



Comparing the Effect of Bupivacaine and Ropivacaine in Cesarean Delivery with Spinal Anesthesia

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Abstract

Background: Spinal anesthesia is the most common technique used for cesarean delivery due to some advantages compared to regional anesthesia. It is easily performed and provides a rapid onset of block. Though bupivacaine is a generally used long-acting amide type local anesthetic drug for spinal anesthesia, ropivacaine may sometimes be selected.

Objectives: This prospective, randomized, double-blinded study was aimed at comparing clinical efficacy and safety between ropivacaine and bupivacaine during cesarean section.

Methods: After getting ethical committee approval and written informed consent, 65 women who referred to Imam Khomeini Hospital of Ahvaz, Iran in 2018 were chosen for elective cesarean delivery under spinal anesthesia. They were randomly allocated to receive either ropivacaine 1% (n = 33) or bupivacaine 0.5% (n = 32). Afterwards, the differences in the anesthetic efficacy, vital signs, and hemodynamics of participants between the two groups were recorded.

Results: Duration of sensory block was shorter in the ropivacaine group than bupivacaine group (132.5 ± 21.6 min vs. 175.8 ± 26.2 min; P < 0.001). Ropivacaine also produced a shorter duration of motor blockade than bupivacaine (124.8 ± 20.2 min vs. 168.2 ± 21.7 min; P < 0.001). There is no difference between the two groups in terms of systolic and diastolic blood pressure, but the heart rate of patients in the bupivacaine group is significantly higher than the ropivacaine group.

Conclusions: The results suggest that ropivacaine and bupivacaine are two efficient drugs in anesthesia in the cesarean section, ropivacaine is a better choice due to little influence on the hemodynamics and shorter duration of sensory block and motor block which are useful for the recovery and also safe to the patients.

Keywords: Bupivacaine, Cesarean Section, Motor Block, Ropivacaine, Sensory Block, Spinal Anesthesia

1. Background

Caesarean section is a common method of termination of pregnancy and there are many reasons for having a cesarean section, including delivery in older ages, reduced delivery rates, increased use of electronic birth control and so on (1). Spinal anesthesia is accepted as a safe technique for cesarean section worldwide. Since it facilitates the relationship between mother and baby and helps breastfeed the baby in the operating room, it seems more appropriate than general anesthesia (2). Spinal anesthesia has many advantages in cesarean section, including reducing the risk of aspiration of the contents of the stomach, avoiding the debilitating factors of analgesics, and the ability to stay awake (3). The proper level of anesthesia for cesarean section is the fourth thoracic nerve root (T4). A higher level

of anesthesia is associated with increased risk of sympathetic paralysis and mother's hemodynamic instability (4). Some of the disadvantages of spinal anesthesia (with topical analgesics) include shortness of postoperative analgesia, headache, damage to the pectoral nerves, nausea, urinary retention, backache, cardiac arrest, hematoma in the spinal canal with or without neurological complications, epidural abscess, and hemodynamic disorders such as hypotension and bradycardia (5).

Bupivacaine, alone or in combination with narcotics, is the most common analgesic medication used for cesarean delivery in spinal anesthesia (6). This medication causes a deep and prolonged sensory block. Using the appropriate dose of bupivacaine for spinal anesthesia can not only reduce hypotension, but it can also provide an appropriate level of spinal anesthesia for the pregnant mother. Reduc-

ing the activity of the sympathetic system after spinal anesthesia is directly associated with the decrease in the dose of bupivacaine (7-9). A dose of 8 - 10 mg is commonly used for bupivacaine (10, 11), which is associated with a high prevalence of hypotension and an increase in complications for both mother and baby (12). Bupivacaine alone can prolong the sensory and motor blockades in spinal anesthesia for lower limb surgery, compared with the combination of 10 μ g epinephrine and 5 μ g sufentanil (13), but the simultaneous use of dexmedetomidine and bupivacaine in spinal anesthesia for intrathecal analgesia has a longer duration of sensory and motor blockage and longer postoperative analgesia with lower side effects (14). Adding intrathecal magnesium sulphate to bupivacaine in patients under lower extremity surgeries is a safe and effective adjuvant therapeutic method for enhancing onset time of motor block (15-17).

Ropivacaine is a long-acting amide local anesthetic being alike to bupivacaine in structural and pharmacodynamics. Ropivacaine has a greater degree of separation between the motor and sensory blockade than bupivacaine and it is used to relieve epidural pain during labor or for cesarean section (3, 4, 18, 19). Adding auxiliary magnesium sulfate to ropivacaine does not increase the analgesic effect in the transversus abdominis plane block after hysterectomy (20). It is associated with a less central nervous system and other toxicities, especially cardiovascular toxicity. Several papers have reported the intrathecal use of ropivacaine for obstetric and nonobstetric patients (3-5). Many researchers have described ropivacaine as being less potent than bupivacaine (6, 19).

2. Objectives

This randomized, double-blinded study was conducted to compare the clinical profile of 10 mg hyperbaric bupivacaine 0.5% and 15 mg ropivacaine 1% in patients undergoing a cesarean section.

3. Methods

3.1. Study Design and Patients' Recruitment

This prospective, randomized, double-blinded study was approved by the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences, and written informed consent was obtained from all patients. Sixty five participants scheduled for elective cesarean delivery under spinal anesthesia were randomly recruited from Imam Khomeini hospital of Ahvaz, Iran in 2018. The inclusion criteria were pregnancy (over 37 weeks and less than 42 weeks), elective cesarean section, ASA Class I - II, a weight of 65 -

95 kg, and a height of 155 - 175 cm. The exclusion criteria were patients' unwillingness to participate in the study, preterm and post-term delivery, any indication of an emergency cesarean section, ASA class higher than II, abnormalities and problems of the embryo, sensitivity to analgesics, and presence of spinal anesthesia contraindications. One group received 15 mg ropivacaine 1% (manufactured by L. Molteni & C Dei Fratelli Societa Di Esercizio SpA, Italy) and another one hyperbaric 10 mg bupivacaine 0.5% (manufactured by AstraZeneca Sweden). The spinal anesthesia was performed in the sitting position on L4 - L5 or L3 - L4, using the Quinque spinal needle (EXEL).

3.2. Assessment and Data Collection

The sensory and motor block levels assessment was performed at 5 minutes intervals for the first 60 minutes and then recorded up to 180 minutes. The sensory block level was measured by the pinprick test. Motor block in the lower limb was assessed by a modified Bromage scale (0 = no paralysis, 1 = unable to raise extended leg, 2 = unable to flex knee, and 3 = unable to flex ankle). The patients' pain severity was assessed based on a visual analog scale (VAS) from 0 (analgesia) to 10 (severe pain). It should be noted that VAS is a self-assessment method for measuring the severity of pain. Anesthesiologist performed all assessment who was blinded to both the group assignment and the drug injected. All patients were followed up for 24 hours after surgery.

The patients' blood pressure was measured and recorded every five minutes in the first 30 minutes and after that, was recorded every 15 minutes. If hypotension decreased below 90 mmHg or 25% lower than the initial blood pressure, 5 mg intravenous ephedrine was injected. If any signs of bradycardia were observed (heart rate less than 60 ppm), the patients were treated with 1 mg atropine intravenously. Hemodynamic parameters including systolic and diastolic blood pressure and baseline heart rate were recorded before the injection.

3.3. Statistical Analysis

The data were analyzed by SPSS (version 22). Repeated measurement analysis and independent *t*-test were performed in this research.

4. Results

Sixty five people with a mean age of 28.55 ± 5.5 years (18 - 40 years) participated in this study. There was no significant difference between the two groups in terms of age, weight, height, BMI, and gestational age ($P < 0.05$) (Table 1).

Table 1. The Profile of the Participants

Group	Mean ± SD	Test Statistic (P Value)
Age, y		-1.293 (0.201)
Ropivacaine	27.63 ± 5.04	
Bupivacaine	29.43 ± 5.96	
Gestational age, wk		-1.258 (0.215)
Ropivacaine	37.75 ± 2.97	
Bupivacaine	38.48 ± 0.96	
Height		0.583 (0.562)
Ropivacaine	165.69 ± 7.24	
Bupivacaine	164.53 ± 8.56	
Weight, kg		-0.158 (0.875)
Ropivacaine	76.94 ± 10.78	
Bupivacaine	77.34 ± 9.69	
Duration of surgery, min		1.248 (0.210)
Ropivacaine	9.02 ± 51.61	
Bupivacaine	8.41 ± 50.12	
BMI, kg/cm²		-2.024 (0.05)
Ropivacaine	25.23 ± 8.97	
Bupivacaine	28.61 ± 3.40	

Table 2. The Results of Repeated Measurement Analysis for Evaluating the Changes of Systolic and Diastolic Blood Pressure and Heart Rate Within and Between Two Groups

Variable, Source	Mean Square	F	P Value
Systolic blood pressure			
Time (within group)	2356.81	10.48	< 0.001
Time × group	118.57	0.53	0.927
Error	224.94		
Group (between group)	766.871	0.995	0.323
Diastolic blood pressure			
Time (within group)	431.96	2.45	0.002
Time × group	152.01	0.86	0.609
Error	176.511		
Group (between group)	603.197	0.596	0.444
Heart rate			
Time (within group)	1942.176	83.716	< 0.001
Time × group	30.622	1.32	0.130
Error	23.199		
Group (between group)	2598.918	113.282	< 0.001

The heart rate, systolic and diastolic blood pressure change significantly during time, and also the trend of changes is almost similar in both ropivacaine and bupivacaine groups. The results show that there is no difference between two groups in terms of systolic and diastolic blood pressure, but the heart rate of patients for bupivacaine group is significantly higher than ropivacaine group, around more than 75 percent of times (Table 2) (Figures 1-3).

The onset of motor and sensory block in the bupivacaine group was significantly faster than the ropivacaine group ($P < 0.001$). The complete sensory and motor blockage in the ropivacaine group was significantly faster than the bupivacaine group ($P < 0.001$) (Table 3).

There was no significant difference between two groups in terms of pain severity at different times ($P > 0.05$) (Table 4). No neurological changes, backache, headache occurred within 24 hours of discharge in either group.

5. Discussion

In the cesarean section, anesthetic drugs may impact on the pregnant woman and fetus (21). Ropivacaine is a L-amide anesthetic that is similar to bupivacaine in structural and pharmacodynamics. Ropivacaine has the advan-

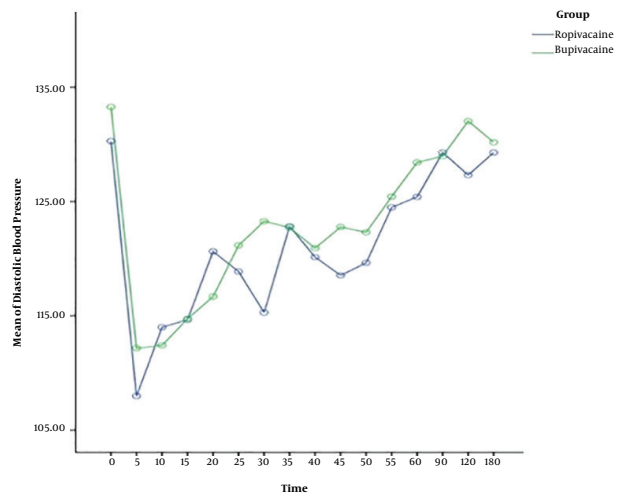


Figure 1. The changes of systolic blood pressure between Ropivacaine and Bupivacaine groups

tage of separated sensory and motor block, with less toxicity to the cardiovascular system and central nervous system (22-24). Some studies have shown that ropivacaine is more effective in sensory and motor block being inferior to the lidocaine but superior to the bupivacaine (25).

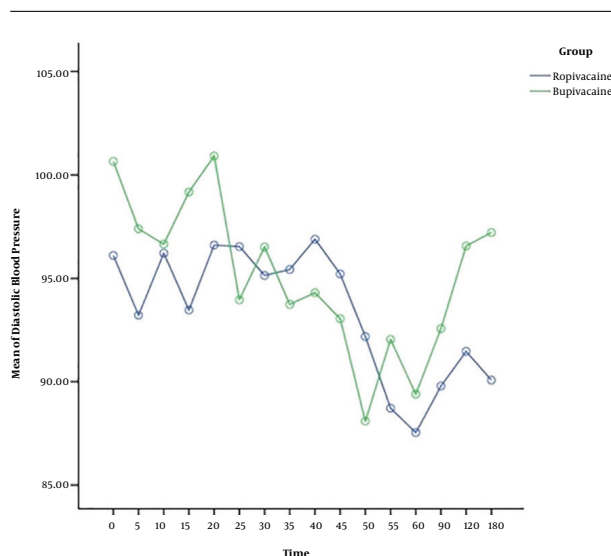


Figure 2. The changes of diastolic blood pressure between ropivacaine and bupivacaine groups

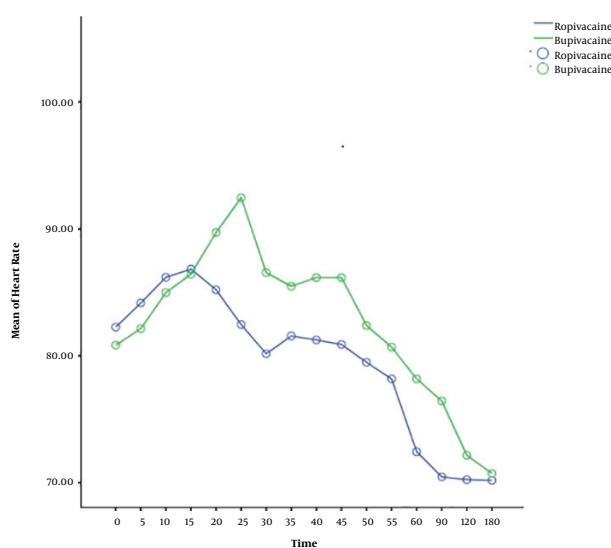


Figure 3. The changes of heart rate between ropivacaine and bupivacaine groups

This study aimed at investigating the clinical efficacy and safety of spinal anesthesia of ropivacaine 1% and bupivacaine 0.5% for elective cesarean delivery. We found that 15 mg ropivacaine 1% produced a parallel and effective clinical profile with shorter duration of sensory and motor block, compared with 10 mg hyperbaric bupivacaine 0.5% for elective cesarean section, although the onset time of sensory and motor block of ropivacaine was significantly longer than that bupivacaine. Wang et al. (26) demonstrated that ropivacaine is more recommended due to lit-

Table 3. Comparison of Motor and Sensory Block in Two Groups

Variable, Group	Mean ± SD	Test Statistic (P Value)
Onset of sensory block		
Ropivacaine	2.32 ± 0.9	-6.051 (< 0.001)
Bupivacaine	1.28 ± 0.4	
Time to complete sensory block		
Ropivacaine	132.5 ± 21.6	7.258 (< 0.001)
Bupivacaine	175.8 ± 26.2	
Onset of motor block		
Ropivacaine	2.86 ± 0.82	-7.798 (< 0.001)
Bupivacaine	1.63 ± 0.38	
Time to complete motor block		
Ropivacaine	124.8 ± 20.2	8.340 (< 0.001)

Table 4. Comparison of Pain Severity at Different Times in the Two Groups

Variable, Group	Mean ± SD	Test Statistic (P Value)
Skin profile		
Ropivacaine	1.95 ± 0.9	1.729 (0.088)
Bupivacaine	1.76 ± 0.6	
Uterus profile		
Ropivacaine	1.87 ± 0.4	-1.90 (0.061)
Bupivacaine	1.60 ± 0.7	
End of surgery		
Ropivacaine	1.17 ± 0.7	1.152 (0.253)
Bupivacaine	1.37 ± 0.7	
Completing the recovery		
Ropivacaine	1.67 ± 0.6	0.492 (0.623)
Bupivacaine	1.75 ± 0.7	

tle effect on the hemodynamics, shorter duration of sensory block and motor block, and lower incidence rate of side effects, which are beneficial to the recovery and also provide safety to the patients while either a low or high dose of ropivacaine and bupivacaine results in the discomfort (27). Chung et al. showed that 18 mg of 0.5% hyperbaric ropivacaine provided similar and effective spinal anesthesia with shorter duration of sensory and motor block, compared with 12 mg of 0.5% hyperbaric bupivacaine for cesarean delivery (28). In a meta-analysis study in 2016 the findings indicated that intrathecal ropivacaine reduces the duration of motor block and it has a similar onset of sensory block and no difference in the incidence of maternal hypotension (29). Hence, ropivacaine is more conductive for cesarean section, with higher satisfaction and more rapid recovery in the motor and it can be an alternative to bupivacaine for cesarean section (26, 30).

The present study displayed that systolic and diastolic blood pressure changes during the time but there is no significant difference between ropivacaine and bupivacaine

groups in this issue. The heart rate of patients for the bupivacaine group is significantly higher than the ropivacaine group. Since bupivacaine provides potent cardiotoxicity, it may increase heart rate and generate discomfort for some pregnant women (24, 31). But, ropivacaine has a lower lipid solubility than bupivacaine which produces a less toxic effect on the cardiovascular system and heart (31).

5.1. Conclusions

In conclusion, 15 mg ropivacaine 1% produced a parallel and effective clinical profile with shorter duration of sensory and motor block, compared with 10 mg hyperbaric bupivacaine for elective cesarean section, although the onset time of sensory and motor blockage of ropivacaine was significantly longer than that of bupivacaine. There is no difference between groups in terms of systolic and diastolic blood pressure, but the heart rate of patients in the bupivacaine group is significantly higher than the ropivacaine group. Therefore, ropivacaine can be an alternative to bupivacaine for cesarean section.

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Footnotes

Authors' Contribution: Reza Akhondzadeh contributed to write and supervise the project. Raziye Homayoon and Mohammadreza Gousheh collected all data, designed, and wrote the manuscript. Alireza Olapour and Mahbobeh Rashidi contributed to write and analyzed the manuscript.

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References

- Cunningham FG, Kenneth L, Bloom SL, Hauth JC, Rouse DJ, Spong CY. *Williams obstetrics*. 23rd ed. New York: McGraw Hill; 2014. 872 p.
- Stoelting R, Miller R. *Basics of anesthesia*. 6th ed. Philadelphia: Churchill Livingstone Elsevier; 2015.
- Arzola C, Wiecek PM. Efficacy of low-dose bupivacaine in spinal anesthesia for cesarean delivery. *Obstet Anesth Digest*. 2012;32(3):194-5. doi: 10.1097/01.aoa.0000417618.03038.1f.
- Santos AC, Birnbach DJ. Spinal anesthesia in the parturient with severe preeclampsia: Time for reconsideration. *Anesth Analg*. 2003;97(3):621-2. doi: 10.1213/01.ane.0000085017.03397.59. [PubMed: 12933372].
- 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. Persian.
- 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. doi: 10.1046/j.1365-2044.2001.02058-5.x. [PubMed: 11493248].
- 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.
- Ngan Kee WD. Prevention of maternal hypotension after regional anaesthesia for caesarean section. *Curr Opin Anaesthesiol*. 2010;23(3):304-9. doi: 10.1097/ACO.0b013e328337ffc6. [PubMed: 20173633].
- Finucane BT. Spinal anesthesia for cesarean delivery. The dosage dilemma. *Reg Anesth*. 1995;20(2):87-9. [PubMed: 7605769].
- Chestnut DH, Wong CA, Tsen LC, Kee WDN, Beilin Y, Mhyre J. *Chestnut's obstetric anesthesia: Principles and practice*. Elsevier Health Sciences; 2014.
- Barash PG, Cullen BF, Stoelting RK. *Clinical anesthesia*. USA: Lippincott Williams & Wilkins; 2006.
- 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):588-99. doi: 10.1007/bf03017387. [PubMed: 12067872].
- 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. doi: 10.5812/aapm.69600. [PubMed: 30538940]. [PubMed Central: PMC6252044].
- 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. doi: 10.1186/s12871-018-0531-7. [PubMed: 29875020]. [PubMed Central: PMC5991430].
- 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. [PubMed: 23825989]. [PubMed Central: PMC3698648].
- Gousheh MR, Akhondzade R, Asl Aghahoseini H, Olapour A, Rashidi M. The effects of pre-spinal anesthesia administration of crystalloid and colloid solutions on hypotension in elective cesarean section. *Anesth Pain Med*. 2018;8(4). e69446. doi: 10.5812/aapm.69446. [PubMed: 30250818]. [PubMed Central: PMC6139530].
- Javaherforoosh F, Akhondzadeh R, Beh Aein K, Olapour A, Samimi M. Effects of Tramadol on shivering post spinal anesthesia in elective cesarean section. *Pak J Med Sci*. 2009;25(1):12-7.
- Cederholm I. Preliminary risk-benefit analysis of ropivacaine in labour and following surgery. *Drug Saf*. 1997;16(6):391-402. doi: 10.2165/00002018-199716060-00005. [PubMed: 9241493].
- Stoelting RK, Miller RD. *Basics of anesthesia*. Churchill Livingstone, Elsevier Health Sciences; 2007.
- Imani F, Rahimzadeh P, Faiz HR, Abdollahzadeh-Baghaei A. An evaluation of the adding magnesium sulfate to ropivacaine on ultrasound-guided transverse abdominis plane block after abdominal hysterectomy. *Anesth Pain Med*. 2018;8(4). e74124. doi: 10.5812/aapm.74124. [PubMed: 30250819]. [PubMed Central: PMC6139531].

21. Gupta R, Bogra J, Singh PK, Saxena S, Chandra G, Kushwaha JK. Comparative study of intrathecal hyperbaric versus isobaric ropivacaine: A randomized control trial. *Saudi J Anaesth.* 2013;7(3):249–53. doi: [10.4103/1658-354X.115326](https://doi.org/10.4103/1658-354X.115326). [PubMed: [24015125](https://pubmed.ncbi.nlm.nih.gov/24015125/)]. [PubMed Central: [PMC3757795](https://pubmed.ncbi.nlm.nih.gov/PMC3757795/)].
22. Jain K, Makkar JK, Yadanappudi S, Anbarasan I, Gander S. Two doses of spinal bupivacaine for caesarean delivery in severe preeclampsia: A pilot study. *Int J Obstet Anesth.* 2012;21(2):195–6. doi: [10.1016/j.ijoa.2011.12.010](https://doi.org/10.1016/j.ijoa.2011.12.010). [PubMed: [22341891](https://pubmed.ncbi.nlm.nih.gov/22341891/)].
23. Leo S, Sng BL, Lim Y, Sia AT. A randomized comparison of low doses of hyperbaric bupivacaine in combined spinal-epidural anesthesia for caesarean delivery. *Anesth Analg.* 2009;109(5):1600–5. doi: [10.1213/ANE.0b013e3181b72d35](https://doi.org/10.1213/ANE.0b013e3181b72d35). [PubMed: [19843797](https://pubmed.ncbi.nlm.nih.gov/19843797/)].
24. Roofthoof E, Van de Velde M. Low-dose spinal anaesthesia for caesarean section to prevent spinal-induced hypotension. *Curr Opin Anaesthesiol.* 2008;21(3):259–62. doi: [10.1097/ACO.0b013e3282ff5e41](https://doi.org/10.1097/ACO.0b013e3282ff5e41). [PubMed: [18458538](https://pubmed.ncbi.nlm.nih.gov/18458538/)].
25. Choi DH, Ahn HJ, Kim JA. Combined low-dose spinal-epidural anesthesia versus single-shot spinal anesthesia for elective caesarean delivery. *Int J Obstet Anesth.* 2006;15(1):13–7. doi: [10.1016/j.ijoa.2005.05.009](https://doi.org/10.1016/j.ijoa.2005.05.009). [PubMed: [16256330](https://pubmed.ncbi.nlm.nih.gov/16256330/)].
26. Wang H, Gao Q, Xu R, Dong W, Zhang Y, Fan J. The efficacy of ropivacaine and bupivacaine in the caesarean section and the effect on the vital signs and the hemodynamics of the lying-in women. *Saudi J Biol Sci.* 2019;26(8):1991–4. doi: [10.1016/j.sjbs.2019.07.014](https://doi.org/10.1016/j.sjbs.2019.07.014). [PubMed: [31889783](https://pubmed.ncbi.nlm.nih.gov/31889783/)]. [PubMed Central: [PMC6923449](https://pubmed.ncbi.nlm.nih.gov/PMC6923449/)].
27. Dyer RA, Joubert IA. Low-dose spinal anaesthesia for caesarean section. *Curr Opin Anaesthesiol.* 2004;17(4):301–8. doi: [10.1097/01.aco.0000137088.29861.64](https://doi.org/10.1097/01.aco.0000137088.29861.64). [PubMed: [17021569](https://pubmed.ncbi.nlm.nih.gov/17021569/)].
28. Chung CJ, Choi SR, Yeo KH, Park HS, Lee SI, Chin YJ. Hyperbaric spinal ropivacaine for caesarean delivery: A comparison to hyperbaric bupivacaine. *Anesth Analg.* 2001;93(1):157–61. doi: [10.1097/00000539-200107000-00031](https://doi.org/10.1097/00000539-200107000-00031). [PubMed: [11429357](https://pubmed.ncbi.nlm.nih.gov/11429357/)].
29. Malhotra R, Johnstone C, Halpern S, Hunter J, Banerjee A. Duration of motor block with intrathecal ropivacaine versus bupivacaine for caesarean section: A meta-analysis. *Int J Obstet Anesth.* 2016;27:9–16. doi: [10.1016/j.ijoa.2016.03.004](https://doi.org/10.1016/j.ijoa.2016.03.004). [PubMed: [27106206](https://pubmed.ncbi.nlm.nih.gov/27106206/)].
30. Ramana Murthy Konda R, Narayana Anpuram L, Chakravarthy K. A study of hyperbaric bupivacaine versus isobaric ropivacaine for elective caesarean deliveries. *J Evol Med Dent Sci.* 2016;5(38):2345–8. doi: [10.14260/jemds/2016/544](https://doi.org/10.14260/jemds/2016/544).
31. Kuusniemi KS, Pihlajamaki KK, Pitkanen MT, Helenius HY, Kirvela OA. The use of bupivacaine and fentanyl for spinal anesthesia for urologic surgery. *Anesth Analg.* 2000;91(6):1452–6. doi: [10.1097/00000539-200012000-00029](https://doi.org/10.1097/00000539-200012000-00029). [PubMed: [11093999](https://pubmed.ncbi.nlm.nih.gov/11093999/)].