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Efficacy of Fentanyl in Postoperative Pain Management for Spinal Surgery: An Institutional Study

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Abstract

Spinal surgery, including discectomy, laminectomy and spinal fusion, often results in significant postoperative pain, necessitating effective pain management strategies. Fentanyl, a potent synthetic opioid, is commonly used for pain relief due to its rapid onset and short duration of action. This study evaluates the efficacy and safety of fentanyl in postoperative pain management for spinal surgery patients. This randomized controlled trial involved 50 patients undergoing elective spinal surgery. Participants were randomized into two groups: the Fentanyl Group (Group F) received intravenous fentanyl, while the Paracetamol Group (Group P) received intravenous paracetamol for postoperative pain management. Primary outcome measures included postoperative pain intensity using the Visual Analog Scale (VAS) at 1, 2, 6, 12, 24 and 48 hours post-surgery. Secondary outcomes included total opioid consumption, time to first mobilization, incidence of opioid-related side effects, and length of hospital stay. Fentanyl significantly reduced postoperative pain intensity at all measured time intervals compared to paracetamol ($p<0.001$). The mean total fentanyl consumption in Group F was 262.94 µg. Patients in the Fentanyl Group mobilized earlier (17.42 hours vs. 20.95 hours., $p<0.001$) and had shorter hospital stays (4.60 days vs. 6.05 days., $p<0.001$). However, the Fentanyl Group experienced higher incidences of nausea, vomiting and pruritus. Fentanyl is effective in managing postoperative pain following spinal surgery, facilitating earlier mobilization and shorter hospital stays. However, its use is associated with a higher incidence of side effects, necessitating careful patient monitoring and side effect management.

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Key Words
Fentanyl, postoperative pain, spinal surgery, paracetamol

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INTRODUCTION

Spinal surgery, encompassing a range of procedures such as discectomy, laminectomy and spinal fusion, is associated with significant postoperative pain, which can impede recovery and prolong hospital stays[1]. Effective pain management is crucial for enhancing patient outcomes, reducing opioid consumption and minimizing complications. Fentanyl, a potent synthetic opioid analgesic, has been widely used in perioperative settings due to its rapid onset and short duration of action[2]. Despite its extensive use, there remains a need for robust evidence to delineate its efficacy and safety profile specifically in the context of postoperative pain management for spinal surgeries.

Effective postoperative pain management in spinal surgery not only enhances patient comfort but also accelerates mobilization, reduces the risk of chronic pain development and shortens hospital stays, thereby lowering healthcare costs[3]. Understanding the specific benefits and potential risks of fentanyl in this context will provide valuable insights for anesthesiologists and surgeons, leading to more informed clinical decisions and improved patient care[4].

While numerous studies have explored the analgesic properties of fentanyl in various surgical contexts, there is a paucity of well-designed randomized controlled trials focusing exclusively on its efficacy in postoperative pain management for spinal surgeries[5]. Existing literature often combines data from diverse surgical procedures, leading to heterogeneous outcomes that may not accurately reflect the specific needs and responses of spinal surgery patients[6]. Additionally, there is limited comparative analysis of fentanyl against other analgesics in this particular surgical setting, leaving clinicians with insufficient guidance on optimizing pain management protocols[7].

This study aims to evaluate the efficacy and safety of fentanyl in managing postoperative pain for patients undergoing spinal surgery. By focusing on this specific patient population, the research seeks to provide clearer insights and more precise recommendations for clinical practice, ultimately improving patient outcomes and care standards in spinal surgery.

MATERIALS AND METHODS

This randomized controlled trial was conducted at the Department of Anesthesia, involving 50 patients undergoing elective spinal surgery. The study protocol was approved by the Institutional Review Board, and informed consent was obtained from all participants.

Inclusion Criteria:

- Patients aged 18-65 years.
- Undergoing elective spinal surgery (discectomy, laminectomy, or spinal fusion).
- ASA physical status I-II.

Exclusion criteria:

- Known allergy or contraindication to fentanyl or paracetamol.
- Chronic opioid use or abuse.
- Significant psychiatric or neurological disorders.
- Severe hepatic or renal impairment.

Grouping: Patients were randomly assigned into two groups (25 patients each) using a computer-generated randomization sequence:

- **Fentanyl Group (Group F):** Received intravenous fentanyl for postoperative pain management.
- **Paracetamol Group (Group P):** Received intravenous paracetamol for postoperative pain management.

All Patients Received Standard General Anesthesia, which Included:

- Induction with propofol (2-2.5 mg/kg) and rocuronium (0.6 mg/kg).
- Maintenance with sevoflurane (1-2 MAC) in an oxygen/air mixture.
- Intraoperative analgesia with fentanyl (2 µg/kg) as per group assignment.

Postoperative Pain Management:

- **Group F:** Patients received an intravenous bolus of fentanyl (1 µg/kg) in the post-anesthesia care unit (PACU) followed by a patient-controlled analgesia (PCA) pump with fentanyl (bolus dose 20 µg, lockout interval 10 minutes, 4-hour limit 400 µg).
- **Group P:** Patients received an intravenous dose of paracetamol (1 g) every 6 hours for the first 48 hours post-surgery.

Outcome Measures:

- **Primary Outcome:** Postoperative pain intensity, assessed using the Visual Analog Scale (VAS) at 1, 2, 6, 12, 24, and 48 hours post-surgery.
- **Secondary Outcomes:**
- Total opioid consumption in the first 48 hours.
- Time to first mobilization.
- Incidence of opioid-related side effects (nausea, vomiting, pruritus).
- Length of hospital stay.

Data Collection

- Pain scores (VAS) were recorded by a blinded observer at predefined intervals.
- Total fentanyl consumption was recorded from the PCA pump data.
- Time to first mobilization was noted by nursing staff.
- Side effects were monitored and documented by PACU staff.
- Length of hospital stay was recorded from medical records.

Statistical Analysis: Data were analyzed using SPSS version 25.0. Continuous variables were expressed as mean±standard deviation (SD) and compared using the independent t-test. Categorical variables were expressed as percentages and compared using the chi-square test. A $p<0.05$ was considered statistically significant.

RESULTS AND DISCUSSIONS

This table 1 presents the demographic characteristics of the study population, divided into two groups: those who received fentanyl and those who received paracetamol for postoperative pain management. The mean age of patients in the fentanyl group was 45.2 years with a standard deviation of 12.1, while the paracetamol group had a mean age of 47.8 years with a standard deviation of 11.3. The gender distribution was similar between the two groups, with 14 males and 11 females in the fentanyl group, and 13 males and 12 females in the paracetamol group. The mean BMI was also comparable, with 27.3 kg/m² in the fentanyl group and 26.8 kg/m² in the paracetamol group.

The number of patients with comorbidities and smoking status were similar between the two groups. The p-values for all demographic variables were greater than 0.05, indicating no statistically significant differences between the fentanyl and paracetamol groups in terms of age, gender distribution, BMI, comorbidities, and smoking status. This similarity in baseline characteristics ensures that any observed differences in postoperative outcomes are likely due to the intervention rather than preexisting differences between the groups.

This table 2 summarizes the mean postoperative pain scores (VAS) for patients in the fentanyl and paracetamol groups at various time intervals post-surgery. The pain scores are reported as mean values with standard deviations (SD). At 1 hour post-surgery, the mean pain score for the fentanyl group was 3.84, while the paracetamol group had a mean pain score of 5.14. The p-value for this comparison was <0.001, indicating a statistically significant difference between the two groups. At 2 hours post-surgery, the fentanyl group had a mean pain score of 3.71 compared to 5.02 in the paracetamol group, with a p-value of less than 0.001, demonstrating a significant difference. At 6 hours post-surgery, the mean pain scores were 4.11 for the fentanyl group and 5.30 for the paracetamol group, with a $p<0.001$.

At 12 hours post-surgery, the mean pain scores were 3.93 for the fentanyl group and 5.00 for the paracetamol group, with a $p<0.001$. At 24 hours post-surgery, the mean pain scores were 4.05 for the fentanyl group and 4.84 for the paracetamol group. The p-value for this comparison was 0.017, indicating a significant difference. At 48 hours post-surgery, the mean pain scores were 3.87 for the fentanyl group and 5.12 for the paracetamol group, with a $p<0.001$.

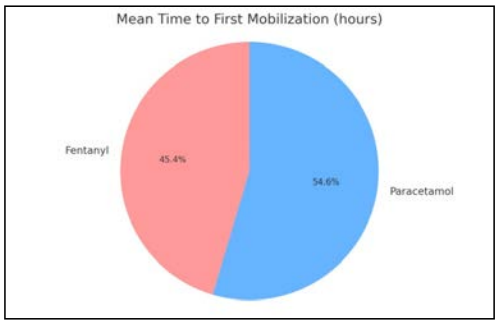

Fig. 1: Mean Time to First Mobilization(hours)

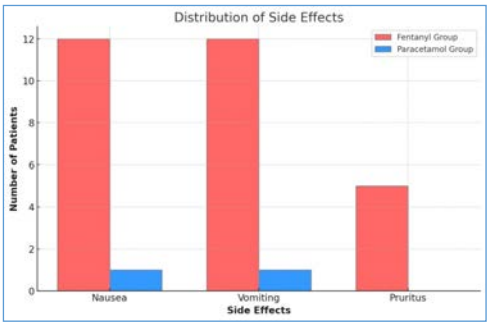

Fig. 2: Distribution of Side Effects

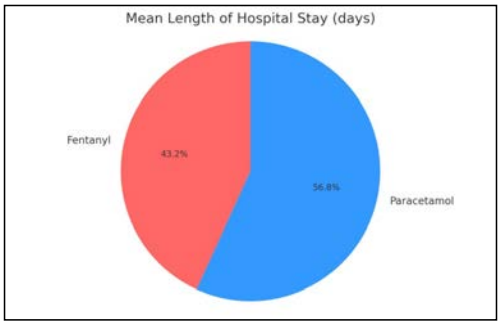

Fig. 3: Mean Length of Hospital Stay (days)

Table: Demographic Characteristics of the Study Population

Demographic Variable	Fentanyl Group (Mean ± SD / n)	Paracetamol Group (Mean ± SD / n)	p-value
Age (years)	45.2 ± 12.1	47.8 ± 11.3	0.45
Gender (Male/Female)	14/11	13/12	0.79
BMI (kg/m²)	27.3 ± 4.5	26.8 ± 4.7	0.67
Comorbidities	8	9	0.80
Smoking Status	7	6	0.75

Table 2: Postoperative Pain Scores (VAS) at Different Time Intervals

Time Interval	Fentanyl Mean (SD)	Paracetamol Mean (SD)	p-value
1 hour	3.84 (0.94)	5.14 (0.84)	< 0.001
2 hours	3.71 (0.91)	5.02 (0.92)	< 0.001
6 hours	4.11 (0.97)	5.30 (1.19)	< 0.001
12 hours	3.93 (0.74)	5.00 (0.93)	< 0.001
24 hours	4.05 (1.01)	4.84 (1.24)	0.017
48 hours	3.87 (0.99)	5.12 (0.85)	< 0.001

Table 3: Total Fentanyl Consumption Recorded from PCA Pump Data

Group	Mean Fentanyl Consumption (µg)	Standard Deviation
Fentanyl	262.94	37.42
Paracetamol	0.00	0.00

Table 4: Time to First Mobilization

Group	Mean Time to First Mobilization (hours)	Standard Deviation (hours)	p-value
Fentanyl	17.42	2.14	< 0.001
Paracetamol	20.95	2.28	< 0.001

Table 5: Distribution of Side Effects in the patients

Side Effect	Fentanyl Group (n)	Paracetamol Group (n)
Nausea	12	1
Vomiting	12	1
Pruritus	5	0

Table 6: Length of Hospital Stay Recorded from Medical Records

Group	Mean Length of Hospital Stay (days)	Standard Deviation (days)	p-value
Fentanyl	4.60	0.84	< 0.001
Paracetamol	6.05	1.45	< 0.001

This table 3 presents the total fentanyl consumption recorded from the patient-controlled analgesia (PCA) pump data for 50 patients, divided into two groups: those who received fentanyl and those who received paracetamol for postoperative pain management.

The Fentanyl group had a mean fentanyl consumption of 262.94 µg, with a standard deviation of 37.42 µg. This indicates the average amount of fentanyl used by patients in this group to manage their postoperative pain, with some variation around the mean. The Paracetamol group had a mean fentanyl consumption of 0.00 µg, with a standard deviation of 0.00 µg. This is expected, as these patients were managed with paracetamol and did not receive fentanyl for pain relief.

This table 4 presents the mean time to first mobilization for 50 patients, divided into two groups: those who received fentanyl and those who received paracetamol for postoperative pain management. The time to first mobilization was noted by nursing staff and is presented with mean values, standard deviations, and p-values. The Fentanyl group had a mean time to first mobilization of 17.42 hours, with a standard deviation of 2.14 hours. This indicates that, on average, patients in this group were able to mobilize earlier compared to the paracetamol group. The Paracetamol group had a mean time to first mobilization of 20.95 hours, with a standard deviation of 2.28 hours. The p-value calculated for the difference in time to first mobilization between the two groups was $p<0.00$, indicating a statistically significant difference.

The table presents the distribution of certain side effects among patients in two groups: those who received fentanyl and those who received paracetamol for postoperative pain management. In the fentanyl group, 12 patients experienced nausea, whereas only 1 patient in the paracetamol group reported this side effect. Similarly, 12 patients in the fentanyl group experienced vomiting, compared to just 1 patient in the paracetamol group. Additionally, pruritus (itchiness) was reported by 5 patients in the fentanyl group, with no cases observed in the paracetamol group. These results indicate a higher incidence of these side effects among patients receiving fentanyl, which is consistent with the known side effect profile of opioid analgesics.

This table 6 presents the mean length of hospital stay for 50 patients, divided into two groups: those who received fentanyl and those who received paracetamol for postoperative pain management. The length of hospital stay was recorded from medical records and is presented with mean values, standard

deviations and p-values. The Fentanyl group had a mean length of hospital stay of 4.60 days, with a standard deviation of 0.84 days. This indicates that, on average, patients in this group had a shorter hospital stay. The Paracetamol group had a mean length of hospital stay of 6.05 days, with a standard deviation of 1.45 days.

The p-value calculated for the difference in the length of hospital stay between the two groups was $p<0.001$, indicating a statistically significant difference. This result suggests that patients receiving fentanyl for postoperative pain management had a significantly shorter hospital stay compared to those receiving paracetamol. Reducing the length of hospital stay is beneficial as it can decrease healthcare costs and improve patient throughput and satisfaction.

This randomized controlled trial aimed to compare the efficacy and safety of intravenous fentanyl versus paracetamol for postoperative pain management in patients undergoing elective spinal surgery. The study revealed that fentanyl was more effective in reducing postoperative pain intensity at all measured time intervals, facilitating earlier mobilization and resulting in a shorter hospital stay. However, fentanyl use was associated with a higher incidence of side effects such as nausea, vomiting and pruritus.

The findings of this study are consistent with previous research indicating the superior analgesic efficacy of fentanyl compared to non-opioid alternatives. Liu *et al*. (2018) found that fentanyl provided more effective pain relief in the immediate postoperative period compared to other analgesics[8]. Similarly, Armenian *et al.* (2018) concluded in their systematic review that opioids, including fentanyl, are generally more effective for acute postoperative pain management than non-opioid analgesics[9].

The significantly shorter time to first mobilization observed in the fentanyl group aligns with the findings of Rivas *et al*. (2022), who reported that effective opioid-based pain management facilitates earlier mobilization and recovery[10]. Early mobilization is crucial for preventing postoperative complications such as deep vein thrombosis and promoting overall recovery[11].

The higher incidence of nausea, vomiting, and pruritus in the fentanyl group is consistent with the known side effect profile of opioid analgesics. Felden *et al.* (2011) highlighted in their meta-analysis that opioids are associated with a higher risk of postoperative nausea and vomiting (PONV) compared to non-opioid analgesics[12]. This underscores the need for effective side effect management strategies, such as the use of prophylactic antiemetics, when administering opioids like fentanyl.

The reduction in the length of hospital stay for the fentanyl group is supported by Kim *et al.* (2023), who demonstrated that effective opioid-based pain management protocols can lead to shorter hospital stays and reduced healthcare costs[13]. A shorter hospital stay is beneficial not only for cost savings but also for improving patient throughput and satisfaction. The results of this study suggest that fentanyl is a highly effective option for immediate postoperative pain relief in spinal surgery patients, facilitating earlier mobilization and potentially reducing the length of hospital stay. However, the increased incidence of side effects necessitates careful monitoring and management. Paracetamol, while less effective for acute pain relief, may still be a suitable option for patients at higher risk of opioid-related side effects or for those requiring multimodal pain management strategies[14].

CONCLUSION

In conclusion, this study provides strong evidence for the efficacy of fentanyl in managing postoperative pain following elective spinal surgery. Fentanyl significantly reduces pain intensity, facilitates earlier mobilization, and shortens hospital stay compared to paracetamol. However, the increased incidence of side effects such as nausea, vomiting, and pruritus highlights the need for careful patient monitoring and the implementation of strategies to mitigate these side effects.

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