DOI: https://doi.org/10.54393/pjhs.v6i2.3323

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 6, Issue 02 (February 2025)

Original Article

OPEN ACCESS

Comparison of Bupivacaine with and without Dexmedetomidine on Duration of Analgesia among Patients Undergoing Cesarean Section Under Spinal Anesthesia

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ARTICLE INFO

Keywords:
Bupivacaine, Dexmedetomidine, Spinal Anesthesia, Cesarean Section, Postoperative Analgesia

How to Cite:
Abbas, S. E., Qayyum, A., Qamar, K., Tahzeeb, S., Javed, K., & Tariq, H. (2025). Comparison of Bupivacaine with and without Dexmedetomidine on Duration of Analgesia among Patients Undergoing Cesarean Section Under Spinal Anesthesia: Bupivacaine and Dexmedetomidine: Cesarean Section Under Spinal Anesthesia. Pakistan Journal of Health Sciences, 6(2), 262-267. https://doi.org/10.54393/pjhs.v6i2.3323

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Received Date: 2nd January, 2025
Revised Date: 20th February, 2025
Acceptance Date: 24th February, 2025
Published Date: 28th February, 2025

ABSTRACT

Spinal anesthesia is commonly used for cesarean sections. Adjuvants like dexmedetomidine are used to prolong anesthesia effects, reduce postoperative analgesic requirements, and enhance patient comfort. Preemptive analgesia, the administration of analgesics before painful stimuli, can further improve outcomes. While dexmedetomidine is known to enhance postoperative analgesia, existing literature primarily focuses on cesarean sections, with limited local evidence available. **Objectives:** To compare bupivacaine and dexmedetomidine on analgesia duration among patients having cesarean section under spinal anesthesia. **Methods:** The quasi-experimental research carried out in the department of Anesthesia of Jinnah Hospital involved 54 women who could be offered cesarean section and were divided into two equal groups (Group B and Group B+D): the former received 10 mg bupivacaine, and the latter 10 mg bupivacaine with the administration of 5 mcg dexmedetomidine intrathecally. Postoperative scores of the pain were measured in the Visual Analogue Scale (VAS). They had rescue analgesia (diclofenac sodium 75 mg) at VAS 3 or above. Vomiting, hypotension, and tachycardia were assessed as complications. SPSS version 25.0 was used in data analysis. **Results:** Pain scores at all-time points were significantly lower in the dexmedetomidine group ($p<0.05$). Time to first rescue analgesia was also longer in Group B+D. **Conclusions:** Adding dexmedetomidine to bupivacaine in spinal anesthesia significantly prolongs analgesia duration and reduces postoperative pain. It is a viable and effective adjuvant for cesarean sections.

INTRODUCTION

Birth processes have changed significantly, with rising global C-section rates [1, 2]. Anesthesia during C-sections alleviates discomfort, posing few negative effects on the mother and newborn [3, 4]. Optimal anesthesia administration ensures quick establishment and minimal hemodynamic changes, reducing the risk of injury to both [5]. Spinal anesthesia (SA) is preferred for most surgical procedures, especially caesarean sections, due to its rapid effect onset and reduced complication risk from the consistent block. However, neuraxial analgesia can cause negative effects, including maternal hypotension, shivering, nausea, and faintness [6, 7]. Bupivacaine is the most frequently used medication in spinal anesthesia, requiring a high sensory block (T4) for caesarean sections, which necessitates large dosages. Adverse effects include hypotension, nausea, vomiting, and prolonged recovery. Studies show that combining bupivacaine with other medications can enhance efficacy and reduce adverse effects [8]. The selective alpha 2 adrenergic receptor agonist, dexmedetomidine, has proved to have versatile

DOI: https://doi.org/10.54393/pjhs.v6i2.3323

application in the perioperative and critical care arenas [9, 10]. Dexmedetomidine is increasingly recognized as a complement to regional anesthesia, with research supporting its safe use in central neuraxial blocks. Past investigations suggest that intrathecal administration of 5 mg dexmedetomidine with hyperbaric bupivacaine during spinal anesthesia may enhance postoperative analgesia while reducing adverse effects [11]. In a research, the mean duration of first analgesia was found as 286 ± 64 minutes among patients who received Bupivacaine along with Dexmedetomidine, while 212.7 ± 70.2 minutes among those who received Bupivacaine only (p>0.001) during spinal anesthesia [12]. Cesarean sections pose significant challenges for patients and families, leading to natural concerns about pain management. It was required that the adjuvants for longer pain control. Dexmedetomidine has shown efficacy in prolonging analgesia after spinal anesthesia in various surgical procedures; however, studies focusing specifically on its use in cesarean sections remain scarce, with limited data on maternal and neonatal safety outcomes [13]. Therefore, it is aimed to conduct a study focusing solely on this procedure. If successful in prolonging pain management, we may incorporate it regularly into practice for improved patient pain control.

Although dexmedetomidine has demonstrated efficacy as an adjuvant to intrathecal bupivacaine in prolonging postoperative analgesia, limited local evidence exists regarding its effectiveness and safety specifically in cesarean section patients within resource-constrained settings. Previous studies have inadequately addressed maternal hemodynamic outcomes and lacked population-specific validation. Therefore, this study aimed to compare bupivacaine alone versus bupivacaine combined with dexmedetomidine for duration of analgesia, pain reduction, and perioperative safety among women undergoing cesarean section under spinal anesthesia.

METHODS

A quasi-experimental research was carried out in the Anesthesia Department of Jinnah Hospital, Lahore, from January 2020 to January 2021 (Ref no 55th /IRB). The sample included 54 female patients aged 18 to 45 years undergoing cesarean section under spinal anesthesia. The inclusion criteria comprised patients of ASA class I or II, with any parity and gestational age, normal PT/APTT and INR levels, and who provided informed consent for spinal anesthesia. Patients with known allergies to bupivacaine or dexmedetomidine, or impaired renal function based on medical records, were excluded. Participants were selected using non-probability consecutive sampling, with 27 patients allocated to each group. A sample size of 54 was calculated, taking the level of significance as 5% with a power of the test as 90%. The mean time for first analgesia was found as 286 ± 92.1 minutes among patients who received bupivacaine along with dexmedetomidine, while 212.7 ± 70.2 minutes among those who received bupivacaine only [12]. Approval was obtained from the hospital's ethical committee before patient enrollment. Eligible patients were identified and evaluated a day before surgery. Demographic and clinical data, including age, weight, parity, gestational age, and previous cesarean history, were recorded. Patients were instructed to fast overnight before surgery. On the day of surgery, informed consent was reconfirmed, hemodynamic stability was ensured, and necessary preparations, including emergency drugs and preload fluids, were arranged. Group B was administered 10 mg bupivacaine whereas group B+D was administered with 10 mg bupivacaine+5ug dexmedetomidine. All patients received subarachnoid block in a sitting position either at L2-L3 or L3-L4 interspace under strict aseptic technique using 25- gauge Quincke spinal needle. Before injecting the drug, they made sure that free flow of cerebrospinal fluid was achieved on proper needle placement. Following the block, patients were placed supine and surgery was initiated. Standard monitoring (non-invasive blood pressure, heart rate, SpO_2) was used throughout the procedure and postoperatively. Patients were assessed at 1, 2, 4, and 8 hours postoperatively using the Visual Analogue Scale (VAS) to evaluate pain. Analgesia (75 mg diclofenac sodium intramuscularly) was administered when VAS was ≥3, and the time from spinal induction to this point was recorded as the time for rescue analgesia. Sensory block onset was defined as the interval from injection to complete loss of sensation, and its duration was from onset until the development of VAS >3. Motor block onset was measured from injection to attainment of Bromage scale 3, with duration ending at recovery to Bromage score 0 in both lower limbs. Complications, including vomiting, hypotension (BP ≤ 90/60 mmHg), and tachycardia (HR > 100 bpm), were also monitored and documented. All the collected data were filled in a proforma. The analysis was undertaken using SPSS version 25.0. The mean and standard deviation were used to analyze quantitative variables (age, BMI, gestational age, the VAS score, time to rescue analgesia). Qualitative variables (parity, previous cesarean section) were described in terms of frequencies and percentages. The independent sample t-test was used to compare the mean value across the two groups following the evaluation of normality of data by the Shapiro-Wilk test, whereas the Chi-square test was used to evaluate differences amongst complications. The p-value that was used to reject the null hypothesis was <0.05.

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RESULTS

Mean ages were 32.48 ± 7.245 years (Group A) and 30.44 ± 8.173 years (Group B). Group A comprised 10 (37.0%) patients aged 18-30 years and 17 (63.0%) aged 31-45 years, while Group B included 14 (51.9%) aged 18-30 years and 13 (48.1%) aged 31-45 years. Mean BMIs were 26.97 ± 6.41 kg/m^2 (Group A) and 27.07 ± 4.68 kg/m^2 (Group B); weights included normal, overweight, and obesity. Mean gestational ages were 36.87 ± 6.59 weeks (Group A) and 37.73 ± 6.98 weeks (Group B). Nulliparity, primiparity, and multiparity varied across groups, table 1.

Table 1: Demographics and Clinical Characteristics of Patients in Study Groups

Characteristics		Group B, (n=27)	Group B+D, (n=27)
Age Groups	18-30 Years	10 (37.0%)	14 (51.9%)
	31-45 Years	17 (63.0%)	13 (48.1%)
	Mean ± SD	32.48 ± 7.24	30.44 ± 8.17
Body Mass Index (BMI)	Normal	15 (55.6%)	19 (70.4%)
	Overweight	11 (40.7%)	7 (25.9%)
	Obese	1 (3.7%)	1 (3.7%)
	Mean ± SD	26.97 ± 6.41	27.07 ± 4.68
Gestational Age	≤37 Weeks	6 (22.2%)	7 (25.9%)
	>37 Weeks	21 (77.8%)	20 (74.1%)
	Mean ± SD	36.87 ± 6.59	37.73 ± 6.98
Parity	Nulliparous	4 (14.8%)	6 (22.2%)
	Primiparous	7 (25.9%)	9 (33.3%)
	Multiparous	16 (59.3%)	12 (44.4%)
History of C-Section	Yes	8 (29.6%)	7 (25.9%)
	No	19 (70.4%)	20 (74.1%)

Sensory block duration was 136.59 ± 19.70 minutes (Group A) versus 148.81 ± 14.14 minutes (Group B). Motor block duration was 177.19 ± 23.69 minutes (Group A) versus 191.18 ± 14.42 minutes (Group B). Mean rescue analgesia times were 146.56 ± 13.86 minutes (Group A) and 178.07 ± 25.52 minutes (Group B), table 2.

Table 2: Comparative Analysis of Outcome Variables among Study Groups

Outcome Variables	Groups	Mean ± SD	p-Value
Sensory Block Duration (Minutes)	Group B	136.59 ± 19.70	0.001
	Group B+D	148.81 ± 14.14	
Motor Block Duration (Minutes)	Group B	177.19 ± 23.69	0.001
	Group B+D	191.18 ± 14.42	
Time For Rescue Analgesia (Minutes)	Group B	146.56 ± 13.86	0.001
	Group B+D	178.07 ± 25.52	

Pain scores at 1, 2, 4, and 8 hours demonstrated significant differences ($p<0.05$), table 3.

Table 3: Comparative Analysis of Postoperative Mean Pain Scores Between Study Groups

Pain Score at Intervals	Groups	Mean ± SD	p-Value
Pain Score at 1 Hour	Group B	4.63 ± 0.79	0.001
	Group B+D	3.41 ± 0.57	
Pain Score at 2 Hours	Group B	3.81 ± 0.83	0.001
	Group B+D	3.00 ± 0.84	
Pain Score at 4 Hours	Group B	2.74 ± 0.71	0.015
	Group B+D	2.22 ± 0.80	
Pain Score at 8 Hours	Group B	2.89 ± 0.69	0.001
	Group B+D	1.48 ± 0.51	

No bradycardia occurred. Vomiting: 3 (11.1%) (Group A); 2 (7.4%) (Group B), p=0.639 (insignificant). Hypotension: 3 (11.1%) (Group A); 2 (7.4%) (Group B), p=0.639 (insignificant). Tachycardia: 2 (7.4%) (Group A); 1 (3.7%) (Group B), p=0.552 (insignificant) (Table 4).

Table 4: Comparison of Complications Between Groups

Complications		Groups		p-Value
		Group B	Group B+D	
Hypotension	Yes	3 (11.1%)	2 (7.4%)	0.639
	No	24 (88.9%)	25 (92.6%)	
Vomiting	Yes	3 (11.1%)	2 (7.4%)	0.639
	No	24 (88.9%)	25 (92.6%)	
Tachycardia	Yes	2 (7.4%)	1 (3.7%)	0.552
	No	25 (92.6%)	26 (96.3%)	

DISCUSSION

In the current investigation, a comparison was made between the administration of bupivacaine and dexmedetomidine together in women who were undergoing caesarean section. According to the findings, the combination of bupivacaine and dexmedetomidine produces a more favourable outcome in terms of post-operative pain management than does bupivacaine on its own. The injection of dexmedetomidine intrathecally during spinal anesthesia has garnered a lot of interest in recent years. This is done to extend the analgesic effect and reduce the amount of pain that patients experience after surgery. As an adjuvant to local anaesthetic, the administration of several dosages of intrathecal dexmedetomidine 3 micrograms, 5 micrograms, 10 micrograms, and 15 micrograms, respectively, has been the subject of a number of investigations. This, in turn, results in a reduction in the transmission of nociceptive signals. It was also reported that the pain-relieving effects of this compound following surgical procedures are caused by the reduction of the activities of the intracellular potassium transporters [14-16]. Dexmedetomidine can produce hypotension and bradycardia due to the fact that it binds to 2 receptors in the locus coeruleus, which in turn lowers the production of norepinephrine and suppresses sympathetic activity. It is important to point out that individuals in the research that was referred to were given an intravenous infusion of dexmedetomidine while they were under spinal anesthesia. In addition, the research carried out by Shukla *et al.* revealed that although MAP was

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comparable between the two groups, those who were given dexmedetomidine were more likely to have tachycardia. However, the previously stated study also looked into the use of dexmedetomidine and $MgSO_4$ in conjunction with spinal anesthesia [17]. The results of the present study illustrated that the block in the group of patients administered with Bupivacaine and dexmedetomidine was incredibly fast compared with the block in the group of patients who received Group B. It was identified that the level of sensory block present between the two groups differed significantly, which is consistent with other work of the previous research. The analyses indicated that the intensity of the pain was less in that group that received bupivacaine combined with dexmedetomidine throughout the recovery room. This was ascertained by application of the discomfort visual analogue scale, which was used to determine the level of discomfort (T0). There was a considerable variation between the groups at the time points T2, T4 and T8 during the post-operative period [18, 19]. A possible explanation for this finding is that dexmedetomidine inhibits spinal cord pain receptors, reducing c-fiber translocation and dorsal horn neuron hyperpolarization. In literature, it was found that patients in the fentanyl group reported less pain in the first hour following surgery, while patients in the morphine group suffered more pain in the second and fourth hours [20, 21]. On the basis of past research conducted on humans, it is expected that intrathecal administration of 5 mg of dexmedetomidine combined with hyperbaric administration of bupivacaine during spinal anesthesia would generate a greater postoperative analgesic benefit with minimal adverse effects [11, 12]. In a study, the mean time for first analgesia was found as 286 ± 64 minutes among patients who received Bupivacaine along with Dexmedetomidine, while 212.7 ± 70.2 minutes among those who received Bupivacaine only (p>0.001) during spinal anesthesia [12]. In addition, the Group B+D group had considerably longer analgesic duration than the Bupivacaine group. The results of previous studies were completely compatible with the results of the research cited. When Shukla *et al.* tested intrathecal bupivacaine with dexmedetomidine and MgSO4, they discovered that the dexmedetomidine group had a faster onset of block and a longer duration of analgesia than the $MgSO_4$ group [17]. This study found that there was a substantial difference in the length of the motor block among the study groups. As compared to Sun *et al.* findings, which found that dexmedetomidine was associated with a prolonged duration of motor block in the dexmedetomidine group, the present study's findings suggest that the higher dose of dexmedetomidine (10 g) used in that study may have contributed to the longer duration of block [18]. In the current investigation, the side effects such as hypotension and vomiting were comparable in study groups, which conformed to the findings of other studies. Additionally, the results of this study were not significantly different from those of other studies. On the other hand, Sun *et al.* found that the fentanyl group had significantly more participants who experienced shivering, as well as nausea and vomiting [18].

The study was limited by its small sample size, single-center quasi-experimental design, and non-probability sampling technique, which may reduce generalizability and increase selection bias. Additionally, neonatal outcomes and long-term maternal safety parameters were not comprehensively assessed. Future large-scale randomized controlled multicenter trials are recommended to evaluate optimal dexmedetomidine dosing, maternal-neonatal safety profiles, and broader clinical applicability across diverse obstetric populations.

CONCLUSIONS

Combining dexmedetomidine with bupivacaine lengthened the time to first rescue analgesia during caesarean sections. Dexmedetomidine is preferable, resulting in quicker blocks, longer-lasting post-operative analgesia, and lower pain intensity. Therefore, adding dexmedetomidine to bupivacaine as an adjuvant during spinal anesthesia in caesarean sections is viable.

Authors' Contribution

Conceptualization: SEA
Methodology: AQ, ST
Formal analysis: AQ, HT
Writing and Drafting: KQ, KJ
Review and Editing: KQ, KJ

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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