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Comparison of Fentanyl Vs. Nalbuphine as Adjuvants to Bupivacaine for Spinal Anesthesia in Elective C-Sections

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HIGHLIGHTS

1. Fentanyl provides faster onset of anesthesia.
2. Nalbuphine offers prolonged post operative pain relief.
3. Fentanyl shows higher incidence of itching.
4. Nalbuphine reduces risk of respiratory depression.
5. Both drugs ensure effective C-section anesthesia.

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ABSTRACT

Introduction: Spinal anesthesia is widely used for lower segment caesarean sections (LSCS) due to its effectiveness and minimal motor blockade, facilitating faster recovery. Bupivacaine, commonly used for spinal anesthesia, can have limitations like hypotension and a short duration of action. Adjuvants such as fentanyl and nalbuphine are often added to enhance the anaesthetic effect and prolong pain relief while minimizing side effects. **Objective:** The study aims to compare the efficacy of fentanyl versus nalbuphine as adjuvants to 0.5% bupivacaine for spinal anesthesia in LSCS, focusing on analgesic duration, sensory and motor block onset, and adverse effects. **Methods:** This prospective, randomized controlled study included 80 ASA I and II full-term parturient women undergoing elective LSCS. Patients were divided into two groups: Group BF received 0.5% bupivacaine with 12.5 µg fentanyl, while Group BN received 0.5% bupivacaine with 0.8 mg nalbuphine. Onset and duration of sensory and motor blockade, duration of analgesia, and adverse events were recorded and analysed using the Mann-Whitney U test for continuous variables and Fisher exact test for categorical variables. **Results:** The duration of analgesia was significantly longer in Group BN (154.8 ± 8.3 min) compared to Group BF (148.1 ± 7.1 min) ($p<0.05$). The onset of sensory block was similar in both groups ($p=0.0533$), while the time to two-segment regression was longer in Group BF (97.8 ± 4.8 min) compared to Group BN (92.3 ± 3.4 min) ($p<0.0001$). No significant differences were found in motor block onset or adverse events between the groups. **Conclusion:** Both fentanyl and nalbuphine, when used as adjuvants to bupivacaine, are effective in enhancing spinal anesthesia during LSCS. Nalbuphine provides longer postoperative analgesia with fewer side effects, making it a favourable alternative to fentanyl.

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INTRODUCTION

Spinal anesthesia is the preferred method for lower segment caesarean sections (LSCS) due to its rapid onset, simplicity, and effectiveness. It involves injecting a local anaesthetic into the subarachnoid space to block pain and sensation in the lower abdomen and legs, making it ideal for caesarean deliveries[1]. One of the major advantages of spinal anesthesia is that it allows the mother to remain conscious and bond with the new-born immediately after delivery, an advantage over general anesthesia, which causes complete unconsciousness[2].

Adequate pain control during LSCS is crucial for both maternal comfort and the success of the surgery. Inadequate pain management can cause maternal distress, potentialy complicating the procedure and delaying recovery[3].

Additionally, stable blood pressure must be maintained during spinal anesthesia, as it often causes a sudden drop in blood pressure due to the sympathetic blockade. If not managed, this hypotension can reduce placental blood flow, increasing the risk of fetal complications such as acidosis. Therefore, proper pain control and stable hemodynamic are essential for favourable maternal and neonatal outcomes[4].

Bupivacaine is the most commonly used local anaesthetic in spinal anesthesia for caesarean sections due to its long duration and effective sensory block. It provides sufficient anesthesia for the length of the procedure, and its minimal impact on motor function supports quicker post-operative recovery[5].

However, bupivacaine has limitations when used alone. Its effects typically last between 90 and 120 minutes, which may be insufficient for longer surgeries. Once the anesthetic wears off, patients may experience discomfort, requiring additional pain relief measures. Moreover, while bupivacaine is effective, using higher doses can increase the risk of complications such as hypotension and bradycardia[6].

To address these limitations, adjuvants are often added to bupivacaine to enhance its effectiveness, prolong its duration, and reduce the need for additional pain relief post-surgery[7]. The combination of bupivacaine with adjuvants allows for lower doses of bupivacaine, which minimizes side effects while still providing effective anesthesia. Adjuvants also help extend both the sensory and motor blockade, providing prolonged pain relief during and after surgery, reducing the need for post-operative pain management interventions[8].

Opioids such as fentanyl and nalbuphine are commonly used adjuvants in spinal anesthesia for LSCS because they offer distinct advantages when combined with bupivacaine. Fentanyl is a synthetic opioid with a fast onset and short duration, making it an effective complement to bupivacaine. It improves intraoperative pain control without significantly increasing motor blockade[9]. By enhancing the sensory block, fentanyl provides better pain management during surgery and reduces the need for additional analgesics afterward. While fentanyl can cause side effects such as itching and mild respiratory depression, these are generally well-tolerated when used in low doses intrathecally[10].

Nalbuphine, an opioid with both agonist and antagonist properties, provides excellent pain relief while minimizing common opioid-related side effects such as nausea, vomiting, and respiratory depression. When combined with bupivacaine, nalbuphine extends post-operative pain relief, reducing the need for further opioid use after surgery. Its dual action makes nalbuphine a favourable option for patients who are sensitive to opioids or at higher risk of experiencing opioid-related complications[11].

Fentanyl is highly lipophilic, meaning it acts quickly when administered intrathecally by binding to mu-opioid receptors in the spinal cord. This inhibits the transmission of pain signals to the brain, providing rapid and localized pain relief[12]. Research shows that adding fentanyl to bupivacaine enhances both the quality and duration of spinal anesthesia. Patients experience better pain control during surgery and require fewer additional analgesics, resulting in higher overall satisfaction[13].

However, fentanyl does come with side effects. The most common is pruritus (itching), though this is typically mild. Respiratory depression is another possible side effect, though it is less common with fentanyl compared to other opioids due to its rapid uptake and shorter duration of action. Nausea and vomiting can also occur but are usually manageable with medications. Despite these potential side effects, fentanyl remains a valuable adjuvant in caesarean sections[14].

Nalbuphine acts as an agonist at kappa-opioid receptors and an antagonist at mu-opioid receptors. This mechanism provides effective pain relief without many of the side effects associated with mu-opioid agonists, such as itching and respiratory depression 15. Its ability to enhance the analgesic effects of bupivacaine without significantly impacting motor function allows for faster post-operative recovery and early mobilization. Nalbuphine's increasing popularity stems from its favourable side-effect profile, as it significantly reduces opioid-related complications while prolonging post-operative pain relief[16].

Nalbuphine provides similar pain relief to other opioids like fentanyl but with fewer side effects. Its action as a mu-antagonist lowers the risk of itching, a common issue with opioids, making it ideal for patients sensitive to such effects[17]. Additionally, its reduced risk of respiratory depression is particularly valuable in caesarean sections, ensuring safety for both mother and new-born. Selecting the right adjuvant is essential for optimizing anesthesia outcomes. Fentanyl and nalbuphine, when combined with bupivacaine, improve anesthesia quality, extend pain relief, and lead to faster recovery, making nalbuphine a safer, effective alternative to traditional opioids[18].

The aim of this study is to compare the effects of adding fentanyl versus nalbuphine as adjuvants to 0.5% bupivacaine for spinal anesthesia in patients undergoing elective lower-segment caesarean sections. The primary objective is to evaluate the duration of analgesia provided by each adjuvant. Secondary objectives include comparing the onset of sensory and motor blockade, assessing the time to two-segment regression and the

duration of motor blockade, and monitoring for adverse events such as respiratory depression, nausea, vomiting, pruritus, sedation, and the Apgar score of the new-born.

MATERIALS AND METHODS

After Institutional Ethical Committee approval, this study was conducted in the Department of Anaesthesiology, ESIC Medical College & PGIMSR, Bangalore, from March 2021 to August 2022. It included full-term singleton parturient, ASA physical status 1 and 2, aged 18-40 years, enrolled for elective caesarean delivery. Exclusions were based on age, height, contraindications to spinal anesthesia, morbid obesity, emergency caesarean sections, and complicated pregnancies.

Data were analysed using SPSS 20.0. Non-parametric tests were applied, including the Mann-Whitney U-Test for continuous variables and Fisher exact test for categorical data. Descriptive statistics included mean, SD, and proportions.

RESULTS

Both the BF and BN groups included 40 patients. The mean age in the BF group was 22.9±1.8 years, with a median of 23 (interquartile range: 21-24). In the BN group, the mean age was 23.8±1.9 years, with a median of 24 (interquartile range: 22-25). There was no statistically significant difference in age between the groups. More patients aged 20-24 were present in the BF group (n=34) compared to the BN group (n=27).

Table 1: Comparison of Height in the Study Subjects Among the Groups

Height (Cms)	Mean ± SD	Median (Q1-Q3)	T-Test	P-Value
Group BF n=40	160.9±4.8	162 (156.5-164)	2.776	0.0070
Group BN n=40	158.2±3.7	158 (154.5-161.5)		

The mean height in the BF group was 160.9±4.8 cm, with a median of 162 (interquartile range: 156.5-164). In the BN group, the mean height was 158.2±3.7 cm, with a median of 158 (interquartile range: 154.5-161.5). A statistically significant difference was found between the two groups, with a p-value of 0.0070,

Table 2: Comparison of Duration of Surgery in the Study Subjects Among the Groups

Duration of Surgery (Min)	Mean ± SD	Median (Q1- Q3)	Mann-Whitney U	P-Value
Group BF n=40	62.4±4.9	60 (60-65)	519.0	0.0047
Group BN n=40	65.5±5.4	65 (60-70)		

The mean duration of surgery in the BF group was 62.4±4.9 minutes, with a median of 60 (interquartile range: 60-65). In the BN group, the mean duration was 65.5±5.4 minutes, with a median of 65 (interquartile range: 60-70). A statistically significant difference between the two groups was observed, with a p-value of 0.0047 using the Mann-Whitney U test.

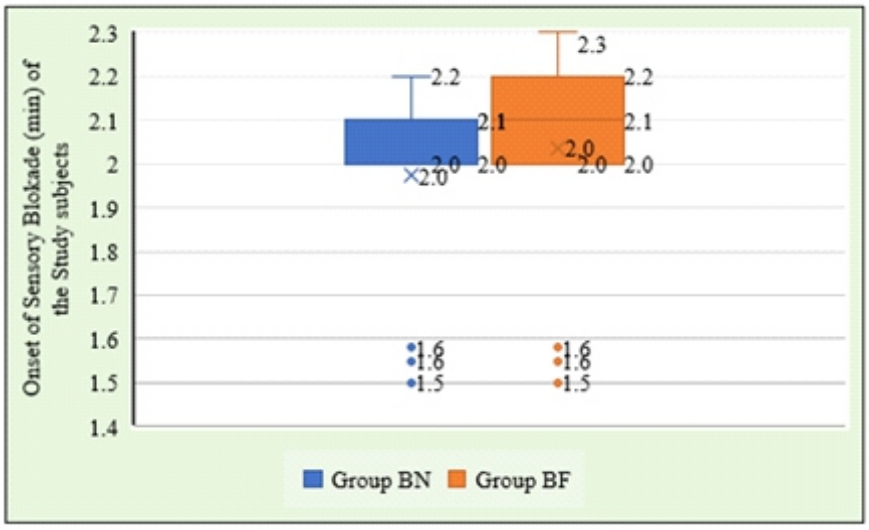

Figure 1: Comparison of Onset of Sensory Blockade in the Study Subjects Among the Groups

The mean onset of sensory blockade in the BF group was 2.0±0.2 minutes, with a median of 2.1 (interquartile range: 2.0-2.2). In the BN group, the mean onset was also 2.0±0.2 minutes,with a median of 2.1 (interquartile range: 2.0-2.1). There was no statistically significant difference between the two groups regarding the onset of sensory blockade, with a p-value of 0.0533

Table 3: Comparison of Onset of Motor Block in the Study Subjects Among the Groups

Onset of Motor Block (min)	Mean ± SD	Median (Q1-Q3)	Mann-Whitney U	P-Value
Group BF n=40	5.3±0.8	6(5-6)	724.0	0.4140
Group BN n=40	5.5±0.5	6(5-6)		

The mean onset of motor block in the BF group was 5.3±0.8 minutes, with a median of 6 (interquartile range: 5-6). In the BN group, the mean onset was 5.5±0.5 minutes, with a median of 6 (interquartile range: 5-6). There was no statistically significant difference between the two groups regarding the onset of motor blockade, with a p-value of 0.4140.

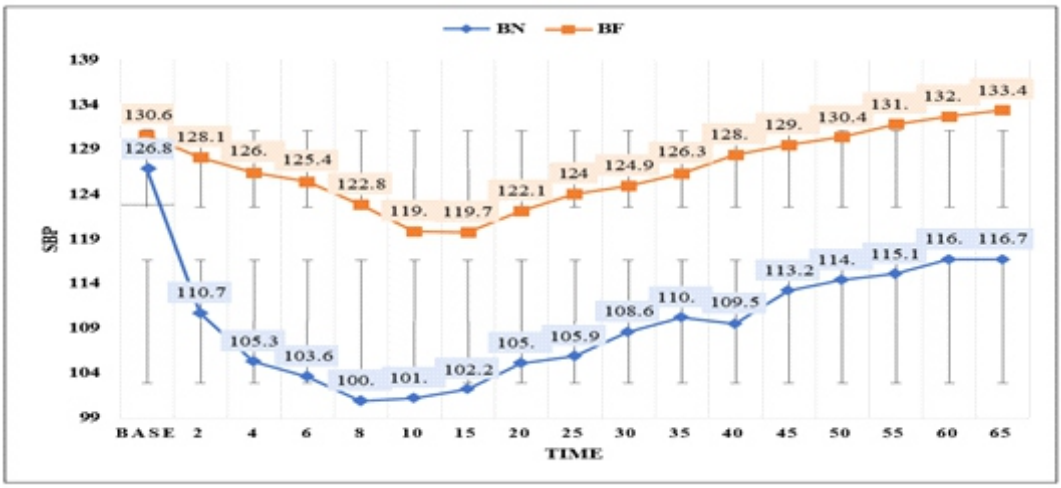

Figure 2: Comparison of SBP at a Different Time Between the Groups

Systolic blood pressure (SBP) was measured every 5 minutes during surgery. The average surgery duration was 65 ± 5.4 minutes in the BN group and 62.4 ± 4.9 minutes in the BF group. Although the baseline SBP showed statistical significance, it lacked clinical relevance. However, the BN group had consistently lower mean blood pressure compared to the BF group throughout the surgery, with statistically significant differences indicated by the p-values.

Table 4: Comparison of Time to two Segment Regression in the Study Subjects Among the Groups

Time to two Segment Regression (min)	Mean ± SD	Median (Q1-Q3)	Mann- Whitney U	P-Value
Group BF n=40	97.8±4.8	95 (95-103.8)	282.0	0.0000
Group BN n=40	92.3±3.4	90 (90-95)		

The mean time to two-segment regression of sensory blockade in the BF group was 97.8±4.8 minutes, with a median of 95 minutes (interquartile range: 95-103.8). In the BN group, the mean time was 92.3±3.4 minutes, with a median of 90 minutes (interquartile range: 90-95). A statistically significant difference was observed between the two groups regarding time to two-segment regression, with a p-value of <0.0001.

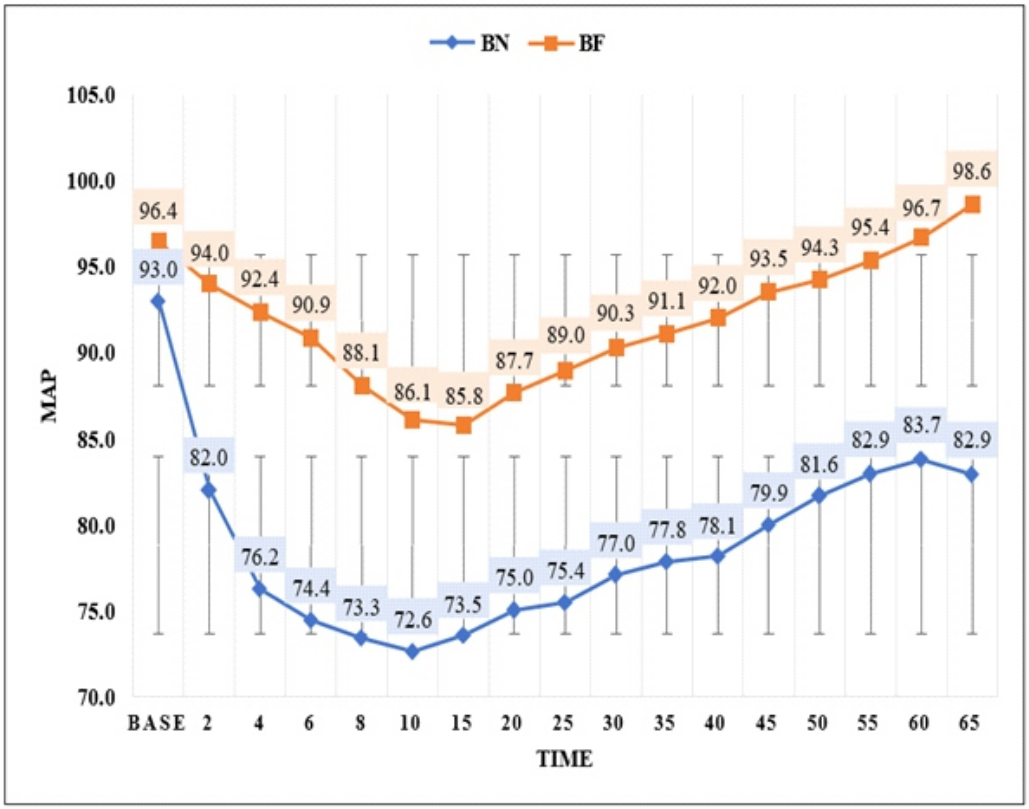

Figure 3: Comparison of MAP at a Different Time Between the Groups

Mean arterial pressure (MAP) was measured every 5 minutes during surgery, with the average duration being 65 ± 5.4 minutes in the BN group and 62.4 ± 4.9 minutes in the BF group. Although the baseline MAP was statistically significant, it had no clinical relevance. However, throughout the surgery, the BN group consistently showed lower mean MAP compared to the BF group, and this difference was statistically significant.

Table 5: Comparison of APGAR Score Among the Groups

Apgar Score	Group BN n=40	Group BF n=40	T-Test	P-Value
5 MIN	8.7 ± 0.5	8.3 ± 0.6	3.798	0.00029
10 MIN	9.0 ± 0.2	9.0 ± 0.2	0.00	1.00

The fetal Apgar score was recorded at 5 and 10 minutes in both groups. At 5 minutes, the score was significantly higher in the nalbuphine group than in the fentanyl group, though this difference was not clinically significant. At 10 minutes, the scores were comparable between the two groups.

DISCUSSION

Regional anesthesia is the preferred technique for caesarean sections, with bupivacaine commonly used for spinal anesthesia, providing 90 to 120 minutes of action. Opioids are frequently used as adjuvants to prolong the blockade and analg-

-esia. Commonly used opioids include fentanyl, morphine, buprenorphine, and nalbuphine. In this study, we compared fentanyl and nalbuphine as adjuvants in caesarean sections. A prospective, randomized controlled study was conducted to compare postoperative analgesia duration, hemodynamic parameters, and neonatal outcomes between the BN and BF groups[19].

In our study, we used 0.8 mg of nalbuphine as an adjuvant to intrathecal bupivacaine, based on Culebras et al.'s findings that it is the minimum effective dose for caesarean sections. We compared this with 12.5 µg of fentanyl, as the equipotent dose ratio of nalbuphine to fentanyl is 1:100. The minimum recommended dose of fentanyl for caesarean sections is 12.5 µg. Previous studies have also compared 0.8 mg of nalbuphine with 25 and 20 µg of fentanyl as intrathecal adjuvants 20.

In our study, the onset of sensory block was 2 ± 0.2 minutes in both groups, with a p-value of 0.0533, showing no statistically significant difference. Sharma et al. found an earlier onset in the intrathecal fentanyl group compared to nalbuphine, which was statistically significant. Gomaa et al. and Geetha et al. found no difference in sensory block onset between fentanyl and nalbuphine, consistent with Bindra et al. The maximum sensory block height (T4-T6) was similar across studies. The time to two-segment regression was longer in the fentanyl group (97.8 ± 4.8) than in the nalbuphine group (92.3 ± 3.4), statistically significant but not clinically relevant. Sharma et al. found similar results, while Gomaa et al. reported comparable regression times between groups. Geetha et al. and Bisht et al. found longer regression times in the nalbuphine group, though they used higher doses[21,22,23,24,25].

In our study, the time to reach Bromage scale 3 for motor block was 5.3 ± 0.8 minutes in the fentanyl group and 5.5 ± 0.5 minutes in the nalbuphine group, with no statistically significant difference. Geetha et al. and Bindra et al. also reported no significant difference between the two groups. However, Gomaa et al., Bisht et al., and Sharma et al. found a significantly faster onset of motor block in the fentanyl group, using higher doses of fentanyl. The mean time to motor block regression to Bromage 0 was 182.9 ± 3.7 minutes in the fentanyl group and 181.8 ± 5.6 minutes in the nalbuphine group, with no significant difference. Geetha et al. and Gomaa et al. observed similar results, while Bisht et al. found a significantly shorter regression time in the fentanyl. group ($p<0.001$)[21,22,23,24,25].

In our study, the duration of complete analgesia was significantly longer in the nalbuphine group (154.8 ± 8.3 min) compared to the fentanyl group (148.1 ± 7.1 min), though the difference was only 6 minutes. Gomaa et al. also observed prolonged analgesia in the nalbuphine group, though not statistically significant. The duration of effective analgesia was 191 ± 9 minutes in the nalbuphine group, compared to 188.3 ± 5.7 minutes in the fentanyl group. Bisht et al., Bindra et al., and Geetha et al. found similar results, with longer analgesia in the nalbuphine group[22,23,24,25].

Intraoperatively and postoperatively, no clinically significant change in heart rate was observed between the groups. Hypotension occurred in both groups but was easily corrected with IV fluids and 6 mg of Injection mephenteramine. Similar findings were reported by Gomaa et al., with no significant differences in hemodynamic variables. In our study, there was also no significant drop in oxygen saturation during the intraoperative or postoperative period[22].

In our study, there was no statistically significant difference in the incidence of nausea and vomiting between the nalbuphine and fentanyl groups. No cases of shivering, respiratory depression, or pruritus were observed, aligning with findings by Gomaa et al., Geetha et al., and Bindra et al. The fetal Apgar scores showed no clinically significant difference between the two groups, further confirming the results of these studies[22,23,24].

CONCLUSION

Intrathecal nalbuphine (0.8 mg) and intrathecal fentanyl (12.5 µg), when used as adjuvants to 0.5% hyperbaric bupivacaine in patients undergoing caesarean sections under subarachnoid block, are effective in enhancing outcomes. Both agents increase the duration of sensory block and prolong analgesia without a significant increase in side effects. As a result, fentanyl and nalbuphine can both be considered effective adjuvants to spinal local anaesthetics, offering extended pain relief and improvedsen sory blockade during caesarean sections without compromising safety.

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