e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(10); 296-302

Original Research Article

Evaluation of Sub-Arachnoid Block using Isobaric Ropivacaine with That of Hyperbaric Bupivacaine in Caesarean Section

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Received: 15-08-2023 / Revised: 18-09-2023 / Accepted: 13-10-2023
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Conflict of interest: Nil

Abstract:

Introduction: Caesarean sections with spinal anaesthesia reduce aspiration risk and allow aware patient involvement. Limited pain alleviation, urine retention, and complications are negatives. Bupivacaine is widely used but can cause hypotension. With bupivacaine, dexmedetomidine and magnesium sulphate boost results. For spinal anaesthesia, ropivacaine, a less strong anaesthetic, is sought, with isobaric formulations becoming popular for their reliability.

Aims and objectives: This study aims to compare the anaesthetic effects of isobaric ropivacaine and hyperbaric bupivacaine in the context of caesarean section procedures.

Method: The study comprised 70 elective lower-segment caesarean section patients with ASA Grades I and II. Prior to surgery, thorough screening ruled out medical and obstetric difficulties, respiratory or cardiovascular issues, allergies, and other health issues Intravenous medicines, hydration preloading, and baseline vital signs were preoperative preparations. Patients were randomly randomised to hyperbaric bupivacaine or isobaric ropivacaine for lumbar punctures. An oxygen supplement was given throughout the surgery.

Results: Table 1 compares Group B with Group R by numerous factors. Both groups had similar mean ages, weights, heights, and surgical times, with non-significant p-values (0.86, 0.18, 0.24, and 0.46). Table 2 shows group variations in sensory levels, timing, and analgesia. Figure 1 shows group differences in dermatome regression, sensory block length, effective analgesia, motor block start, and recovery. Group B had slightly greater rates of nausea/vomiting, hypotension, and shivering, but no significant vital sign changes (Table 3).

Conclusion: For elective caesarean sections, 15 mg of isobaric ropivacaine provides adequate anaesthesia with sensory block and safety above bupivacaine.

Keywords: Spinal anaesthesia, ropivacaine, sensory block length, effective analgesia, motor block start

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Introduction

The Caesarean section procedure is frequently employed for pregnancy termination, with several factors contributing to its prevalence. These factors encompass advanced maternal age, declining rates of vaginal deliveries, and the escalating utilization of electronic contraception methods. The employment of "spinal anaesthesia for caesarean" section is widely acknowledged and sanctioned as a secure practice on a worldwide level. Given its ability to enhance the bond between mother and infant and facilitate breastfeeding in the operation room, it appears to be a more suitable alternative to general anesthesia [1,2]. The utilization of spinal anesthesia in cesarean section procedures offers several notable benefits. These advantages encompass a decreased likelihood of aspiration of gastric contents, avoidance of the adverse effects associated with analgesic medications, and the possibility for the patient to remain conscious during the procedure. The use of a subarachnoid block has been widely regarded as the preferred method for administering anesthesia during "lower segment cesarean section (LSCS)". This technique offers several advantages, including its rapid onset of action, ease of administration, effectiveness in providing anesthesia to the mother, and less risk of fetal toxicity [3,4].

Caesarean anaesthesia is usually best performed by targeting the fourth thoracic nerve root. There exists a positive correlation between an increased level of anaesthesia and a heightened probability of sympathetic paralysis and maternal hemodynamic instability. There are several drawbacks associated with spinal anesthesia when combined with topical analgesics [5]. These include limited duration of postoperative pain relief, urinary retention, potential harm to the pectoral nerves, cardiac arrest, occurrence of headaches, feelings of nausea, back

pain, formation of hematoma in the spinal canal with or without resulting neurological problems, development of epidural abscess, and hemodynamic conditions disorders such as bradycardia and hypotension [6].

Bupivacaine, either as a standalone agent or in conjunction with narcotics, is the prevailing analgesic medicine employed for spinal anesthesia during cesarean delivery. This medicine induces a profound and sustained sensory blockade. The utilization of optimal dosage of bupivacaine in spinal anesthesia has the potential to not only mitigate hypotension but also ensure the attainment of an adequate level of spinal anesthesia in pregnant individuals [7]. The decrease in bupivacaine dosage is directly correlated with the reduction in sympathetic system activity following spinal anesthesia. Bupivacaine is frequently administered at a dosage range of 8 - 10 mg, a practice that is often accompanied by a notable incidence of hypotension and an elevated risk of problems for both the mother and the infant. The administration of bupivacaine as a standalone agent has been observed to extend the duration of sensory and motor blockades in lower limb surgery under spinal anesthesia [8,9].

In comparison, the combined administration of 5 µg sufentanil and 10 µg epinephrine does not exhibit the same level of prolongation. However, when dexmedetomidine and bupivacaine are used for intrathecal analgesia along with spinal anesthesia, a more pronounced and sustained motor and sensory blockage is achieved. Additionally, this combination results in a longer period of postoperative analgesia and a reduced occurrence of adverse effects. The use of intrathecal magnesium sulfate along with bupivacaine among patients undergoing lower extremities procedures has been identified as a secure and efficacious supplementary therapeutic approach to expedite the initiation of motor block [10,11].

Ropivacaine is a type of long-acting amide local anesthetic that shares structural and pharmacological similarities with bupivacaine. Ropivacaine exhibits a higher level of differentiation among the sensory and motor blockage when compared to bupivacaine. Consequently, it is employed for the purpose of alleviating epidural pain in the context of labor or cesarean section procedures [12]. The addition of magnesium sulfate to ropivacaine did not result in a significant enhancement of the analgesic efficacy in the transversus abdominis plane block following hysterectomy. The substance is linked to reduced central nervous system function and various harmful effects, particularly those affecting the cardiovascular system. The intrathecal administration of ropivacaine has been documented in many studies for both obstetric and nonobstetric populations [13,14].

Ropivacaine, an amino-amide “local anesthetic (LA)” drug, shares a chemical structure identical to bupivacaine but exhibits a lower potency of approximately 30-40% when compared to bupivacaine. Extensive research has been conducted on the use of ropivacaine for “spinal anesthesia (SA)”. The initial investigations assessed the effectiveness as well as safety of isobaric ropivacaine for neuraxial blockade [15]. The safety of intrathecal ropivacaine was demonstrated, with a shorter duration of action compared to bupivacaine and a lower occurrence of “transient neurological symptoms (TNS)” as compared to intrathecal lignocaine. The utilization of hyperbaric “local anesthetic (LA)” agents via intrathecal administration has gained increased prominence due to their ability to consistently induce certain block features and ensure reliable “spinal anesthesia (SA)”. At present, the availability of “hyperbaric solutions of ropivacaine” for clinical use is limited due to the difficulties involved in maintaining their pharmacological stability [16].

Method

This study comprised 70 elective lower-segment caesarean section patients with ASA Grade I and II. Medical or obstetric complications were excluded before surgery, as were respiratory or cardiovascular diseases, bronchial asthma, allergies, epilepsy, pregnancy-induced hypertension, diabetes, tuberculosis, extreme height or weight, shock, or coagulation disturbances. Preoperative tests included haemoglobin, urine, blood grouping, and Rh typing. After obtaining informed consent for anaesthesia, surgery, and blood transfusion, patients received 50 mg of Ranitidine and 4 mg of Ondansetron intravenously before spinal anaesthesia. Preload with Ringer's lactate solution and baseline vital signs and oxygen saturation were done before spinal anaesthesia. Aseptic L3-L4 lumbar puncture was done, and patients were randomly assigned to two groups: Group I (B) received hyperbaric bupivacaine (0.5%) 10 mg (2 ml) and Group II (R) got isobaric ropivacaine (0.75%) 15 mg (2 ml). All patients got 5 litres per minute of oxygen through a transparent face mask. Pinprick feeling was used to assess sensory block levels, time to analgesia, maximal sensory dermatomal level, two-segment regression, and complete sensory recovery (great toe sensation return, S1). Postoperative pain was monitored, and systemic narcotics were given only upon request. Effective analgesia was measured from subarachnoid anaesthesia to the first need for analgesics using the Bromage PR-1964 scale. O (no motor block) through III (full motor block) grades were used to measure motor block onset and recovery. Motor block time was determined, and intraoperative and postoperative problems such as hypotension, bradycardia, and vomiting were

addressed. The symptoms of nausea and vomiting were managed with the administration of 4 mg of intravenous Ondansetron, accompanied by the constant monitoring of oxygen saturation levels.

Inclusion and exclusion criteria

Inclusion

- Women with ASA grades I and II who are pregnant.
- Patients receiving elective lower segment caesarean.
- Without major medical or obstetric issues.
- Patients receiving low transverse (modified Fannestiel) caesarean surgery.
- Patients without respiratory, cardiovascular, bronchial asthma, or drug/food allergies.
- Absence of epilepsy, pregnancy-induced hypertension, diabetes, or TB.

Exclusion

- ASA Grade III+ pregnancies.
- Patients having non-elective lower segment caesarean sections.
- Critical medical or obstetric patients.
- Patients having non-low transverse caesarean sections (modified Fannestiel).
- Patients with respiratory, cardiovascular, bronchial asthma, or drug/food allergies.

Statistical analysis

Statistical analysis of the data used two methods. Student's unpaired t-test was used to assess if Group I and Group II had statistically significant differences in several parameters or measures. Second, the Chi-Square test was used to estimate associations between events in binomial samples, including postoperative neurological symptoms, post-dural puncture headache (PDPH), and other covariates. If the significance level was less than 0.05, any detected differences or relationships were unlikely to be random.

Result

The study compares two groups, Group B and Group R, based on a number of different criteria in Table 1. First, there is little difference between the two groups' mean ages, weights, heights, and surgical times, with non-significant p-values of 0.86, 0.18, 0.24, and 0.46, respectively. This implies that there aren't any statistically significant variations between the two groups' baseline characteristics. The table also shows data on the beginning of sensory block; overall, the mean onset times (66±5.8 seconds for Group B and 67±54.5 seconds for Group R) are similar, but Group B has more patients (26 vs. 24) in the age range of 61–70. Moreover, Table 1 shows that the two groups are well-matched with respect to surgical and demographic characteristics, providing the foundation for a reliable comparison of the primary outcomes.

Table 1: Comparision Group B and Group R, based on a number of different criteria

Variable	Group B (mean±SD)	Group B (mean±SD)	P value
Age (yrs)	25± 3.4	24± 3.5	0.86
Weight (kg)	53± 4.5	52± 6.3	0.18
Height (cm)	151± 3.7	149± 4.7	0.24
Duration of surgery (min)	52± 7	51± 5	0.46
Onset of sensory block (sec)	No of patient		
	Group B	Group R	
51-60	3	1	
61-70	26	24	
71-80	5	9	
81-90	1	1	
Total	35	35	
Mean ±SD (sec)	66±5.8	67±54.5	

Table 2 summarises the study's assessments of Group B and Group R regarding maximal sensory level, time to achieve it, and degree of analgesia. First, when looking at the highest possible sensory level, Group B has more people in the T4 and T6 range, while Group R has more people in the T2 and T3 range. This indicates that the two groups have different sensory level distributions. Second, while both groups take around three minutes to attain their peak sensory state, Group B does so in 318.81 seconds on average, whereas Group R takes 341.49 seconds. All patients in Group B are classified as having Category IV analgesia, while just one patient in Group R is classified as having Category III analgesia. Table 2 displays potential variations in sensory acuity, timing, and analgesia between the two groups, suggesting the presence of significant distinctions.

Table 2: Group B and Group R regarding maximal sensory level, duration, and analgesia.

Maximum sensory level	No of patients	
	Group B	Group R
T2	0	15
T3	0	10
T4	12	7
T5	6	2
T6	17	1
TOTAL	35	35
Time Required For Maximum Sensory Level(sec)	No Of Patients	
	Group B	Group R
181-240	9	6
241-360	26	24
361-480	3	5
Total	35	35
Mean±SD(sec)	318±81	341±49
Degree of analgesia	Group B	Group R
I	0	0
II	0	0
III	0	1
IV	35	34
Total	35	35

Figure 1 shows dermatome regression, total sensory block length, effective analgesia duration, motor block start, and motor recovery duration in Group B and Group R. Group B regressed to sensory levels between 71-90 minutes and Group R between 71-100 minutes for dermatome regression. The mean regression time was marginally shorter in Group B (83±7 minutes) compared to Group R (86±7 minutes). Both groups had comparable sensory block durations of 180–240 minutes. The mean effective analgesic duration for both groups was 150-155 minutes. Interestingly, Group B had motor block onset between 181 and 240 seconds, but Group R had a larger range. Finally, Group B had a longer motor recovery length (143±11 minutes) than Group R (78±9 minutes). These data show that anaesthesia affects sensory and motor function differently in the two groups.

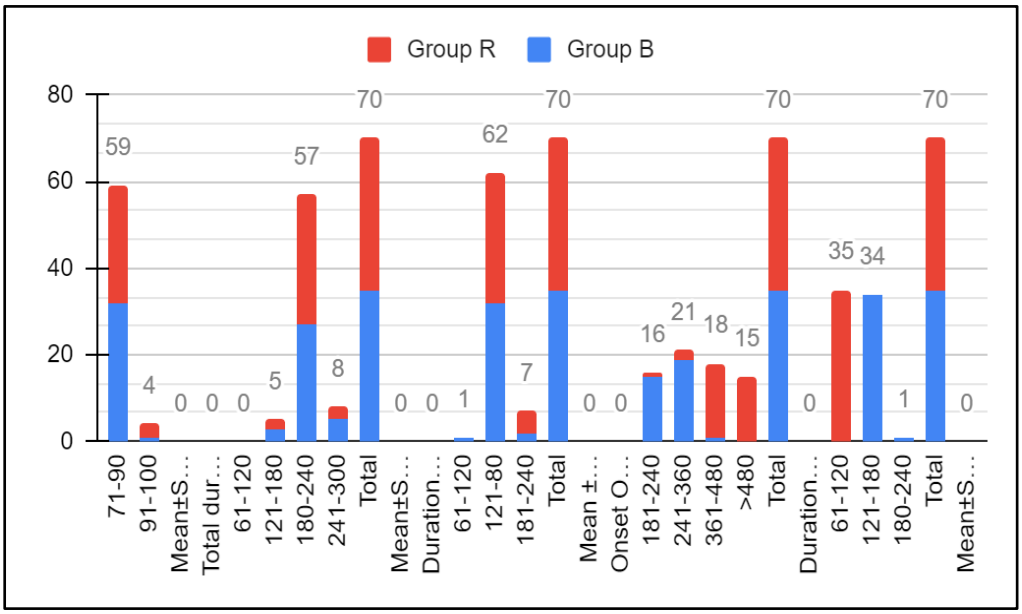

Figure 1: Different variations between Group B and Group R

Table 3 provides a complete description of Group B and Group R side effects and physiological characteristics. The incidences of nausea/vomiting, hypotension, and shivering were similarly low in both groups, however, they were slightly more common in Group B. Two people in Group B reported bradycardia, but none did in Group R. Notably, neither group experienced any occurrences of pruritus or

respiratory depression. There were no statistically significant variations in vital signs between the groups at any time point (p-values > 0.05): heart rate, systolic blood pressure, oxygen saturation, and respiratory rate. This indicates that the anaesthesia had equal effects on the vital signs and oxygen levels of both groups, suggesting that the side effects encountered were generally moderate.

Table 3: Group B and Group R side effects and physiological characteristics

Side effects	**Group B**	**Group R**	
Nausea/ vomiting	3	2	
Hypotension	27	26	
Bradicardia	2	0	
Pruritus	0	0	
Respiratory depression	0	0	
Shivering	3	4	
Pulse Rate	**Group B Mean±Sd**	**Group R Mean±Sd**	**P Value**
Preoperative	77±7	77±6	0.64(Ns)
After 15 Min	83±8	80±8	0.4(Ns)
After 90 Min	83±7	81±7	0.4(Ns)
After 180 Min	81±7	79±7	0.5(Ns)
Systolic BP	**Group B Mean±SD**	**Group R Mean±SD**	**P Value**
Preoperative	122±8	123±9	0.43(Ns)
After 15 Min	82±14	80±9	0.5(Ns)
After 90 Min	113±9	112±14	0.6(Ns)
After 180 Min	122±5	119±7	0.09(Ns)
Spo2	**Group B Mean±Sd**	**Group R Mean±Sd**	**P Value**
Preoperative	98±0.7	98±0.7	0.7
After 15 Min	98±0.7	98±0.7	0.7
After 90 Min	98±08	98±0.7	0.8
After 180 Min	98±0.7	98±0.8	0.4
Respiratory Rate	**Group B Mean±Sd**	**Group R Mean±Sd**	**P Value**
Preoperative	16±1	16±1	0.15
After 15 Min	16±1	16±1	0.15
After 90 Min	17±1	16±1	0.16
After 180 Min	17±1	16±1	0.16

Discussion

The utilization of neuraxial anesthesia in the field of obstetrics was first introduced by Oskar Kreis in 1900 through the implementation of the spinal block technique. Since its initial development, the subarachnoid blocking approach has undergone significant refinement. Over time, a variety of medications have been employed to administer analgesia and anesthesia specifically for procedures below the umbilicus [17]. The study was undertaken in response to the emergence of novel alternatives, such as an intrathecal medication that offers suitable sensory and motor blockage while causing minimum hemodynamic alterations, thereby ensuring the safe administration of lower-segment cesarean sections. A total of 90 patients were allocated into three groups, with each group consisting of 30 patients. Three groups, namely Group R, Group B, and Group L, were administered "0.5% isobaric ropivacaine", "2.2 mL of 0.5% hyperbaric bupivacaine", and "0.5% isobaric levobupivacaine" respectively. The sensory block, hemodynamic stability, motor block, and any problems were compared among all groups. The administration of 12 mg of isobaric levobupivacaine and 12 mg of isobaric ropivacaine, in comparison to 12 mg hyperbaric bupivacaine, intrathecally, has been found to offer sufficient anesthesia for cesarean section procedures. The comparatively shorter span of motor block observed in ropivacaine, in comparison to the other two medications, may offer advantages for facilitating early ambulation. Additionally, Group R had a decreased incidence of hypotension [21].

The principal objective of ambulatory anesthesia is to achieve prompt recuperation while minimizing adverse effects. Ropivacaine may be a valuable agent in situations where there is a need for equal spinal anesthesia and expedited restoration of motor function, owing to its characteristic of sensory-motor dissociation [18]. The objective of a study conducted in the past for comparing and evaluating the effectiveness of intrathecal isobaric bupivacaine and ropivacaine, as well as to analyze their respective profiles of recovery post-opratively in individuals following arthroscopic knee surgery. The administration of isobaric ropivacaine was found to be correlated with a prolonged initiation

and reduced span of action of motor and motor block, heightened need for analgesia post-operatively, elevated incidence of complications, and comparable discharge times in comparison to bupivacaine. Hence, in the context of daycare knee arthroscopy, the utilization of isobaric bupivacaine may be deemed more advantageous compared to isobaric ropivacaine, particularly in instances where the surgical procedure is expected to have a prolonged duration [22].

At present, racemic bupivacaine is extensively employed as the preferred local anaesthetic for spinal anaesthesia in parturients undergoing elective caesarean delivery. The usage of levobupivacaine, the isolated S (–) enantiomer of bupivacaine, has shown a substantial increase in India owing to its several advantages, including decreased neurotoxicity and cardiotoxicity, as well as a shorter duration of motor block. Nevertheless, there is a scarcity of research conducted regarding the effectiveness of this intervention in the field of obstetric anesthesia [19]. Consequently, a research study was undertaken to assess and compare the degrees of sensory and motor block, along with the occurrence of adverse effects, arising from the consumption of equal amounts of hyperbaric levobupivacaine and bupivacaine, supplemented with intrathecal fentanyl, in elective caesarean deliveries. The study's findings suggest that the use of an "Intrathecal isobaric levobupivacaine-fentanyl" combination may serve as a viable substitute for a hyperbaric bupivacaine-fentanyl combination in cesarean surgery. This alternative demonstrates reduced efficacy in inducing motor block, while simultaneously preserving hemodynamic stability even at elevated levels of sensory block [23].

The administration of hyperbaric ropivacaine has been found to result in a more consistent sensory and motor block, characterized by a quicker onset and superior quality of muscle relaxation when compared to the use of isobaric ropivacaine [20]. A study was conducted to evaluate and compare the effectiveness of hyperbaric ropivacaine and isobaric ropivacaine in individuals having surgical procedures involving the lower abdomen region. The trial had a randomized controlled double-blind design, consisting of two distinct groups of patients. Group A was administered a 3 mL dose of isobaric ropivacaine with a concentration of 6 mg/mL, resulting in a total dosage of 18 mg. Group B was administered a dose of 3 ml of hyperbaric ropivacaine at a concentration of 6 mg/ml, resulting in a total dose of 18 mg. The researchers recorded the commencement and span of sensory block specifically at the level T10 dermatome. They also documented the greatest extent of both the lower and upper spread of the sensory block, as well as the strength and duration of the motor block. The administration of intrathecal hyperbaric ropivacaine has been found to offer a more expeditious, sufficient, and high-quality sensory and motor block, along with a swifter post-operative recuperation, in comparison to the use of isobaric ropivacaine [24].

Bupivacaine is a type of amide local anesthetic that is commonly employed in both hyperbaric and isobaric formulations. Intrathecal administration of these substances is employed to deliver regional anesthetic specifically for cesarean section procedures. Numerous experiments have been conducted to assess the efficacy of "hyperbaric and isobaric bupivacaine". However, none have yielded definitive evidence supporting the superiority of either formulation. The analysis demonstrated that "intrathecal hyperbaric bupivacaine" exhibited a more rapid initiation of sensory blocking at the T4 level as compared to isobaric bupivacaine [25].

Conclusion

The study concludes that for elective caesarean sections, an intrathecal injection of 15 mg of isobaric ropivacaine (2 ml of 0.75%) offers adequate anaesthesia. Compared to bupivacaine, ropivacaine has a similar onset of sensory block, but it reaches a higher maximum level of sensory block. Furthermore, there are similarities between ropivacaine and bupivacaine in terms of the time needed to achieve the maximum sensory block, the two-segment dermatome regression, the overall duration of sensory block, and the length of time of effective analgesia. Compared to bupivacaine, ropivacaine has a delayed onset of motor block and a shorter duration of motor block. This implies that ropivacaine can be used safely during elective C-sections, particularly if there is no foetal distress and the procedure takes less than 78±9 minutes. The clinical value of ropivacaine in obstetric anaesthesia for elective caesarean sections is further illuminated by these findings.

References

1. Arzola C, Wieczorek PM. Efficacy of low-dose bupivacaine in spinal anesthesia for cesarean delivery. Obstet Anesth Digest. 2012; 32(3):194–5.
2. Santos AC, Birnbach DJ. Spinal anesthesia in the parturient with severe preeclampsia: Time for reconsideration. Anesth Analg. 2003; 97 (3):621–2.
3. Golmohammadi M, Mansuri P, Jafari Javid M, Khalkhali HR, Aghdashi M. [Comparison of the effects of colloid loading before and after spinal anesthesia to prevent maternal hypotension in cesarean section. J Adv Med Biomed Res. 2013;21(89):1–9.
4. Burns SM, Cowan CM, Wilkes RG. Prevention and management of hypotension during spinal anaesthesia for elective caesarean section: A

survey of practice. Anaesthesia. 2001; 56(8):794–8.
5. Rasooli S, Parish M, Mahmoodpoor A, Moslemi F, Sanaie S. Effect of spinal low dose bupivacaine-sufentanyl for cesarean section in preeclamptic parturients on neonatal outcome. Shiraz E-Med J. 2009;10(4):201–8.
6. Ngan Kee WD. Prevention of maternal hypotension after regional anaesthesia for caesarean section. Curr Opin Anaesthesiol. 2010; 23(3): 304–9.
7. Finucane BT. Spinal anesthesia for cesarean delivery. The dosage dilemma. Reg Anesth. 1995;20(2):87–9.
8. Chestnut DH, Wong CA, Tsen LC, Kee WDN, Beilin Y, Mhyre J. Chestnut's obstetric anesthesia: Principles and practice. Elsevier Health Sciences; 2014.
9. Barash PG, Cullen BF, Stoelting RK. Clinical anesthesia. USA: Lippincott Williams & Wilkins; 2006.
10. Lee A, Ngan Kee WD, Gin T. Prophylactic ephedrine prevents hypotension during spinal anesthesia for cesarean delivery but does not improve neonatal outcome: A quantitative systematic review. Can J Anaesth. 2002;49(6):58 8–99.
11. Derakhshan P, Imani F, Koleini ZS, Barati A. Comparison of adding sufentanil and low-dose epinephrine to bupivacaine in spinal anesthesia: A randomized, double-blind, clinical trial. Anesth Pain Med. 2018;8(5):e69600.
12. Rahimzadeh P, Faiz SHR, Imani F, Derakhshan P, Amniati S. Comparative addition of dexmedetomidine and fentanyl to intrathecal bupivacaine in orthopedic procedure in lower limbs. BMC Anesthesiol. 2018;18(1):62.
13. Faiz SH, Rahimzadeh P, Sakhaei M, Imani F, Derakhshan P. Anesthetic effects of adding intrathecal neostigmine or magnesium sulphate to bupivacaine in patients under lower extremities surgeries. J Res Med Sci. 2012;17 (10):918–22.
14. Gousheh MR, Akhondzade R, Asl Aghahoseini H, Olapour A, Rashidi M. The effects of prespinal anesthesia administration of crystalloid and colloid solutions on hypotension in elective cesarean section. Anesth Pain Med. 2018; 8(4): e69446.
15. Whiteside JB, Burke D, Wildsmith JA. Comparison of ropivacaine 0.5% (in glucose 5%) with bupivacaine 0.5% (in glucose 8%) for spinal anaesthesia for elective surgery. Br J Anaesth. 2003;90:304–8.
16. Fettes PD, Hocking G, Peterson MK, Luck JF, Wildsmith JA. Comparison of plain and hyperbaric solutions of ropivacaine for spinal anaesthesia. Br J Anaesth. 2005;94:107–11.
17. Kallio H, Snäll EV, Tuomas CA, Rosenberg PH. Comparison of hyperbaric and plainropivacaine 15 mg in spinal anaesthesia for lower limb surgery. Br J Anaesth. 2004;93:664–9.
18. vanKleef JW, Veering BT, Burm AG. Spinal anesthesia with ropivacaine: A double-blind study on the efficacy and safety of 0.5% and 0.5% solutions in patients undergoing minor lower limb surgery. AnesthAnalg. 1994;78: 1125–30. Wahedi W, Nolte H, Klein P. Ropivacaine for spinal anesthesia. A dose-finding study. Anaesthesist. 1996;45:737–44.
19. Hunt CO, Naulty JS, Bader AM, Hauch MA, Vartikar JV, Datta S, et al. Perioperative analgesia with subarachnoid fentanyl bupivacaine for cesarean delivery. Anesthesiology 1989; 71:53540.
20. Vichitvejpaisal P, SvastdiXuto O, Udompunturux S. A comparative study of isobaric and hyperbaric solution of bupivacaine for spinal anaesthesia in caesarean section. J Med Assoc Thai 1992;75: 27882.
21. Leisure G, DiFazio C. Ropivacaine the new local anaesthetic. Semin Anesth 1996;15:19.
22. Oraon, P., Hembrom, B., Kumar, M., Ram, B., & Lakra, L. Comparative Study between Intrathecal 0.5% Isobaric Levobupivacaine, 0.5% Isobaric Ropivacaine, and 0.5% Hyperbaric Bupivacaine in Elective Lower Segment Cesarean Section: A Randomized Clinical Study. Anesthesia, Essays and Researches, 2022;16(2): 238-243.
23. Oraon, P., Hembrom, B., Kumar, M., Ram, B., & Lakra, L. Comparative Study between Intrathecal 0.5% Isobaric Levobupivacaine, 0.5% Isobaric Ropivacaine, and 0.5% Hyperbaric Bupivacaine in Elective Lower Segment Cesarean Section: A Randomized Clinical Study. Anesthesia, Essays and Researches, 2022;16(2): 238-243.
24. Goyal, A., Shankaranarayan, P., & Ganapathi, P. A randomized clinical study comparing spinal anesthesia with isobaric levobupivacaine with fentanyl and hyperbaric bupivacaine with fentanyl in elective cesarean sections. Anesthesia, Essays and Researches, 2015;9(1): 57-62.
25. Gupta, R., Bogra, J., Singh, P. K., Saxena, S., Chandra, G., & Kushwaha, J. K. Comparative study of intrathecal hyperbaric versus isobaric ropivacaine: A randomized control trial. Saudi Journal of Anaesthesia, 2013;7(3): 249-253.
26. Sng, B. L., Siddiqui, F. J., Leong, W. L., Assam, P. N., Chan, E. S., Tan, K. H., & Sia, A. T. Hyperbaric versus isobaric bupivacaine for spinal anaesthesia for caesarean section. The Cochrane Database of Systematic Reviews, 2016(9).