



LOWER THORACIC SPINE SURGERIES UNDER SPINAL ANESTHESIA: A NOVEL INITIATIVE

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Abstract

Background: Spinal anesthesia is a safe and effective alternative to general anesthesia for patients undergoing lumbar spine surgery, and numerous reports have demonstrated its advantages. **Aim:** To compare the efficacy of intrathecal tramadol and fentanyl as adjuvants to bupivacaine in lower thoracic spine surgeries. **Methods:** The study was carried out in the Department of Anesthesiology at Government Medical College (GMC) Anantnag. The study included 60 patients who were equally divided into two groups, Group T (tramadol-bupivacaine) and Group F (fentanyl-bupivacaine), to compare the efficacy of intrathecal tramadol and fentanyl as adjuvants to bupivacaine in lower thoracic spine surgeries. Group-F received 0.5% bupivacaine heavy 3 ml (15 mg) + fentanyl 0.5 ml (25 µg) intrathecally, and Group-T received 0.5% bupivacaine heavy 3 ml (15 mg) + tramadol 0.5 ml (25 mg) intrathecally. Both groups were observed for characteristics of motor and sensory blockade, hemodynamic parameters, and perioperative complications. Patients were monitored for a Ramsay score for sedation, a VAS score for pain, and the time required for post operative analgesia. **Results:** The onset of sensory blockade was significantly faster in Group F (4.5 ± 0.9 minutes) compared to Group T (6.3 ± 1.1 minutes, $p < 0.001$). Similarly, the onset of motor blockade was significantly earlier in Group F (5.1 ± 1.0 minutes) than in Group T (7.2 ± 1.3 minutes, $p < 0.001$). The duration of sensory blockade was significantly longer in Group F (233.4 ± 18.6 minutes) compared to Group T (210.5 ± 17.4 minutes, $p < 0.001$). Likewise, the duration of motor blockade was significantly prolonged in Group F (180.2 ± 15.3 minutes) compared to Group T (162.7 ± 14.2 minutes, $p < 0.001$). The duration of postoperative analgesia, which is a crucial factor in pain management, was also significantly greater in Group F (340.1 ± 25.7 minutes) than in Group T (280.3 ± 22.6 minutes, $p = 0.002$). **Conclusion:** This study found that fentanyl demonstrated a significantly faster onset and longer duration of both sensory and motor blockade compared to tramadol. Additionally, fentanyl provided superior postoperative analgesia with fewer adverse effects, particularly nausea and vomiting.

Keywords: Lower thoracic spine surgeries, spinal anaesthesia, Bupivacaine, Fentanyl, Tramadol, VAS, Postoperative analgesia

Introduction

The thoracic spine plays a crucial role in maintaining posture, protecting vital organs, and facilitating movement. It consists of twelve vertebrae (T1 to T12) and extends from the base of the neck to approximately five inches below the shoulder blades. Unlike the lumbar spine, the thoracic region has limited mobility, which is essential for safeguarding the heart, lungs, and other vital structures. Due to its anatomical and functional significance, lower thoracic spine surgeries are performed to address various degenerative, traumatic, and neoplastic conditions. These surgeries encompass a wide range of procedures, including discectomies, laminectomies, and spinal fusions. However, postoperative pain in this patient population can be severe and challenging to manage due to extensive tissue trauma, nerve root manipulation, and musculoskeletal involvement. Inadequate pain control not only compromises patient comfort but also impedes early mobilization and rehabilitation, potentially prolonging hospital stays and increasing the risk of complications.

Spinal anesthesia is a preferred modality for surgeries involving the lower half of the body due to its efficacy, rapid onset, and inherent benefits such as reduced blood loss and protection against thromboembolic events. Local anesthetics, such as bupivacaine, are commonly used for intrathecal anesthesia, providing effective sensory and motor blockade. However, the duration of analgesia provided by local anesthetics alone may be insufficient for prolonged postoperative pain relief. To enhance the duration of analgesia and improve patient outcomes, various adjuvants have been explored and incorporated into intrathecal anesthesia protocols. Among these, opioids such as morphine, fentanyl, and tramadol have been widely utilized due to their ability to provide effective and prolonged postoperative analgesia. However, opioid use is associated with adverse effects, including respiratory depression, pruritus, nausea, vomiting, and urinary retention.

Fentanyl is a lipophilic opioid that exerts its analgesic effects by binding to mu-opioid receptors, resulting in potent pain relief. It is approximately 75-100 times more potent than morphine and is commonly used intrathecally to enhance sensory blockade and extend the duration of analgesia. A key advantage of intrathecal fentanyl is its minimal impact on motor blockade, allowing for effective pain relief while preserving motor function, which is particularly beneficial in postoperative recovery. Despite its benefits, intrathecal fentanyl use requires careful monitoring due to potential side effects such as respiratory depression, pruritus, and nausea.

Tramadol, a centrally acting analgesic, possesses both opioid and non-opioid mechanisms of action. It acts as a weak mu-opioid receptor agonist while also inhibiting serotonin and norepinephrine reuptake, modulating pain perception. Unlike traditional opioids, tramadol has a lower risk of respiratory depression and other opioid-related side effects, making it an attractive alternative for intrathecal analgesia. However, preservative-containing tramadol formulations may pose a risk of neurotoxicity when administered intrathecally. Therefore, in this study, preservative-free tramadol will be used to evaluate its efficacy and safety in intrathecal anesthesia.

Given the need for effective postoperative pain management in lower thoracic spine surgeries, this study aims to compare the effects of intrathecal fentanyl-bupivacaine and tramadol-bupivacaine combinations.

Materials and methods

Study Design and Setting

This observational study was conducted to evaluate the effect of intrathecal fentanyl-bupivacaine and tramadol-bupivacaine combinations in patients undergoing lower thoracic spine surgeries. The study was carried out in the Department of Anesthesiology at Government Medical College (GMC) Anantnag.

Inclusion and Exclusion Criteria

Inclusion Criteria:

Patients who fulfilled the following criteria were included in the study:

1. Individuals aged between 18 and 60 years.

2. Patients classified as American Society of Anesthesiologists (ASA) grade I or II.
3. Patients scheduled to undergo lower thoracic spine surgeries (T7-T12) under spinal anesthesia.
4. Patients who voluntarily provided informed consent for participation in the study.

Exclusion Criteria:

Patients were excluded from the study if they met any of the following conditions:

1. History of hypersensitivity or contraindications to bupivacaine or fentanyl.
2. Higher thoracic spine surgeries (T1-T6)
3. Refusal to participate in the study.
4. History of alcohol or drug abuse.
5. Current use of sedatives or hypnotics.
6. Presence of uncontrolled hypertension, hyperthyroidism, cardiovascular disease, psychiatric disorders, or diabetes.

Sample size estimation

The sample size was determined using the standard formula for comparing two independent means. The formula used for sample size estimation was:

$$N_{\text{each group}} = (Z_{1-\alpha/2} + Z_{\beta})^2 \times (SD_1^2 + SD_2^2) / d^2$$

Considering expected standard deviation (SD) of Tramadol group being 15.1 and that of fentanyl group being 14.8 mins and d being 50 mins as per the study conducted by Afolayan et al., the calculated sample for each group was 26.8, which was rounded off to 30 in each group.

Study Procedure

As the procedure was routinely performed using one or the other drug combination, patients were allocated accordingly, and outcomes were observed. The anesthesia technique was standardized for all participants. After obtaining informed consent, patients underwent a preoperative assessment, including baseline demographic data collection such as age, sex, weight, and medical history. Routine preoperative investigations were reviewed to ensure eligibility.

On the day of surgery, spinal anesthesia was administered in a standardized manner. Spinal was given in lateral or sitting position as per patient comfort and safety. Free flow of cerebrospinal fluid (CSF) was confirmed, and one of the two anesthetic combinations was injected intrathecally. After giving spinal in the L3-L4 space, the patients were put in slight trendelenburg (head down) position before spinal drug sets in till desired level was reached above the level of concerned dermatome.

- **Group F:** Bupivacaine with fentanyl.
- **Group T:** Bupivacaine with tramadol (preservative-free).

Following the administration of spinal anesthesia, sensory and motor blockade levels were assessed at regular intervals. The onset and duration of sensory blockade were evaluated using the pinprick method, while motor blockade was assessed using the modified Bromage scale.

Data Collection and Monitoring

Baseline characteristics, including demographic details and medical history, were documented before the procedure. Intraoperative data, including sensory and motor blockade onset times, duration of surgery, hemodynamic parameters, and intraoperative complications, were recorded. Postoperatively, pain intensity was assessed at predefined intervals using a validated pain scale, and the duration of analgesia was noted. Any postoperative adverse effects were documented. Patients were monitored in the postoperative period for at least 24 hours to ensure the safety and effectiveness of the administered anesthetic regimen.

Statistical Analysis

The collected data were compiled and analyzed using appropriate statistical methods. Continuous variables were expressed as mean $\pm$ standard deviation (SD), while categorical variables were presented as frequencies and percentages. The comparison of sensory and motor blockade durations, hemodynamic parameters, and postoperative pain scores between the two groups was performed using appropriate statistical tests. A *p*-value of <0.05 was considered statistically significant.

Results

The sociodemographic characteristics of the patients, as detailed in Table 1, revealed no statistically significant differences between the two groups. The block-related characteristics of the patients, as summarized in Table 2, indicated significant differences between the two groups. The onset of sensory blockade was significantly faster in Group F (4.5 ± 0.9 minutes) compared to Group T (6.3 ± 1.1 minutes, $p < 0.001$). Similarly, the onset of motor blockade was significantly earlier in Group F (5.1 ± 1.0 minutes) than in Group T (7.2 ± 1.3 minutes, $p < 0.001$). The duration of sensory blockade was significantly longer in Group F (233.4 ± 18.6 minutes) compared to Group T (210.5 ± 17.4 minutes, $p < 0.001$). Likewise, the duration of motor blockade was significantly prolonged in Group F (180.2 ± 15.3 minutes) compared to Group T (162.7 ± 14.2 minutes, $p < 0.001$). The duration of postoperative analgesia, which is a crucial factor in pain management, was also significantly greater in Group F (340.1 ± 25.7 minutes) than in Group T (280.3 ± 22.6 minutes, $p = 0.002$).

The incidence of adverse events among the patients is presented in Table 3. Nausea was reported in 26.7% of patients in Group T and 10% in Group F, with a statistically significant difference ($p = 0.041$). Vomiting was more frequent in Group T (23.3%) than in Group F (6.7%), though the difference did not reach statistical significance ($p = 0.078$). The incidence of respiratory depression was identical in both groups (3.3%), and no statistically significant difference was observed ($p = 1.000$). Hypotension was slightly more frequent in Group T (23.3%) compared to Group F (13.3%), but the difference was not statistically significant ($p = 0.213$).

Table 1. sociodemographic characteristics of the patients

Parameters	Group T	Group F	p-value
Mean age (years)	46.7 $\pm$ 7.9	45.3 $\pm$ 8.2	0.672
Mean weight (kg)	69.1 $\pm$ 7.1	68.5 $\pm$ 6.5	0.721
ASA I	24 (80)	22 (73.3)	0.562

Table 2. Block related characteristics of the patients

Parameters	Group T	Group F	p-value
Onset of sensory blockade (min)	6.3 $\pm$ 1.1	4.5 $\pm$ 0.9	$<0.001^*$
Onset of motor blockade (min)	7.2 $\pm$ 1.3	5.1 $\pm$ 1.0	$<0.001^*$
Duration of sensory blockade (min)	210.5 $\pm$ 17.4	233.4 $\pm$ 18.6	$<0.001^*$
Duration of motor blockade (min)	162.7 $\pm$ 14.2	180.2 $\pm$ 15.3	$<0.001^*$
Duration of postoperative analgesia (min)	280.3 $\pm$ 22.6	340.1 $\pm$ 25.7	0.002*

Table 3. Incidence of adverse events the patients

Adverse events	Group T	Group F	p-value
Nausea	8 (26.7)	3 (10)	0.041*
Vomiting	7 (23.3)	2 (6.7)	0.078
Respiratory depression	1 (3.3)	1 (3.3)	1.000
Hypotension	7 (23.3)	4 (13.3)	0.213

Discussion

The present study compared the efficacy of intrathecal fentanyl-bupivacaine and tramadol-bupivacaine combinations in patients undergoing lower thoracic spine surgeries. The findings indicated that fentanyl provided a faster onset of both sensory and motor blockade, a longer duration of analgesia, and fewer adverse effects compared to tramadol.

The onset of sensory blockade was significantly quicker in the fentanyl group (4.5 ± 0.9 minutes) compared to the tramadol group (6.3 ± 1.1 minutes, $p < 0.001$). These results align with the findings of *Arora et al. (2022)*, who reported that fentanyl led to a faster sensory block onset compared to tramadol in cesarean section patients ($p < 0.001$). Similarly, *Raju et al. (2017)* found that fentanyl achieved peak sensory block at T4 compared to T5 with tramadol, supporting its quicker effect.

The onset of motor blockade was also significantly faster with fentanyl (5.1 ± 1.0 minutes) than with tramadol (7.2 ± 1.3 minutes, $p < 0.001$). *Rani et al. (2022)* reported comparable results, indicating that fentanyl produced a more rapid onset of motor blockade than tramadol in lower abdominal surgeries.⁴ The study by *Dalvi et al. (2016)* further supports these findings, demonstrating a significantly quicker motor block onset with fentanyl compared to tramadol ($p < 0.05$).

The duration of sensory blockade was significantly prolonged in the fentanyl group (233.4 ± 18.6 minutes) compared to the tramadol group (210.5 ± 17.4 minutes, $p < 0.001$). These findings are in agreement with *Sree et al. (2023)*, who reported similar durations for sensory blockade with fentanyl and tramadol but noted superior postoperative analgesia with fentanyl. Likewise, *Avinash et al. (2020)* found that fentanyl extended sensory blockade duration longer than tramadol but was still inferior to clonidine in prolonging analgesia.

Similarly, the duration of motor blockade was significantly longer in the fentanyl group (180.2 ± 15.3 minutes) compared to the tramadol group (162.7 ± 14.2 minutes, $p < 0.001$). This observation is consistent with *Zahid et al. (2017)*, who found that tramadol resulted in shorter motor block duration compared to fentanyl ($p < 0.05$). *Afolayan et al. (2014)* also reported that fentanyl resulted in more prolonged anesthesia than tramadol in patients undergoing open appendectomy.

Postoperative analgesia was notably superior in the fentanyl group (340.1 ± 25.7 minutes) compared to the tramadol group (280.3 ± 22.6 minutes, $p = 0.002$). The results correspond with *Dalvi et al. (2016)*, who reported that fentanyl significantly prolonged postoperative analgesia compared to tramadol ($p < 0.001$). Similarly, *Subedi et al. (2013)* found that fentanyl provided effective postoperative pain relief but tramadol exhibited a slightly longer analgesia duration in their study on cesarean section patients.

Adverse event analysis revealed that nausea and vomiting were more frequent in the tramadol group than in the fentanyl group ($p = 0.041$ and $p = 0.078$, respectively). This finding corroborates *Sawhney et al. (2019)*, who found a higher incidence of nausea and vomiting with tramadol compared to fentanyl. Respiratory depression was comparable in both groups (3.3%), consistent with *Kumar et al. (2011)*, who found no significant differences in respiratory effects between fentanyl and butorphanol groups.

Conclusion

This study found that fentanyl demonstrated a significantly faster onset and longer duration of both sensory and motor blockade compared to tramadol. Additionally, fentanyl provided superior postoperative analgesia with fewer adverse effects, particularly nausea and vomiting. These findings align with previous research, reinforcing the advantage of fentanyl as an intrathecal adjuvant. Given its efficacy in prolonging analgesia and minimizing complications, fentanyl appears to be the preferred choice over tramadol for spinal anesthesia in lower thoracic spine surgeries. Future studies with larger sample sizes are recommended for further validation.

Conflict of interest: Nil

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