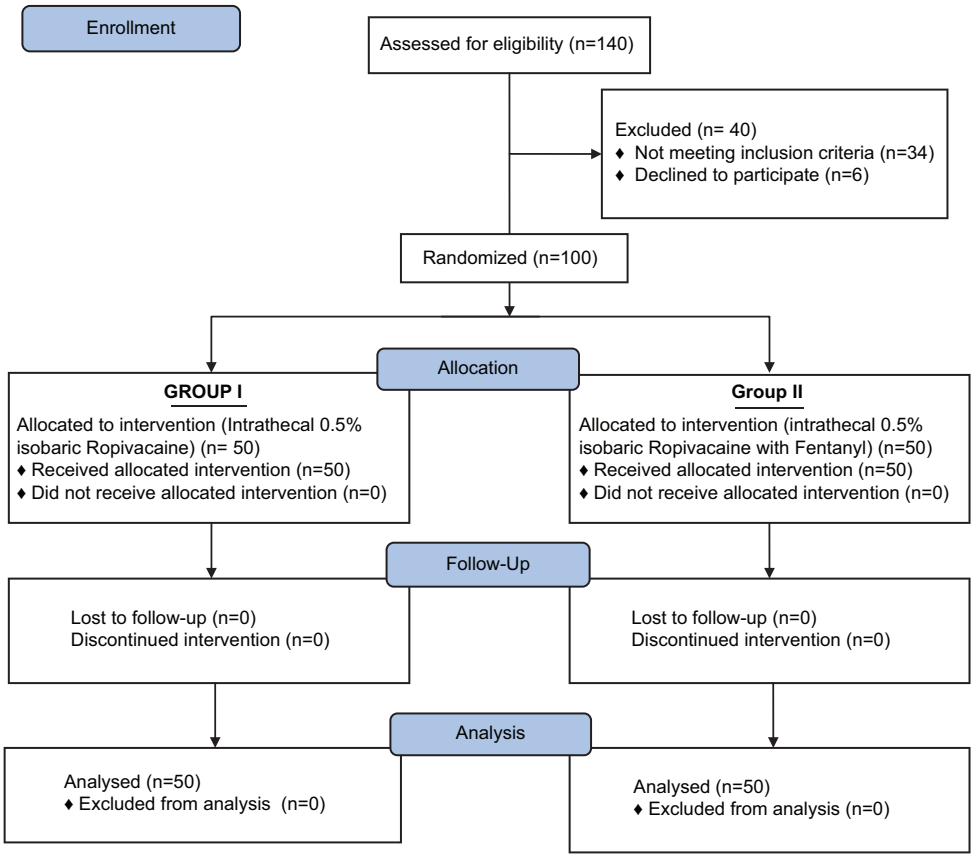

Figure 1: CONSORT 2010 Flow Diagram

tetracaine has a longer duration of action but has a narrow margin of safety, bupivacaine has a slow onset of action and the sensory and motor blockade produced by bupivacaine is often long which is not necessary for operations of short duration.[9] Thus, every drug has some disadvantage in it which prevents it from becoming an ideal agent for spinal anesthesia.[10]

Ropivacaine is a new long-acting local anesthetic drug belonging to the same class as bupivacaine and mepivacaine. Although bupivacaine and mepivacaine have been in use for more than 30 years, ropivacaine is unique. The name ropivacaine refers to both the racemate and the marketed S-enantiomer.[11] Historically, bupivacaine was used clinically as it had a long duration of action. Subsequently, it was found that "propyl" derivatives of pipecoloxylidides were less toxic than butyl derivatives (bupivacaine). Ropivacaine is a pure S (−) enantiomer, unlike bupivacaine, which is a racemate, developed for the purpose of reducing potential toxicity and improving relative sensory and motor block profiles. Cardiotoxicity of ropivacaine is less than bupivacaine as ropivacaine causes lesser depression of cardiac contractility.

Factors which are believed to influence the extent and duration of intradural spinal anesthesia include gravity and the baricity, volume, and concentration of the injected local anesthetic solution.[12] Barker, in 1907, demonstrated that hyperbaric anesthetic solutions spread rapidly under the influence of gravity and are collected in the lowest part while isobaric solutions remained localized at the site of injection.

Opioids have been commonly used as an adjuvant for spinal anesthesia. Combination of an opioid with local anesthetic reduces local anesthetic requirement, hastens the onset

of action and provides intense analgesia. However, such opioids are not devoid of side effects such as pruritus, somnolence or may be distressing such as nausea, and vomiting, or respiratory depression.[13-15]

In the present study, both the groups were comparable in terms of demographic variables, physical attributes of height and weight, ASA Grade, and duration of surgery.

Onset and Peak Sensory Block

The onset and peak of the sensory blockade were attained faster when fentanyl was added to ropivacaine, thus, suggesting that adding fentanyl might potentiate block.

The results are similar to study by Yegin *et al.*[16] where it was observed that the addition of 25 mcg added to 18 mg of hyperbaric ropivacaine in TURP significantly improved the quality and prolonged the duration of analgesia without causing a substantial increase in the frequency of major side effects.

The results were also comparable to the study conducted by Biswas and Rudra,[17] which showed that fentanyl 12.5 mg prolongs the duration of bupivacaine-induced sensory blockade (sensory regression to L1 dermatome).

The results were also comparable to the study by Akhtar *et al.*,[18] where it was observed that the onset was faster and the duration of analgesia was longer when fentanyl was added to ropivacaine.

However, it was, in contrast, to a study conducted by Boztug *et al.*[19] which concluded that 25 mcg fentanyl added to 8 mg ropivacaine provided shorter sensory blockage duration then 10 mg ropivacaine alone. Furthermore, the study by Sanli *et al.*[20] did not find any significant difference in the attainment of peak sensory action.

Administration of fentanyl intrathecally is an established method for intraoperative anesthesia and to supplement post-operative analgesia.

Two-segment Regression

The two-segment regression time was more when fentanyl was added to ropivacaine, indicating the prolonged duration of anesthesia.

The results were comparable to the study conducted by Biswas and Rudra,[17] which showed that fentanyl 12.5 mg prolonged the duration of bupivacaine-induced sensory blockade (sensory regression to L1 dermatome).

Similarly, studies by Sanli *et al.*,[20] Murali and Narsaiah,[21] and Seetharam and Bhat[22] showed that delayed regression on addition of fentanyl to ropivacaine.

Motor Block

The onset of motor block was earlier with the addition of fentanyl. Furthermore, the addition of fentanyl did prolong the duration of motor block. Thus, clearly, fentanyl potentiates the motor block induced by ropivacaine.

This was similar to the study by Akhtar *et al.*,[18] it was observed that the onset was faster and the duration of motor block was longer when fentanyl was added to ropivacaine.

This is, in contrast, to a study conducted by Boztug *et al.*[19] who evaluated the effects of low dose intrathecal isobaric ropivacaine with or without fentanyl and concluded that 25 mcg fentanyl added to 8 mg ropivacaine provided shorter motor blockage duration than 10 mg ropivacaine alone. Similarly, in the studies by Sanli *et al.*,[20] Murali and Narsaiah,[21] and Seetharam and Bhat,[22] no significant differences were seen in the onset and recovery of motor action on addition of fentanyl to ropivacaine.

Cardiorespiratory Stability

The pulse rate, blood pressure, respiratory rate, and SpO2 were almost the same throughout the study. There were minor differences between the groups, which were not statistically significant. There was no incidence of bradycardia, hypotension, or respiratory depression in any Group.

This was similar to the study by McNamee *et al.*,[23] who concluded that intrathecal ropivacaine provided a higher degree of cardiovascular stability with low incidence of bradycardia.

Similarly, Boztug *et al.*,[19] in their study of intrathecal ropivacaine versus ropivacaine plus fentanyl for out-patient arthroscopic knee surgery, postulated that none of the patients in either group had episodes of hypotension or bradycardia. Mean arterial pressure and heart rate changes were similar between the two groups.

However, in the study by Akhtar *et al.*,[18] intraoperative bradycardia was observed in 3% of patients in the ropivacaine group and the incidence of hypotension was 27% in the ropivacaine group and 10% in the ropivacaine with fentanyl group. However, it was not statistically significant. Similarly studies by Murali and Narsaiah,[21] Seetharam and Bhat[22] and Koltka *et al.*[24] reported incidences of bradycardia and hypotension.

Thus, ropivacaine is safe for spinal anesthesia in terms of cardiorespiratory stability.

Side Effects

There was one incidence of pruritus in the ropivacaine with fentanyl group. However, it was not statistically significant.

This is in contrast to the study by Akhtar *et al*.,[18] where it was observed that the onset was faster and the duration of analgesia was longer when fentanyl was added to Ropivacaine.

Similarly, Murali and Narsaiah[21] in their study reported the incidence of shivering and pruritus. The incidence of pruritus was more in the ropivacaine with fentanyl group. Seetharam and Bhat[22] also reported incidences of shivering and pruritus.

Limitations

The study was limited to the OPD attendance in indoor admission of the patients undergoing a few elective surgeries such as elective arthroscopy and ACL repair surgeries, lower abdominal surgeries as hernia, gynecology surgeries such as vaginal hysterectomy, total abdominal hysterectomy, and urological surgeries. Therefore, the results may not be generalized.

CONCLUSION

Thus, from the present study, it can be effectively concluded that ropivacaine is a safe anesthetic in terms of cardiorespiratory stability and side effects. The addition of fentanyl to ropivacaine significantly potentiates the block, both sensory, and motor, without altering the beneficial effects of cardiorespiratory stability and side effect profile.

REFERENCES

1. Herbowski L. The maze of the cerebrospinal fluid discovery. Anat Res Int 2013;2013:596027.
2. Corning JL. Spinal anaesthesia and local medication of the cord. NY Med J 1885;42:483-5.
3. Bier A. Experiments on the cocainization of the spinal cord. Dtsche Z Chir 1899;51:361-9.
4. Bernards CM. Rostral spread of epidural morphine: The expected and the unexpected. Anesthesiology 2000;92:299-301.
5. Bromage PR. A comparison of the hydrochloride and carbon dioxide salts of lidocaine and prilocaine in epidural analgesia. Acta Anaesthesiol Scand Suppl 1965;16:55-69.
6. Pflug AE, Halter JB. Effect of spinal anesthesia on adrenergic tone and the neuroendocrine responses to surgical stress in humans. Anesthesiology 1981;55:120-6.
7. Robertson DH, Lewerentz H, Holmes F. Subarachnoid spinal analgesia. A comparative survey of current practice in Scotland and Sweden. Anaesthesia 1978;33:913-23.
8. Atkinson RS. Spinal Intradural Analgesia: Recent Advances. Vol. 15. Edinburgh: Churchill-Livingstone; 1985. p. 75.
9. Adams BW. Lignocaine spinal analgesia in transurethral prostatectomy. Anaesthesia 1956;11:297-302.
10. Lund PC, Cwik JC, Vallesteros F. Bupivacaine – a new long-acting local anesthetic agent. A preliminary clinical and laboratory report. Anesth Analg 1970;49:103-14.
11. Kindler CH, Paul M, Zou H, Liu C, Winegar BD, Gray AT, *et al*. Amide local anesthetics potently inhibit the human tandem pore domain background K+ channel TASK-2 (KCNK5). J Pharmacol Exp Ther 2003;306:84-92.
12. Greene NM. Physiology of Spinal Anaesthesia. 2nd ed. Baltimore: Williams and Wilkins; 1969.
13. Bonnet F, Boico O, Rostaing S, Loriferne JF, Saada M. Clonidine-induced analgesia in postoperative patients: Epidural versus intramuscular administration. Anesthesiology 1990;72:423-7.
14. Hall JE, Uhrich TD, Ebert TJ. Sedative, analgesic and cognitive effects of clonidine infusions in humans. Br J Anaesth 2001;86:5-11.
15. Armand S, Langlade A, Boutros A, Lobjoit K, Monrigal C, Ramboatiana R, *et al*. Meta-analysis of the efficacy of extradural clonidine to relieve postoperative pain: An impossible task. Br J Anaesth 1998;81:126-34.
16. Yegin A, Sanli S, Hadimioglu N, Akbas M, Karsli B. Intrathecal fentanyl added to hyperbaric ropivacaine for transurethral resection of the prostate. Acta Anaesthesiol Scand 2005;49:401-5.
17. Biswas BN, Rudra A. Intrathecal fentanyl with hyperbaric bupivacaine improves analgesia during caesarean delivery and in early post op period. Indian J Anaesth 2002;46:469-72.
18. Akhtar N, Quadir A, Athar M, Singh N. Recovery profile of intrathecal ropivacaine with or without fentanyl: A randomized double-blind controlled trial in equivalent doses. Int J Health Allied Sci 2016;5:158.
19. Boztuğ N, Bigat Z, Ertok E, Erman M. Intrathecal ropivacaine versus ropivacaine plus fentanyl for out-patient arthroscopic knee surgery. J Int Med Res 2005;33:365-71.
20. Sanli S, Yegin A, Kayacan N, Yilmaz M, Coskunfirat N, Karsli B. Effects of hyperbaric spinal ropivacaine for caesarean section: With or without fentanyl. Eur J Anaesthesiol 2005;22:457-61.
21. Murali CH, Narsaiah GL. Effects of fentanyl on isobaric ropivacaine in subarachnoid anesthesia for lower abdominal and lower extremity surgeries. Int J Res Med Sci 2016;4:2850-5.
22. Seetharam KR, Bhat G. Effects of isobaric ropivacaine with or without fentanyl in subarachnoid blockade: A prospective double-blind, randomized study. Anesth Essays Res 2015;9:173-7.
23. McNamee DA, Parks L, McClelland AM, Scott S, Milligan KR, Ahlén K, *et al*. Intrathecal ropivacaine for total hip arthroplasty: Double-blind comparative study with isobaric 7.5 mg ml(-1) and 10 mg ml(-1) solutions. Br J Anaesth 2001;87:743-7.
24. Koltka K, Uludag E, Senturk M, Yavru A, Karadeniz M, Sengul T, *et al*. Comparison of equipotent doses of ropivacaine-fentanyl and bupivacaine-fentanyl in spinal anaesthesia for lower abdominal surgery. Anaesth Intensive Care 2009;37:923-8.

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