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Comparative study of Bupivacaine with magnesium sulfate versus bupivacaine with dexmedetomidine in peripheral nerve stimulator-guided transversus abdominis plane block for post-operative analgesia in cesarean section

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ABSTRACT

Background: Magnesium sulfate and dexmedetomidine can be used as an adjuvant to local anesthetic solutions to enhance the quality and duration of peripheral nerve blocks. **Aims and Objective:** The objective was to compare magnesium sulfate and dexmedetomidine as adjuvants to bupivacaine (0.25%) in a transversus abdominis plane (TAP) block using a peripheral nerve stimulator (PNS) for post-operative pain relief in parturients undergoing caesarean delivery. **Materials and Methods:** A total of 150 pregnant women of ASA Grade I and II in the age range of 18–40, underwent elective cesarean delivery under the subarachnoid block, were divided into three groups of 50 each: Group A (bupivacaine and normal saline), Group B (bupivacaine and $MgSO_4$), and Group C (bupivacaine and dexmedetomidine). Following caesarean delivery, all participants went through a bilateral PNS guided TAP block utilizing one of the treatment techniques. At 0 h, 2 h, 4 h, 6 h, 12 h, 24 h, and 48 h, all patients were monitored for pain, hemodynamic parameters, and side effects. **Results:** The present study was carried out on 60 patients of thyroid lesions, out of which 21 cases were benign and 39 cases were malignant lesions. Correlation between ICC and reverse transcription-polymerase chain reaction (RT-PCR), a significant correlation was observed between ICC and RT-PCR for BRAF mutation ($P<0.001$). As per location of tumor is concerned, no significant correlation was observed with BRAF through ICC ($P>0.001$). The total concordance between ICC and quantitative RT-PCR was 96.8% (Pearson Chi-square test P-value is less than the significance level (0.05), which was statistical significant ($P<0.001$). The sensitivity and specificity of BRAF ICC on cellblock in malignant thyroid lesions was 76.9% and 100%, respectively. The sensitivity and specificity of BRAF RT-PCR on cellblock in malignant thyroid lesions was 79.4% and 100%, respectively. The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of combined BRAF ICC with RT-PCR was 96.8%, 100%, 100%, 90%, and 97.5%, respectively, on cellblock in malignant thyroid lesions. **Conclusion:** Dexmedetomidine and magnesium sulfate can be safely used as an adjuvant to bupivacaine (0.25%) to prolong the duration of pain relief while reducing the consumption of other analgesics without significant side effects.

Key words: Local anesthetic; Dexmedetomidine; Bupivacaine; Pregnant women

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INTRODUCTION

According to recent studies conducted, poor post-cesarean pain management is linked to an increased risk of chronic pain[1] and post-traumatic stress disorder.[2]

Effective post-operative pain control is associated with decreased stress response and overall reduced hospital stay. Intravenous or intramuscular analgesics such as opioids and non-steroidal anti-inflammatory drugs are associated with their own side effects and reduced efficacy of post-operative pain control.

Peripheral nerve block of the abdominal wall using nerve stimulator or ultrasound is relatively new and promising tool in controlling post-operative pain undergoing caesarean section.

Adjuvants to local anesthetics (LAs) are used in various regional anesthetic procedures to quicken the onset, enhance the quality of the block, and prolong the duration of the block.

Magnesium sulfate can be used as an adjuvant to LA solutions to enhance the quality and lengthen the block duration of various types because it avoids central sensitization by peripheral nociceptive stimulation.[3]

The alpha-2 agonist dexmedetomidine had been recently allowed for use as a sedative for intravenous use and as an adjuvant to medication that alleviates pain. Dexmedetomidine selectively acts on alpha$_2$ receptors of spinal cord which confers the analgesic property to this drug.[4,5]

Aims and objectives

- To compare magnesium sulphate and dexmedetomidine as adjuvants to bupivacaine (0.25%) in transversus abdominis plane (TAP) block using peripheral nerve stimulator (PNS) for post-operative pain relief in lower segment cesarean section (LSCS) patients.

MATERIALS AND METHODS

Ethical

Ethical committee's approval was duly taken. Data were collected in the department of pathology from the bed side tickets of the patients after taking a short history and informed consent from the patient.

Source of data

The prospective study was done in Maharani Laxmi Bai Medical College, Jhansi, between January 2022 and September 2022 including 150 pregnant women was applied for underwent elective cesarean delivery under the subarachnoid block.

Parturient were divided into three groups (50 patients each):

- Group A: 0.25% Bupivacaine (18 mL)+Normal Saline (2 mL) (Figure 1)
- Group B: 0.25% Bupivacaine (18 mL)+150mg Magnesium sulphate (1.5 mL) diluted with Normal Saline (2 mL) (Figure 2)
- Group C: 0.25% Bupivacaine (18 mL)+ Dexmedetomidine 0.5μg/kg diluted with Normal Saline (2 mL) (Figure 2).

Inclusion criteria

The following criteria were included in the study:

- Prebooked patients who had given consent for post-cesarean TAP block
- Age: 20–40 years
- American society of anesthesiologist classification status 1 or 2
- Body mass index <35 kg/m square.

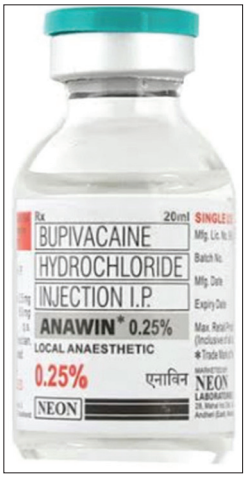

Figure 1: Bupivacaine hydrochloride injection I.P

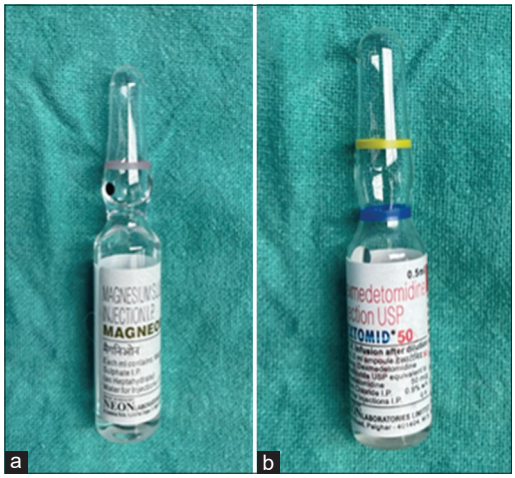

Figure 2: A-magnesium sulfate and B-dexmedetomidine

Exclusion criteria

The following criteria were excluded from the study:

- Any condition that contraindicates administration of peripheral nerve block (such as coagulopathy or hypovolemic shock)
- Patients known to have allergies to LAs
- A history of cardiorespiratory disorder
- A history of hepatic or renal disorder.

Methodology

All participants who met the inclusion criteria were randomized in to one of the three groups (A, B or C) using computer generated randomization. Routine nil per oral guidelines were followed before the scheduled LSCS; sedative or analgesic medications other than those used in the study were avoided in the 24 h before and after the cesarean section. After shifting the parturient to the operation theater, all the essential monitoring were attached, an intravenous line was secured in left upper extremity and Foley's catheterization was done aseptically. Preoperatively, the parturient blood pressure, heart rate, and oxygen saturation were recorded. All patients were preloaded with 1 L of crystalloids. A subarachnoid block was performed with a 27G Quincke's spinal needle in the sitting position with bupivacaine heavy 0.5%, 10 mg with 20 μg of fentanyl to achieve a sensory block level of T6 for the cesarean section. The patient's heart rate, non-invasive blood pressure, oxygen saturation, and electrocardiogram were monitored during the intraoperative period. At the end of the cesarean section, the operative wound was covered with a sterile pad. The TAP block was performed under strict aseptic precautions after cleaning the site of injection with an antiseptic solution. Subcostal nerve stimulation-guided TAP block was given after locating the subcostal nerve at the midpoint between the costal margin and iliac crest in the midaxillary line. The end motor response was twitches of the anterior abdominal wall, which persisted with current intensity at 0.4 mA.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) version 23 IBM (USA) was used to perform the statistical analysis. MS Excel was first used to analyze and code the data. The statistical test of one-way analysis of variance was employed to assess how much the continuous variable's means varied between the groups and whether there was any significance in this difference. At a 95% confidence level, a P=0.05 or less was regarded as statistically significant.

RESULTS

The mean age and standard deviation in Groups A, B, and C were 27.98±6.56 years, 28.52±6.48 years and 29.6±5.74 years, respectively. The mean weight and standard deviation were 57.56±10.06 kg, 57.2±11.16 kg and 59.54±11.13 kg in Groups A, B, and C, respectively. The mean height and standard deviation in the three groups were 154.26±9.37 cm, 157.56±9.26 cm, and 154.16±9.23 cm. The mean duration of surgery was 50.98±20.35 min in Group A, 48.86±20.8 min in Group B, and 50.52±19.5 min in Group C. There was no significant difference in age, weight, height, and duration of surgery among the three groups (Table 1).

The mean heart rate of the participants in each group decreased steadily when compared with baseline over the course of the study. Furthermore, there was statistically significant difference in mean heart rates among three groups at 2 h (P=0.045), 4 h (P=0.024), 6 h (P=0.036), 8 h (P=0.047), and 12 h (P=0.043) postoperatively, after that, the difference was not statistically significant (Table 2).

Mean arterial pressure of participants in each group was also decreased, as was the case with heart rate, when comparisons were made with the baseline. A statistically significant difference was found among the three groups at 2 h (P=0.011), 4 h (P=0.019), and 6 h (P=0.044) postoperatively. However, no statistically significant difference was observed in mean arterial pressure at any other time among the three groups from baseline (Table 3).

The visual analog scores (VAS) were recorded postoperatively to assess the pain relief. A highly significant difference (P<0.0001) was found between the mean pain scores (VAS) among the three groups postoperatively measured at 2 h, 4 h, 6 h, 8 h, 12 h, 24 h, and 48 h, respectively. The mean VAS score was lowest in group C in comparison to Groups A and B (Table 4).

The time duration for the requirement of first rescue analgesia was the maximum for Group C (Mean±S.D=5.15±0.60) and minimum for Group A (Mean±S.D.=2.17±0.48) (P<0.0001) (Table 5).

Hypotension and bradycardia were reported more frequently with dexmedetomidine group as compared with normal saline and magnesium sulfate groups. The normal saline group experienced more nausea and vomiting episodes than the magnesium sulfate and dexmedetomidine groups. There was no significant association of the side effects among the three groups (P=0.852) (Table 6).

DISCUSSION

According to the study, lower VAS ratings were found when dexmedetomidine (0.5 g/kg) and magnesium sulfate

Table 1: Mean demographic and baseline parameters among participants

Parameters	Group A (n=50)	Group B (n=50)	Group C (n=50)	P-value (ANOVA test)
Mean age (years)	27.98±6.56	28.52±6.48	29.6±5.74	0.423
Mean weight (kilograms)	57,56±10.06	57.2±11.16	59.54±11.13	0.508
Mean height (centimetres)	154.26±9.37	157.56±9.26	154.16±9.23	0.118
Mean duration of surgery (minutes)	50.98±20.35	48.86±20.80	50.52±19.50	0.859

ANOVA: Analysis of variance

Table 2: Comparison of mean heart rates among various groups

Mean time (hours)	Group A (n=50)	Group B (n=50)	Group C (n=50)	P-value (ANOVA test)
0 h (baseline)	94.74±3.25	93.78±2.03	94.36±2.83	0.217
2 h	92.94±5.99	90.2±6.64	90.51±5.14	**0.45 (Significant)**
4 h	92.48±5.67	90.66±7.72	88.34±8.79	**0.024 (Significant)**
6 h	92.06±7.89	90.11±8.03	87.95±7.76	**0.036 (Significant)**
8 h	92.12±8.31	90.28±7.84	88.02±8.53	**0.047 (Significant)**
12 h	89.11±5.28	87.18±5.38	86.08±7.29	**0.043 (Significant)**
24 h	85.47±6.20	85.44±6.62	84.98±7.05	0.918
48 h	83.02±8.77	83.12±6.45	81.56±6.44	0.492

ANOVA: Analysis of variance

Table 3: Mean intergroup comparison of mean arterial pressure

Mean time (hours)	Group A (n=50)	Group B (n=50)	Group C (n=50)	P-value (ANOVA test)
0 h (baseline)	103.70±10.46	102.65±9.56	100.13±8.41	0.159
2 h	102.13±10.64	102.41±8.90	97.38±8.24	**0.11 (Significant)**
4 h	101.47±11.02	102.05±9.73	97.03±7.91	**0.019 (Significant)**
6 h	101.93±10.69	99.04±9.26	96.94±9.79	**0.044 (Significant)**
8 h	101.27±11.20	99.29±10.41	97.43±8.34	0.165
12 h	100.64±11.42	100.37±8.79	99.87±11.15	0.933
24 h	101.23±10.52	100.96±10.07	98.26±10.74	0.294
48 h	101.50±10.08	99.38±7.61	99.90±8.67	0.460

ANOVA: Analysis of variance

Table 4: Mean VAS scores among different groups (Mean±standard deviation)

Mean time in hours (postoperative)	Group A (n=50)	Group B (n=50)	Group C (n=50)	P-value (ANOVA test)
2 h	2.48±1.62	2.01±1.44	1.13±0.54	<0.0001
4 h	2.12±1.07	1.83±1.16	1.02±0.94	<0.0001
6 h	2.51±1.42	1.87±1.59	1.15±1.68	<0.0001
8 h	2.94±1.16	2.02±0.75	1.65±1.38	<0.0001
12 h	3.74±1.52	2.24±1.68	1.85±1.30	<0.0001
24 h	3.42±1.38	2.11±1.49	1.59±1.26	<0.0001
48 h	3.51±1.76	2.26±1.94	1.37±1.64	<0.0001

ANOVA: Analysis of variance, VAS: Visual analogue scores

Table 5: Mean time to first analgesia after TAP block among different groups

Time to first analgesic	Group A (n=50)	Group B (n=50)	Group C (n=50)	P-value (ANOVA test)
Mean time in hours	2.17±0.48	3.22±0.57	5.15±0.60	<0.0001

TAP: Transversus abdominis plane, ANOVA: Analysis of variance

Table 6: Intergroup comparison of side effects

Side effects	Group A (n=50) (%)	Group B (n=50) (%)	Group C (n=50) (%)	P-value (ANOVA test)
Hypotension	6 (12)	5 (10)	10 (20)	>0.05 (0.852)
Bradycardia	9 (18)	11 (22)	14 (28)	
Nausea/Vomiting	5 (10)	4 (8)	4 (8)	

ANOVA: Analysis of variance

(150 mg) were administered as an adjuvant to bupivacaine (18 mL), compared to bupivacaine and normal saline. The VAS scores were lower with the dexmedetomidine group compared to the magnesium sulfate group. When compared to the magnesium sulfate and normal saline groups, the time needed for rescue analgesia after cesarean section was longer with dexmedetomidine. In the dexmedetomidine group, bradycardia and hypotension were also frequent side effects.

The TAP block has been used successfully as part of multimodal analgesic technique for post-operative pain relief after cesarean delivery.[6] It adequately relieves somatic pain by blocking the thoracolumbar nerves from T10 to L1.[7]

One of the earliest studies on the application of ultrasound-guided TAP blocks for laparoscopic surgery was carried out by Mukhtar and Singh.[8] They performed a left-sided unilateral TAP block, which significantly reduced the consumption of analgesics.

The efficacy of ultrasound-guided TAP block following cesarean birth under spinal anesthesia with bupivacaine and fentanyl was assessed by Baaj et al.[9] After the procedure, patients either had a bilateral ultrasound-guided TAP block with 20 mL of 0.25% bupivacaine (B group, n=20) or saline (S group, n=20) on each side. In comparison to the control group, the TAP block with bupivacaine lowered post-operative VAS scores by 25%. The total amount of morphine needed in the first 24 h following surgery was also less in the bupivacaine group than in the placebo group (25.89±5.13 mg vs. 62±4.78, $P<0.05$).

The NMDA receptor antagonistic effect of magnesium sulfate, which prevents central sensitization through peripheral nociceptive stimulation, along with its competitive blockage of calcium channels thereby reducing acetylcholine release from presynaptic nerve endings, may be responsible for the analgesic effects of the compound on the peripheral nerves.[10]

In their investigation comprising of 60 patients undergoing upper extremity orthopaedic surgery, Haghighi et al.,[11] concluded that adding a dose of 3 mL of 20% magnesium sulfate with lidocaine (5 mg/kg) prolonged the Motor and Sensory Block of the axillary Brachial Plexus Block.

When 300 mg of $MgSO_4$ was used as an adjuvant with 0.25% bupivacaine while performing the TAP block, Rana et al.,[12] showed a statistically significant longer duration of analgesia. In addition, Munshi et al., noted that 300 mg $MgSO_4$ prolonged post-operative analgesia in LSCS patients.[13]

Dexmedetomidine is alpha 2 adrenergic agonist that acts on the alpha 2c and alpha 2a receptors of the dorsal horn of the spinal cord to reduce glutamate and substance P release as well as the hyperpolarization of neurons. When used as an adjuvant, it extends the duration of the effects of LAs. The C fibers, that are not myelinated, are more common in sensory block. In addition, it has an opioid-sparing effect. Typical negative effects include bradycardia and hypotension due to reduction in central sympathetic drive.[14]

According to a study, TAP block following abdominal hysterectomy with bupivacaine and dexmedetomidine (BD) raised the mean time to first morphine use (470 vs. 280 min), reduced the overall dosage of morphine used postoperatively, and had a smaller VAS score at 8 h following surgery when compared with bupivacaine alone.[15] A different study found that, when contrasted with bupivacaine alone, TAP block with BD reduced the VAS scores for up to 24 h after surgery and decreased total post-operative morphine consumption.[16]

Ammar and Mahmoud[17] in accordance with what we have found, reported that adding a dose of dexmedetomidine (0.75 μg/kg) to bupivacaine (0.33%) for infraclavicular brachial plexus block in patients undergoing upper extremity surgery accelerated the onset of sensory and motor block, prolonged the duration of postoperative analgesia, and reduced opioid requirement with a lower pain assessment score, but there were no side effects noted in their study.

In 60 patients who were having hand and forearm surgery, Esmaoglu et al.,[18] observed that the axillary brachial plexus block produced by adding a dose of dexmedetomidine (100 μg) to levobupivacaine 0.5% had a rapid onset time, a considerable duration of the block and a prolonged duration of analgesia. In their investigation, bradycardia was listed as an adverse effect as we found in our study.

The research that we conducted and certain previous studies have demonstrated that dexmedetomidine may cause bradycardia and hypotension in certain individuals during and after the surgical procedure.[19]

Therefore, our study clearly supports the previous research work in that both magnesium sulfate and dexmedetomidine are efficacious in improving the duration and quality of pain relief when mixed with bupivacaine for post-operative pain relief after cesarean section.

Limitations of the study

Study was small sample size, short study duration, and difficult logistics.

CONCLUSION

- Magnesium sulfate and Dexmedetomidine were useful adjuvants to bupivacaine for TAP block in improving the post-operative pain relief of parturients undergoing cesarean delivery
- Dexmedetomidine provided lesser need for post-operative rescue analgesics, but the incidence of hypotension and bradycardia was higher than magnesium sulfate
- Therefore, it can be concluded that both Dexmedetomidine and magnesium sulfate can be safely used as an adjuvant to PNS-guided TAP block to provide post-operative pain relief after cesarean delivery while reducing the consumption of other analgesics without significant side effects.

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