Section: Anaesthesiology

Original Research Article

A COMPARATIVE STUDY ON EFFICACY OF 12MG 0.75% HYPERBARIC ROPIVACAINE WITH 10MG 0.5% HYPERBARIC BUPIVACAINE FOR LOWER SEGMENT CESAREAN SECTION DELIVERY UNDER SUBARACHNOID BLOCK

Zehra[1], Roshan Shende[2], Niteen Nandanwankar[3], Dharamsingh Pawar[4]

[1]Postgraduate Student, Department of Anaesthesiology, Shri Vasantrao Naik Govt Medical College, Yavatmal, Maharashtra, India.
[2]Associate Professor, Department of Anaesthesiology, Shri Vasantrao Naik Govt Medical College, Yavatmal, Maharashtra, India.
[3]Head of Department, Department of Anaesthesiology, Shri Vasantrao Naik Govt Medical College, Yavatmal, Maharashtra, India
[4]Associate Professor, Department of Anaesthesiology, Shri Vasantrao Naik Govt Medical College, Yavatmal, Maharashtra, India.

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Corresponding Author:
Dr. Roshan Shende,
Associate Professor, Shri Vasantrao Naik Government Medical College, Yavatmal, India
Email: dr.roshanshende02@gmail.com

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ABSTRACT

Background: **S**pinal anesthesia, has emerged as a common and preferred method for administering anesthesia during cesarean deliveries. Ropivacaine, a relatively new amino-amide local anesthetic introduced in the market in the late 1990s, offers several advantages. As the S (-) enantiomer of bupivacaine, ropivacaine appears to be less potent and induces a less intense motor block of shorter duration compared to bupivacaine. This study evaluated the clinical effectiveness and safety of two local anesthetics, ropivacaine and bupivacaine, in cesarean section deliveries.

Materials and Methods: This prospective randomized study included 100 parturients aged 20-35 years with ASA physical status Grade II, randomly divided into two groups: Group B received 10 mg of 0.5 % hyperbaric bupivacaine and Group R received 12mg of 0.75% hyperbaric ropivacaine. The time for onset and duration of sensory and motor blockade for both agents were observed, hemodynamic parameters and adverse effects were monitored.

Results: The results demonstrated that bupivacaine had a faster onset and longer duration of action compared to ropivacaine. Specifically, the time to achieve sensory blockade was significantly shorter in the bupivacaine group, with a duration of 145 minutes for sensory block and 149 minutes for motor block, compared to 123 and 132 minutes, respectively, in the ropivacaine group. However, ropivacaine showed a better control of heart rate during the procedure. Both anesthetics were well tolerated overall, with no statistically significant differences in adverse effects, although the incidence of hypotension, bradycardia, vomiting, and shivering was slightly higher in the bupivacaine group.

Conclusion: The study concludes that while bupivacaine offers faster onset and longer-lasting anesthesia, ropivacaine may be safer for patients with cardiovascular concerns due to its superior hemodynamic stability. Therefore, the choice of anesthetic should be tailored to the clinical situation, with bupivacaine being more appropriate for longer procedures, and ropivacaine preferable when early recovery and cardiovascular stability are priorities. Further research is suggested to refine dosage strategies to achieve an optimal balance between efficacy and safety in the use of these anesthetics.

Keywords: Spinal anesthesia, cesarean section, Ropivacaine, Bupivacaine, sensory blockade, motor blockade.

INTRODUCTION

Modern cesarean sections are performed for a wide range of indications, which can be broadly categorized into maternal and fetal concerns. Some common reasons necessitating cesarean deliveries include fetal distress, labor complications such as dystocia, cephalo-pelvic disproportion, prolonged labor, multiple pregnancies, placental issues, breech presentations, and uterine rupture. These diverse indications highlight the complexity and urgency often associated with cesarean procedures, requiring careful consideration of the best anesthetic techniques to ensure safety and effectiveness during delivery.[1]

Subarachnoid block (SAB), also known as spinal anesthesia, has emerged as a common and preferred method for administering anesthesia during cesarean deliveries. This technique has several advantages, including rapid onset, effective anesthesia, minimal systemic drug exposure to the fetus, and a lower risk of aspiration compared to general anesthesia. SAB is now widely used in both elective and emergency cesarean deliveries due to its reliable performance, rapid onset, and reduced fetal drug exposure, making it an optimal choice for many practitioners.[2,3]

While spinal anesthesia is generally safe, it is important to acknowledge its potential complications. Hypotension is a common side effect resulting from sympathetic blockade, which can be effectively managed with intravenous fluids and vasopressors. Additionally, patients may experience nausea and vomiting, which can arise from hypotension or the use of opioids. These side effects are typically manageable with antiemetics, ensuring that the patient's comfort is maintained throughout the procedure.[4]

In comparison to other anesthetic techniques, general anesthesia (GA) carries higher risks, such as maternal aspiration, neonatal depression, and prolonged recovery times. Epidural anesthesia, involving the injection of a local anesthetic into the epidural space, allows for adjustable and prolonged anesthesia but has a slower onset compared to SAB. Furthermore, epidurals may sometimes lead to incomplete or patchy anesthesia, and they tend to be more expensive. However, the advantage of epidural anesthesia lies in its ability to provide effective pain relief for longer procedures or labor that may last many hours. In contrast, the fixed duration of spinal anesthesia may necessitate supplementation if a procedure is prolonged, further complicating its use in some scenarios.[5,6]

The choice of anesthesia for cesarean deliveries often depends on several factors, including the clinical situation, patient preferences, and institutional protocols. Given its efficacy, safety profile, and rapid onset, SAB remains the preferred technique in many settings. This method involves the injection of a small volume of local anesthetic into the subarachnoid space. This results in a temporary loss of sensation and motor function below the level of injection, providing the profound anesthesia necessary for cesarean surgery.[7]

The onset of spinal anesthesia is rapid, usually taking effect within minutes, and it provides complete sensory and motor blockade for about 1.5 to 3 hours, depending on the specific agents and dosages used. The reliability of spinal anesthesia in achieving consistent and profound sensory blockade makes it particularly suitable for scheduled cesarean sections, allowing for a smooth surgical experience for both the mother and the newborn.[8]

When comparing spinal anesthesia to epidural anesthesia, several distinct advantages and limitations come into play. While epidural anesthesia involves placing a catheter in the epidural space for continuous infusion or intermittent boluses of anesthetic & has a slower onset and may not provide the same level of dense anesthesia as spinal techniques. Moreover, the cost associated with epidural anesthesia can be higher. Conversely, the fixed duration of spinal anesthesia can be limiting for prolonged procedures, where additional anesthetic may be required.[9]

The selection of local anesthetics used in spinal anesthesia for cesarean sections is critical for optimal outcomes. Bupivacaine is widely used due to its high efficacy and favorable safety profile, providing excellent sensory blockade that ensures effective anesthesia during the procedure. However, bupivacaine tends to produce a significant motor block of longer duration, which is typically unnecessary for cesarean sections. On the other hand, Ropivacaine, a relatively new amino-amide local anesthetic introduced in the market in the late 1990s, offers several advantages. As the S (-) enantiomer of bupivacaine, ropivacaine appears to be less potent and induces a less intense motor block of shorter duration compared to its counterpart. Importantly, ropivacaine has shown less cardiovascular and central nervous system toxicity than bupivacaine, enhancing its safety profile.[10,11]

In addition to its inherent advantages, the use of hyperbaric Ropivacaine further enhances the predictability and control of anesthetic spread, improving both safety and efficacy. The ability to predictably control anesthetic distribution is particularly beneficial in obstetric anesthesia, where precise dosing is crucial for both maternal and fetal safety.[12] The study conducted aimed to compare the efficacy and safety of 12 mg of 0.75% hyperbaric Ropivacaine with 10 mg of 0.5% hyperbaric Bupivacaine for lower segment cesarean section (LSCS) under spinal anesthesia.

This research holds significant implications for clinical practice. By evaluating the two anesthetics, healthcare providers can make informed decisions about the best options available for their patients undergoing cesarean sections.With the ongoing advancements in anesthetic techniques and medications, the goal remains to provide optimal care for mothers and their newborns during one of the

most critical moments of life. As we continue to refine these practices, the integration of patient safety, comfort, and effective anesthesia will remain at the forefront of cesarean delivery protocols.[13,14]

The study aims to evaluate the clinical efficacy and safety of 0.75% hyperbaric Ropivacaine compared to 0.5% hyperbaric Bupivacaine for lower segment cesarean sections performed under subarachnoid block. The primary objectives include comparing the onset time for sensory blockade, the duration until maximum sensory and motor blockade is achieved, and the overall duration of both sensory and motor blockade. Additionally, the secondary objectives focus on assessing hemodynamic parameters and any adverse effects that may arise during the procedures.

MATERIALS AND METHODS

This prospective observational study was conducted at the Department of Anesthesiology at a tertiary care institute, for 18 months from the date of approval by the Institutional Ethics Committee (IEC). Ethical approval has been obtained from the Ethical Approval Committee of tertiary care institute.

Study Population: The study population consisted of 100 parturients aged 20 to 35 years, categorized as American Society of Anesthesiologists (ASA) physical status Grade II, who were at a gestational age between 37 and 42 weeks and undergoing elective cesarean deliveries. Participants were randomly assigned to two groups,with group B receiving 10 mg of 0.5% hyperbaric Bupivacaine and group R receiving 12 mg of 0.75% hyperbaric Ropivacaine for subarachnoid block. Preanesthetic evaluations included comprehensive laboratory tests and assessments, and informed consent was obtained from all participants after providing detailed explanations of the surgical and anesthetic procedures in their native language. Exclusion criteria included patients refusing consent, those undergoing emergency surgeries, ASA Grade III and IV patients, individuals with contraindications to neuraxial blocks, and those with inadequate or failed subarachnoid blocks.

Data Analysis: Data from the study were recorded in Microsoft Excel and subsequently analyzed using SPSS version 24. Continuous variables were presented as mean ± standard deviation (SD), with comparisons made between groups utilizing the independent t-test for normally distributed data and the Mann-Whitney U test for non-normally distributed data. Categorical variables were represented as frequencies and percentages, with the Chi-square test employed for comparison. A p-value of less than 0.05 was deemed statistically significant, indicating meaningful differences between the groups.

RESULTS

The study compared the age and gestational age distribution between two groups, B and R. The mean age was 26.86 ± 4.4 years for group B and 28.18 ± 4.30 years for group R, with a median age of 28 and 29 years, respectively. The age range was 21-35 years for group B and 20-35 years for group R, with no significant difference (p=0.244). For gestational age, the mean was 39 ± 1.47 weeks in group B and 39.67 ± 1.40 weeks in group R. The median gestational age was 40 weeks for group B and 39.67 weeks for group R, with ranges of 37-41 and 36-41 weeks, respectively, and a p-value of 0.06.

The study also compared weight, height, and BMI between two groups, B and R. In terms of weight, group B had a mean of 62 ± 10.7 kg, while group R had a mean of 66.09 ± 9.34 kg, with no significant difference (p=0.12). The median weight was 66.7 kg for group B and 67.55 kg for group R. For height, group B had a mean of 161.5 ± 6.7 cm, and group R had a mean of 155.97 ± 6.43 cm, with a near-significant difference (p=0.05). The median height was 159 cm in group B and 157.18 cm in group R. Regarding BMI, group B had a mean of 24.8 ± 5.7, and group R had a mean of 24.45 ± 4.42, with no significant difference (p=0.79).

Table 1: Time for Onset of Sensory Blockade.

		B Group	R Group	P-value:
Time for Onset of sensory block(mins)	Mean with SD	1.2 ±0.4	2.4 ± 0.9	0.01
	Median	1.2	2.1	
	Range	1-1.4	2-2.6	

Table 2: Time For Max Sensory Blockade

		B Group	R Group	P-value:
Time for max sensoryblock (mins)	Mean with SD	7.94 ± 1.09	9.98 ± 0.93	0.0013

Table 3: Duration of sensory blockade

		B Group	R Group	P-value:
Duration of sensory blockade	Mean with SD	145 ± 19.62	123 ± 18	0.003

Table 4: Time for onset of Max Motor Blockade

		B Group	R Group	P-value:
Time of onset for Motor Block (mins)	Mean with SD	10.5 ± 1.99	12.15 ± 1.97	0.003

Table 5: Duration of Motor Blockade

		B Group	R Group	P-value:
Duration of Motor Block (min)	Mean with SD	149 ± 20.17	132 ± 23.7	0.014

Table 6: Adverse Effects

A. Incidence of Hypotension

Incidence of hypotesion	b group	Percentage	R GROUP	Percentage	P VALUE
YES	13	26%	11	22 %	0.92
NO	37	74%	39	78 %	
TOTAL	50	100%	50	100 %	

B. Incidence of Bradycardia

Bradycar DIA	B Group	Percentage	R Group	Percentage	P VALUE
YES	10	20%	8	16 %	0.84
NO	40	80%	42	84 %	
TOTAL	50	100%	50	100 %	

C. Incidence of Vomiting

Vomiting	B GROUP	Percentage	R GROUP	Percentage	P VALUE
YES	3	6%	2	4 %	0.93
NO	47	94%	48	96 %	
TOTAL	50	100 %	50	100 %	

D. Incidence of Shivering

Incidence Of Shivering	B GROUP	Percentage	R GROUP	Percentage	P VALUE
YES	2	4%	3	6%	0.91
NO	48	96%	47	94 %	
TOTAL	50	100 %	50	100 %	

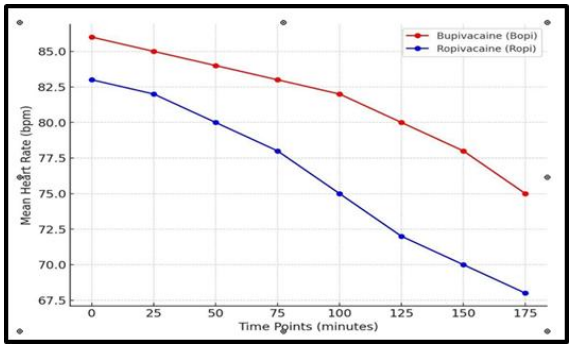

Figure 1: Changes of heart rate

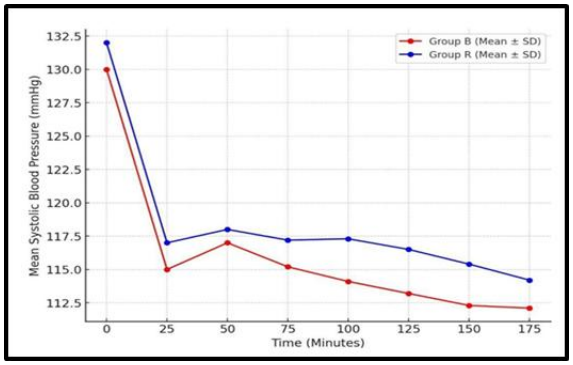

Figure 2: Changes in Systolic blood pressure over time

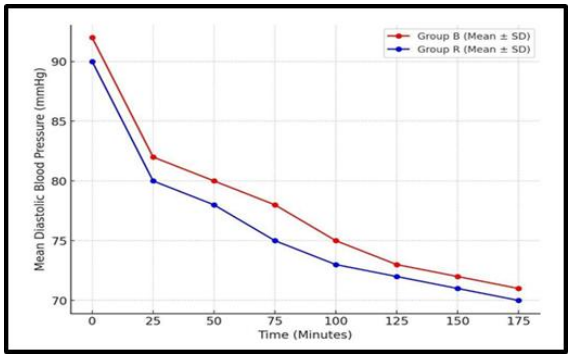

Figure 3: changes of diastolic blood pressure

DISCUSSION

Subarachnoid block (SAB), commonly known as spinal anesthesia, has emerged as the preferred technique for cesarean section deliveries due to its rapid and effective anesthesia. SAB is particularly valuable in emergency situations, where the quick onset of anesthesia is crucial. As advancements in spinal needle design and the development of new anesthetic agents continue to progress, the safety and effectiveness of SAB have improved, solidifying its status as a cornerstone technique for cesarean deliveries around the world. Among the local anesthetics used, Bupivacaine has traditionally been the drug of choice, but Ropivacaine is gaining popularity due to its favorable properties, such as a higher propensity to block sensory nerve fibers over motor fibers and a reduced risk of cardiac toxicity in cases of overdose. Both Ropivacaine and Bupivacaine are classified as amino-amide local anesthetics, but they differ in their structural and

pharmacological characteristics. Ropivacaine is the S-enantiomer, while Bupivacaine is a racemic mixture of both R and S enantiomers. Some studies suggest that a dose of 12 mg of Ropivacaine produces anesthesia comparable to 8 mg of Bupivacaine in parturients. This research aims to evaluate the clinical efficacy and safety of 0.75% hyperbaric Ropivacaine in comparison to 0.5% hyperbaric Bupivacaine for lower segment cesarean section delivery under subarachnoid block.[15-17]

In the demographic profile of the study participants, the mean age of those in the Ropivacaine group was approximately 28.18 years, while the Bupivacaine group had a mean age of 26.86 years. However, this 8888888/difference was not statistically significant. The mean gestational age was slightly higher in the Ropivacaine group at 39.67 weeks compared to 39 weeks in the Bupivacaine group, but again, the difference did not reach statistical significance. Additionally, the Ropivacaine group exhibited lower average weight and height compared to the Bupivacaine group, though these differences were not statistically significant either. Both groups had comparable body mass index (BMI) values, reinforcing the similarity of the demographic profiles across groups.[18]

When evaluating the onset of sensory blockade, the study found that the mean time to achieve sensory blockade at T10 was significantly quicker in the Bupivacaine group, averaging 1.2 minutes compared to 2.4 minutes in the Ropivacaine group. The Bupivacaine group also reached the maximum cephalic spread to T6 faster than the Ropivacaine group, with average times of 7.94 minutes and 9.98 minutes, respectively, indicating that Bupivacaine offers a more rapid onset of sensory block. Several studies correlate these findings, reporting similar outcomes in terms of faster onset times with Bupivacaine compared to Ropivacaine.

In terms of the duration of sensory blockade, Bupivacaine again demonstrated superiority, lasting an average of 145 minutes before regression to the S1 dermatome, compared to 123 minutes for Ropivacaine. This statistically significant difference aligns with other research indicating that Bupivacaine generally provides a longer duration of sensory block.[19]

The study also assessed the onset of maximum motor blockade, with results showing that the time to reach maximum motor blockade was quicker in the Bupivacaine group (10.5 minutes) compared to the Ropivacaine group (12 minutes), a finding that highlights the faster onset of action with Bupivacaine. This conclusion is supported by previous studies that consistently indicate a quicker onset of motor blockade with Bupivacaine.

Further examining the duration of motor blockade, the Bupivacaine group again outperformed the Ropivacaine group, with a duration of 149 minutes compared to 132 minutes, suggesting that Bupivacaine offers a more prolonged motor block. This finding aligns with several other studies that have reported longer motor blockade durations associated with Bupivacaine.[20]

In terms of hemodynamic parameters, the study noted that the Ropivacaine group exhibited better heart rate control during surgery, suggesting enhanced cardiovascular stability. Although there were no significant differences in systolic and diastolic blood pressure between the two groups, the overall heart rate was more stable in the Ropivacaine group, reinforcing its profile as a safer option for maintaining cardiovascular stability during procedures.[21]

The adverse effects associated with both anesthetics were monitored, revealing that hypotension occurred in 26% of the Bupivacaine group and 22% of the Ropivacaine group, though these differences were not statistically significant. Similarly, bradycardia, vomiting, and shivering were observed in both groups, with incidence rates indicating that both anesthetics had relatively few side effects.[22,23]

While both Ropivacaine and Bupivacaine are effective for spinal anesthesia during cesarean deliveries, Bupivacaine demonstrates faster onset times for both sensory and motor blockade, as well as a longer duration of action. Ropivacaine, on the other hand, appears to provide better cardiovascular stability, making it a valuable option for managing hemodynamic parameters during surgery. The findings contribute to the ongoing evaluation of optimal anesthetic choices for cesarean deliveries, with considerations for efficacy, safety, and patient outcomes.[24,25]

CONCLUSION

The study concludes that Bupivacaine demonstrated an earlier onset and peak of sensory and motor blockade, along with longer-lasting effects compared to Ropivacaine, although it was associated with a higher incidence of adverse effects, such as hypotension and bradycardia, which were not statistically significant. Thus, the choice of anesthetic should be tailored to the patient's clinical needs, considering Bupivacaine for prolonged procedures and Ropivacaine for shorter surgeries or patients at higher risk for adverse effects. Further research may be necessary to optimize dosages and combinations for a better balance between efficacy and safety.

REFERENCES

1. King J. Are there adverse outcomes for child health and development following caesarean section delivery? Can we justify using elective caesarean section to prevent obstetric pelvic floor damage?. International Urogynecology Journal. 2021 Jul;32:1963-9.
2. Louis A, Tiwary MK, Sharma P, Nair AS. Comparison of Postoperative Pulmonary Outcomes in Patients Undergoing Cesarean Section under General and Spinal Anesthesia: A Single-Center Audit. Anesthesia Essays and Researches. 2021 Oct 1;15(4):439-42.
3. Chatterjee D, Arendt KW, Moldenhauer JS, Olutoye OA, Parikh JM, Tran KM, Zaretsky MV, Zhou J, Rollins MD. Anesthesia for Maternal–Fetal Interventions: A Consensus

Statement From the American Society of Anesthesiologists Committees on Obstetric and Pediatric Anesthesiology and the North American Fetal Therapy Network. Anesthesia & Analgesia. 2021 Apr 1;132(4):1164-73.
4. Biricik E, Ünlügenç H. Vasopressors for the treatment and prophylaxis of spinal induced hypotension during caesarean section. Turkish journal of anaesthesiology and reanimation. 2021 Feb;49(1):3.
5. Samra T, Aditya A, Amar PK, Jain K, Saini V, Naik N, Amar PK. Ultrasound-Guided Lumbar Plexus-Sciatic Nerve Blocks Versus Epidurals for Orthopaedic Surgeries: A Study to Compare the Competency of Novice Anaesthesiology Residents in a High-Volume Level 1 Trauma Centre. Cureus. 2024 Sep 16;16(9).
6. Nanji JA, Carvalho B. Pain management during labor and vaginal birth. Best Practice & Research Clinical Obstetrics & Gynaecology. 2020 Aug 1;67:100-12.
7. Kitaw TM, Limenh SK, Chekole FA, Getie SA, Gemeda BN, Engda AS. Decision to delivery interval and associated factors for emergency cesarean section: a cross-sectional study. BMC pregnancy and childbirth. 2021 Dec;21:1-7.
8. Schwartz RH, Hernandez S, Noor N, Topfer J, Farrell K, Singh N, Sharma A, Varrassi G, Kaye AD. A Comprehensive Review of the Use of Alpha 2 Agonists in Spinal Anesthetics. Pain physician. 2022;25(2):E193.
9. Nimma SR, Gillespie N, Gans A. Epidural Anesthesia. InPeripartum Care of the Pregnant Patient: A Question-and-Answer Review for Anesthesiologists and Obstetricians 2024 Sep 4 (pp. 117-129). Cham: Springer Nature Switzerland.
10. Yılmaz HO, Turan A. Liposomal bupivacaine, pain relief and adverse events. InTreatments, Mechanisms, and Adverse Reactions of Anesthetics and Analgesics 2022 Jan 1 (pp. 291-307). Academic Press.
11. Xu HT, Chen L, Chen PJ, Pan C, Onel E, Gottlieb IJ. CPL-01, an Investigational Long-Acting Ropivacaine, Exhibits Extended-Release Properties after Mini-abdominoplasty. Jpn J Med. 2022;5:1.
12. Bishop D, van Dyk D, Dyer RA. Safe obstetric anaesthesia in low-and middle-income countries—a perspective from Africa. BJA education. 2023 Nov 1;23(11):432-9.
13. Chappell D, Neuhaus C, Kranke P. Optimal care for mother and child: Safety in obstetric anaesthesia. Best Practice & Research Clinical Anaesthesiology. 2021 May 1;35(1):41-51.
14. Saha U. General Anatomical and Physiological Considerations in the Newborn and Neonates. InClinical Anesthesia for the Newborn and the Neonate 2023 (pp. 137-204). Singapore: Springer Nature Singapore.
15. Louis A, Tiwary MK, Sharma P, Nair AS. Comparison of Postoperative Pulmonary Outcomes in Patients Undergoing Cesarean Section under General and Spinal Anesthesia: A Single-Center Audit. Anesthesia Essays and Researches. 2021 Oct 1;15(4):439-42.
16. Gahlot D, Wadhwa B, Saxena KN. Use of TIVA as an adjuvant to SAB in a COVID-19-positive parturient with morbid obesity posted for emergency caesarean section− A case report. MAMC Journal of Medical Sciences. 2022 Jan 1;8(1):76-8.
17. de Lima FF, da Silva BB, Oliveira JD, de Moura LD, da Silva GH, Fernandes PC, Souza RI, Dos Santos AC, de Paula E. Prolonged anesthesia and decreased toxicity of enantiomeric-excess bupivacaine loaded in ionic gradient liposomes. International Journal of Pharmaceutics. 2021 Sep 5;606:120944.
18. Olapour A, Akhondzadeh R, Rashidi M, Gousheh M, Homayoon R. Comparing the effect of bupivacaine and ropivacaine in cesarean delivery with spinal anesthesia. Anesthesiology and pain medicine. 2020 Feb;10(1).
19. Brusich KT, Valenčić L, Polonijo Ž. Physiology and Pharmacology of Epidurally Administered Drugs. InEpidural Administration-New Perspectives and Uses 2022 Dec 20. IntechOpen.
20. Gu S, Luo Q, Wen C, Zhang Y, Liu L, Liu L, Liu S, Chen C, Lei Q, Zeng S. Application of advanced technologies—nanotechnology, genomics technology, and 3D printing technology—in precision anesthesia: a comprehensive narrative review. Pharmaceutics. 2023 Sep 6;15(9):2289.
21. Pasha MN, Pasha SN, Naeem A, Haque SH. Effect on Cardiovascular System by Hyperbaric Bupivacaine and Isobaric Ropivacaine Given By Sub-Arachnoid Block in Planned Lower Extremity Surgery. ANNALS OF ABBASI SHAHEED HOSPITAL AND KARACHI MEDICAL & DENTAL COLLEGE. 2022 Aug 30;27(03):73-9.
22. Pandey S, Borkar S, Monteiro JM, Mathew S, Vernekar D, Barreto O, Gopinathan PA, Pillai VG, Kishan AV, Joute IL. Comparative Study of 0.5% Bupivacaine, 0.5% Ropivacaine, and 0.75% Ropivacaine With Fentanyl as a Continuous Intraoperative Epidural Infusion on Post-operative Analgesia. Cureus. 2024 May;16(5).
23. Khalil RS, Mehmud A, Banerjee R, Malhotra R, Banerjee A. Intrathecal ropivacaine versus bupivacaine in a non-obstetric population-A meta-analysis and trial sequential analysis. Indian Journal of Anaesthesia. 2024 Feb 1;68(2):129-41.
24. Jaafarpour M, Vasigh A, Najafi F, Sayadi H, Shafiei E. A comparative study on the effect of intrathecal bupivacaine vs. ropivacaine on maternal and neonatal outcomes after cesarean section: A systematic review and meta-analysis. Anesthesiology and Pain Medicine. 2023 Jun;13(3).
25. Viderman D, Ben-David B, Sarria-Santamera A. Analysis of bupivacaine and ropivacaine-related cardiac arrests in regional anesthesia: a systematic review of case reports. Revista Española de Anestesiología y Reanimación (English Edition). 2021 Oct 1;68(8):472-83.