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Original Research Article

To Evaluate Intra and Post-Operative Analgesic Efficacy of Ketamine as an Adjuvant to Intrathecal Bupivacaine in Caesarean Sections at Tertiary Care Hospital Bikaner Rajasthan

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Conflict of interest: Nil

Abstract:

Background: This study aims to evaluate the effectiveness of ketamine as an adjuvant to intrathecal bupivacaine in patients undergoing caesarean section, comparing outcomes such as onset and duration of sensory and motor block, postoperative pain scores, and requirement for rescue analgesia. By conducting this study, we will aim to contribute valuable evidence regarding the benefits and risks associated with the combined use of ketamine and bupivacaine in this clinical setting.

Methods: This study was a prospective randomised comparative study which was conducted in the Department of Anaesthesiology, Sardar Patel Medical College and A.G of Hospitals, Bikaner after obtaining approval from Institute Ethical Committee and written informed consent from patients.

Result: The mean onset time of sensory block was significantly lower in Group K compared to Group B. This difference was statistically significant ($p = 0.004$). The mean duration of sensory block was higher in Group K compared to Group B. This difference was statistically significant ($p = 0.028$). The mean onset time of motor block was significantly lower in Group K compared to Group B. This difference was highly statistically significant ($p < 0.001$). The mean duration of motor block was significantly higher in Group K compared to Group B. This difference was highly statistically significant ($p < 0.001$). The mean time for first rescue analgesia was significantly higher in Group K compared to Group B. This difference was highly statistically significant ($p< 0.001$). The mean number of analgesic doses was significantly higher in Group B compared to Group K. This difference was highly statistically significant ($p < 0.001$).

Conclusion: The present study concludes that the addition of preservative-free ketamine (0.1mg/kg) as an adjuvant to intrathecal hyperbaric bupivacaine (0.5%) in patients undergoing elective lower segment caesarean section significantly improves the quality and duration of spinal anaesthesia. The ketamine group demonstrated a significantly faster onset and prolonged duration of both sensory and motor blockade compared to bupivacaine alone.

Keywords: Bupivacaine, Ketamine, Lower Segment Caesarean.

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Introduction

Spinal anesthesia is the most preferred and widely practiced anesthetic technique for lower segment caesarean section (LSCS). Spinal anesthesia involves the administration of local anesthetic agents into the subarachnoid space, usually at the lumbar intervertebral level, resulting in reversible blockade of sensory, motor, and sympathetic nerve fibers. [1] Bupivacaine, a long-acting amide local

anesthetic, is commonly used for spinal anesthesia in caesarean section and is considered the drug of choice due to its ability to provide dense and reliable sensory and motor blockade of adequate duration.[2] However, intrathecal bupivacaine alone often fails to provide satisfactory postoperative analgesia. Increasing the dose or volume of local anesthetic to prolong analgesia may lead to adverse effects such as excessive sympathetic blockade, hypotension, prolonged motor block, and an increased risk of local anesthetic systemic toxicity.[3]

To improve the quality and duration of spinal anesthesia, various adjuvants have been added to intrathecal local anesthetics. Opioids such as fentanyl and morphine have traditionally been used as intrathecal adjuvants due to their potent analgesic properties and local anesthetic-sparing effect. However, their use is associated with maternal and fetal side effects including nausea, vomiting, pruritus, urinary retention, respiratory depression, hypotension, and neonatal bradycardia. These limitations have prompted the search for safer non-opioid adjuvants.[4]

In addition, ketamine inhibits the release of excitatory neurotransmitters such as glutamate and substance P at the spinal level, further contributing to its analgesic effect. When used in sub-anesthetic doses, ketamine provides effective analgesia without significant respiratory depression. Its sympathomimetic properties may also help maintain hemodynamic stability, which is particularly advantageous in obstetric patients who are prone to hypotension following spinal anesthesia. [5]

This study aims to evaluate the effectiveness of ketamine as an adjuvant to intrathecal bupivacaine in patients undergoing caesarean section, comparing outcomes such as onset and duration of sensory and motor block, postoperative pain scores, and requirement for rescue analgesia. By conducting this study, we will aim to contribute valuable evidence regarding the benefits and risks associated with the combined use of ketamine and bupivacaine in this clinical setting.

Material and Methods

Study Design: A Prospective Randomised comparative trial (hospital-based study).

Study Setting: This study was a prospective randomised comparative study which was conducted in the Department of Anaesthesiology, Sardar Patel Medical College and A.G of Hospitals, Bikaner after obtaining approval from Institute Ethical Committee and written informed consent from patients.

Study Period: July 2025 to December 2025.

Study Population: Patients who are willing to undergo LSCS at the hospital setting who are meeting all the inclusion criteria during the study period were the study population.

Inclusion Criteria:

1. Age group - 18 to 45 year.
2. Elective lower segment caesarean section.
3. BMI 18-30 Kg/m².
4. ASA grade I-II.

Exclusion Criteria:

1. Patients refusal.
2. Known allergy to drug used in the study.
3. Patients diagnosed with placenta previa, pre-eclampsia, eclampsia and other obstetrics co-morbidities.
4. Pre-existing hepatic, renal or cardiorespiratory, neurological related co-morbidities.
5. Patients with an increase in intracranial pressure.
6. Coagulation defects.
7. Local site infection.
8. Severe hypovolemia.
9. Contraindications to spinal anaesthesia.
10. Emergency caesarean sections.
11. ASA grade III and IV.

Sampling Technique: Simple randomised sampling by computer generated randomisation.

Sample Size & Calculation: Based on the findings of Khezri et al, the difference in total ephedrine requirement between Intervention and control groups was 2 mg. The pooled standard deviation for total ephedrine requirement was reported as 5.3 mg. The sample size was calculated at 5% alpha error and 80% power of study using the following formula:

$N = [(Zalpha + Zbeta)^2 \times (SD)^2] / (\Delta)^2$

$N = [7.84 \times (SD)^2] / (\Delta)^2$

$N = [7.84 \times (5.3)^2] / (2)^2$

$N = 56 \simeq 60$

Where:

- n = sample size per group
- Zα/2Z_ = Z value corresponding to significance level (e.g., 1.96 for
- α = 0.05)
- β value corresponding to power (e.g., 0.84 for 80% power)
- SD = pooled standard deviation in estimate = 5.3
- Δ = effect size of estimate = 2.0

Using the formula, we recruited 60 cases per group - a total of 120 study participants.

Allocation: The Patients were divided in two groups by lottery system (simple random sampling). The first patients who fulfilled the inclusion criteria were

allotted group B. Then every other patients who fulfilled inclusion criteria were placed in group K and then again in group B. Thus all the patterns were equally divided in two groups.

Group	Drugs	No. of Patients	Total Drug Volume
Group B	Injection bupivacaine 0.5% heavy 2.0 ml + 0.9% Normal saline 0.5 ml	60	2.5 mL
Group K	Injection bupivacaine 0.5% heavy 2.0 ml + Injection Ketamine 0.1 mg/kg body Weight	60	2.5 mL

Results

Table 1: Comparison of demographic parameters in both groups

Demographic Characteristics	Group B		Group K		T	P
	+Mean	SD	Mean	SD		
Age Group (years)	25.33	4.64	25.62	4.79	0.329	0.743
Body Weight (kg)	56.97	9.61	59.57	11.07	1.374	0.172
Height (cms)	158.47	7.24	155.93	6.99	1.949	0.054

The comparison of mean of demographic parameters between Group B and Group K demonstrated that both groups were statistically comparable with respect to age, body weight, and height ($p > 0.05$).

Table 2: Final outcome

Variable	Group B	Group K	p-value
Onset of Sensory Block (seconds)	75.33±14.56	68.88±9.02	0.04
Duration of Sensory Block (minutes)	131.57±25.72	139.87±13.27	0.028
Onset of Motor Block (seconds)	82.82±15.43	73.05±10.25	0.01
Duration of Motor Block (minutes)	149.23±26.22	169.82±18.99	0.01
Time of First Rescue Analgesia	236.13±19.16	286.60±14.60	0.01
Number of Total Analgesia	2.03±0.74	1.33±0.48	0.01

The mean onset time of sensory block was significantly lower in Group K compared to Group B. This difference was statistically significant ($p = 0.004$). The mean duration of sensory block was higher in Group K compared to Group B. This difference was statistically significant ($p = 0.028$). The mean onset time of motor block was significantly lower in Group K compared to Group B. This difference was highly statistically significant ($p < 0.001$). The mean duration of motor block was significantly higher in Group K compared to Group B. This difference was highly statistically significant ($p < 0.001$). The mean time for first rescue analgesia was significantly higher in Group K compared to Group B. This difference was highly statistically significant ($p< 0.001$). The mean number of analgesic doses was significantly higher in Group B compared to Group K. This difference was highly statistically significant ($p < 0.001$).

Table 3: Distribution of cases according to side effects and complications in both groups

Side effects & complications	Group B		Group K		Total	
	No.	%	No.	%	No.	%
Nausea	2	3.3	0	-	2	1.7
Nausea+Hypotension	5	8.3	0	-	5	4.2
Vomiting	0	-	1	1.7	1	0.8
Vomiting+Hypotension	1	1.7	1	1.7	2	1.7
Nil	52	86.7	58	96.7	110	91.7
Total	60		60		120	
z2	8.327					
P	0.080					

Although the incidence of side effects appeared lower in Group K, the difference between the two groups was not statistically significant ($\chi^2 = 8.327$, $p = 0.080$).

Table 4: Distribution of cases according to emergency drugs during intraoperative in both groups

Emergency Drugs	Group B		Group K		Total	
	No.	%	No.	%	No.	%
Inj. Mefentermine 6mg	5	8.3	1	1.7	6	5.0
Nil	55	91.7	59	98.3	114	95.0
Total	60		60		120	
z2	2.807					
P	0.094					

Although the requirement of vasopressor support appeared lower in Group K compared to Group B, the difference between the two groups was not statistically significant ($\chi^2 = 2.807$, $p = 0.094$).

Discussion

In Group B, the majority of patients (36.7%) had onset of sensory block between 71–80 seconds, followed by 28.3% in the 61–70 seconds range. Additionally, 25.0% of patients had onset greater than 80 seconds, while only 10.0% achieved onset within 60 seconds. In contrast, Group K demonstrated a relatively earlier onset, with the highest proportion of patients (35.0%) in the 61–70 seconds category, followed by 31.7% in the 71–80 seconds range. Notably, a higher proportion of patients in Group K (16.7%) achieved onset within 60 seconds compared to Group B (10.0%), and fewer patients had delayed onset (>80 seconds) in Group K (16.7% vs. 25.0%). The mean onset time of sensory block was significantly lower in Group K (68.88 ± 9.02 seconds) compared to Group B (75.33 ± 14.56 seconds). This difference was statistically significant ($t = 2.917$, $p = 0.004$).

Overall, these findings indicate that the addition of ketamine to intrathecal bupivacaine significantly hastens the onset of sensory block compared to bupivacaine alone.

The distribution of cases according to duration of sensory block demonstrated a longer duration in Group K compared to Group B. In Group B, the majority of patients (50.0%) had a sensory block duration between 121–150 minutes, while 33.3% had a shorter duration of less than 120 minutes, and 16.7% had a duration exceeding 150 minutes.

In contrast, Group K showed a shift toward longer durations, with the majority of patients (73.3%) falling in the 121–150 minutes category. Only 5.0% of patients in Group K had a duration of less than 120 minutes, while a higher proportion (21.7%) experienced a prolonged duration of more than 150 minutes compared to Group B. The mean duration of sensory block was higher in Group K (139.87 ± 13.27 minutes) compared to Group B (131.57 ± 25.72 minutes). This difference was statistically significant ($t = 2.222$, $p = 0.028$).

Overall, these findings indicate that the addition of ketamine to intrathecal bupivacaine significantly prolongs the duration of sensory block compared to bupivacaine alone, suggesting improved analgesic efficacy.

Similar findings in Safari et al., who reported significantly faster sensory block onset and prolonged duration of anaesthesia in the ketamine group. Similar findings were also observed by Basuni A et al. [6] and Gupta N et al. [7], who demonstrated earlier onset and prolonged sensory blockade with intrathecal ketamine as an adjuvant to bupivacaine. Furthermore, Alur J et al. [8] also reported earlier sensory blockade onset and superior analgesic profile in the ketamine group.

In Group B, nearly half of the patients (48.3%) experienced onset of motor block after more than 80 seconds, indicating a relatively delayed 0onset. Only 6.7% of patients achieved motor block within 60 seconds, while 26.7% and 18.3% had onset within 61–70 seconds and 71–80 seconds, respectively. In contrast, Group K demonstrated an earlier onset of motor block, with a higher proportion of patients achieving onset within shorter time intervals—13.3% within 60 seconds, 33.3% within 61–70 seconds, and 28.3% within 71–80 seconds. Importantly, fewer patients in Group K (25.0%) had delayed onset (>80 seconds) compared to Group B. The mean onset time of motor block was significantly lower in Group K (73.05 ± 10.25 seconds) compared to Group B (82.82 ± 15.43 seconds). This difference was highly statistically significant ($t = 4.084$, $p < 0.001$).

Overall, these findings indicate that the addition of ketamine to intrathecal bupivacaine significantly hastens the onset of motor block, providing a quicker onset of anesthesia compared to bupivacaine alone.

In Group B, the majority of patients had a motor block duration

between 121–150 minutes (36.7%) and 151–180 minutes (33.3%), while 16.7% had a shorter duration of less than 120 minutes and 13.3% experienced a duration exceeding 180 minutes. In contrast, Group K showed a clear shift toward longer durations of motor block, with the majority of patients (56.7%) falling in the 151–180 minutes category. Additionally, a higher proportion of patients in Group K (26.7%) had a duration greater than 180 minutes, while none of the patients had a duration less than 120 minutes. The mean duration of motor

block was significantly higher in Group K (169.82 ± 18.99 minutes) compared to Group B (149.32 ± 26.22 minutes). This difference was highly statistically significant ($t = 4.904$, $p < 0.001$). Overall, these findings indicate that the addition of ketamine to intrathecal bupivacaine significantly prolongs the duration of motor block compared to bupivacaine alone, suggesting enhanced and sustained anesthetic effect. These findings are consistent with those reported by Basuni A et al. [6], who observed higher motor block levels and prolonged block duration with ketamine-containing intrathecal regimens. Similar observations were made by Gupta N et al. [7], who reported prolonged motor block duration and improved block quality with intrathecal ketamine. In addition, Kumar et al. 9 concluded that intrathecal ketamine significantly shortens motor block onset and enhances block characteristics.

In Group B, the majority of patients (46.7%) required two doses of analgesia, followed by 28.3% who required three doses, and only 25.0% required a single dose. In contrast, Group K showed a markedly lower analgesic requirement, with the majority of patients (66.7%) requiring only one dose of analgesia, while 33.3% required two doses. Notably, none of the patients in Group K required three doses of analgesia.

The mean number of analgesic doses was significantly higher in Group B (2.03 ± 0.74) compared to Group K (1.33 ± 0.48). This difference was highly statistically significant ($t = 6.190$, $p < 0.001$).

Overall, these findings indicate that the addition of ketamine to intrathecal bupivacaine significantly reduces the total postoperative analgesic requirement, thereby improving the quality and duration of analgesia.

Similar findings of Khezri B M et al [10]., who reported significantly prolonged postoperative analgesia and reduced 24-hour analgesic consumption with intrathecal ketamine. Same findings observed by Khezri B M et al. [10], who demonstrated delayed first analgesic request in the ketamine group. Comparable findings were also reported by Alur J et al. 8 and Kumar et al. [9], confirming improved postoperative analgesia with intrathecal ketamine.

Conclusions

The present study concludes that the addition of preservative-free ketamine (0.1mg/kg) as an adjuvant to intrathecal hyperbaric bupivacaine (0.5%) in patients undergoing elective lower segment caesarean section significantly improves the quality and duration of spinal anaesthesia. The ketamine group demonstrated a significantly faster onset and prolonged duration of both sensory and motor blockade compared to bupivacaine alone.

Intrathecal ketamine also provided superior postoperative analgesia, as evidenced by delayed requirement of first rescue analgesia and reduced postoperative analgesic consumption. Intraoperative hemodynamic parameters remained relatively more stable in the ketamine group, though not clinically significant; with lower incidence of hypotension and bradycardia. Neonatal outcomes, assessed by Apgar scores at 1 and 5 minutes, were comparable between the two groups, indicating no adverse neonatal effects.

Furthermore, the incidence of adverse effects and complications was minimal and comparable between groups, confirming the safety profile of intrathecal ketamine at the studied dose. Therefore, preservative-free intrathecal ketamine can be considered a safe and effective adjuvant to bupivacaine for spinal anaesthesia in elective caesarean section, providing enhanced block characteristics, improved postoperative analgesia, better hemodynamic stability, and satisfactory maternal and neonatal outcomes.

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