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A Comparison of Motor Recovery After Spinal Anesthesia with and Without Fentanyl-Morphine Adjuvants

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ABSTRACT

Spinal anesthesia is a commonly used regional anesthesia technique in various surgical procedures. One important parameter following spinal anesthesia is motor block recovery. Shorter motor recovery duration may benefit patients by reducing side effects and enabling earlier mobilization. This study aimed to compare motor recovery time between spinal anesthesia without adjuvant and spinal anesthesia combined with fentanyl 25 µg and morphine 100 µg. This comparative analytic study used an observational approach with purposive sampling. A total of 84 respondents were divided into two groups: 42 patients received 0.5% bupivacaine 12.5 mg without adjuvant, and 42 patients received 0.5% bupivacaine 10 mg combined with fentanyl 25 µg and morphine 100 µg. Motor recovery time was measured from intrathecal injection to the achievement of a Bromage Score of 0. The mean motor recovery time in the non-adjuvant group was 164.95 ± 24.685 minutes, while the adjuvant group showed a shorter recovery time of 116.90 ± 17.177 minutes. Mann–Whitney analysis demonstrated a statistically significant difference between the two groups ($p < 0.001$). Spinal anesthesia combined with fentanyl and morphine was associated with faster motor recovery compared with spinal anesthesia without adjuvant.

Keywords: Adjuvant, Bromage Score, Duration of Motor Recovery, Spinal Anesthesia

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1. INTRODUCTION

Spinal anesthesia is one of the most commonly used and effective regional anesthesia techniques in various surgical procedures. Unlike general anesthesia, which causes complete loss of consciousness, spinal anesthesia blocks sensation in certain parts of the body while the patient remains conscious. This technique involves injecting local anesthetic agents into the Cerebrospinal Fluid (CSF) surrounding the spinal cord,

specifically into the subarachnoid space between the lumbar vertebrae L3–L4 or L4–L5. The procedure temporarily inhibits nerve signal transmission, resulting in loss of sensation and muscle relaxation in the lower body (Liu, 2024).

A prospective multicenter study involving 67 hospitals in Indonesia, with 1,731 registered subjects, reported that spinal anesthesia was the most frequently used anesthetic technique in obstetric patients undergoing cesarean section (96.42%). However, 1.16% of subjects required conversion to another anesthetic technique (Aryasa et al., 2023). Based on data obtained from RSUD R. Syamsudin, SH, there were 2,016 surgical procedures performed between July and September 2025, of which 712 procedures utilized spinal anesthesia techniques.

Bupivacaine is the most commonly used local anesthetic agent in spinal anesthesia and has become the only approved alternative to lidocaine due to its significantly lower risk of Transient Neurologic Symptoms (TNS). However, the duration of action of bupivacaine (0.5–0.75%) ranges from 3 to 6 hours, which is considered excessively long for many surgical procedures, particularly in outpatient settings. Several studies have demonstrated that lower concentrations of bupivacaine can reduce block duration to approximately 120 minutes (Schubert et al., 2023). To improve analgesic effectiveness and prolong analgesia duration, spinal anesthesia is often combined with adjuvant agents.

Adjuvants are drugs that work synergistically with local anesthetics to enhance the quality and efficacy of regional anesthesia techniques. Adjuvants may accelerate drug onset, prolong analgesia duration, improve analgesic quality, and reduce potential drug-related side effects (Prabhakar et al., 2019). Historically, opioids have been the most widely used adjuvants and possess the greatest amount of safety evidence supporting their use (Prabhakar et al., 2019). Nevertheless, opioid adjuvants are also associated with several adverse effects, including nausea, vomiting, pruritus, and respiratory depression (Pierson et al., 2025). One of the important parameters following spinal anesthesia is motor block recovery.

The Bromage Score is an indicator used to assess motor response after spinal anesthesia. Evaluation of motor block in both conventional spinal anesthesia and spinal anesthesia combined with adjuvants is commonly performed using the Bromage Score assessment (Rusmawati et al., 2024). A shorter duration of motor block may benefit patients by minimizing side effects

and enabling faster motor recovery (Suhanda et al., 2023).

Previous research conducted on patients undergoing cesarean section compared ERACS spinal anesthesia using bupivacaine 7.5 mg combined with fentanyl 25 µg and morphine 100 µg with non-ERACS spinal anesthesia using bupivacaine 12.5 mg. The study demonstrated differences in motor recovery time: patients receiving the ERACS method achieved a Bromage Score of 0 within 26–35 minutes postoperatively, with the fastest recovery occurring within 26–35 minutes and the longest within 56–65 minutes. In contrast, patients receiving the non-ERACS method achieved a Bromage Score of 0 on average within 126–135 minutes postoperatively, with the fastest recovery occurring within 76–85 minutes and the longest within 286–295 minutes (Rusmawati et al., 2024).

In addition, a literature review comparing mobilization differences between conventional post-cesarean section methods and ERACS methods reported that the average mobilization time in conventional post-cesarean section patients was 20.41 hours after surgery. In contrast, in ERACS patients, it was 10.00 hours after surgery. This finding indicated a difference of 10.41 hours, demonstrating that mobilization in ERACS patients was achieved more rapidly compared with conventional methods (Zuleikha et al., 2023).

According to a preliminary survey conducted at RSUD R. Syamsudin, SH, between July and September 2025, 712 surgical procedures were performed using spinal anesthesia. Among these, 496 procedures used 0.5% bupivacaine 12.5 mg without adjuvant, while 216 procedures used 0.5% bupivacaine 10 mg combined with fentanyl 25 µg and morphine 100 µg as adjuvants.

Although previous studies have demonstrated the benefits of ERACS protocols and opioid adjuvants in spinal anesthesia, limited studies have specifically compared motor recovery duration between spinal anesthesia without adjuvant and spinal anesthesia combined with fentanyl 25 µg and morphine 100 µg in clinical practice settings. Therefore, this study is important to evaluate whether the addition of fentanyl and morphine adjuvants can provide faster motor recovery and support enhanced postoperative recovery.

Based on the background above, this study aims to compare motor recovery duration between spinal anesthesia without adjuvant and spinal anesthesia combined with fentanyl 25 µg and morphine 100 µg. The research problem

addressed in this study is whether there is a significant difference in motor recovery time between patients receiving spinal anesthesia without adjuvant and those receiving spinal anesthesia with fentanyl 25 µg and morphine 100 µg.

2. METHODS

This study employed a comparative analytic design with an observational approach. The researcher observed and compared two groups of patients who received different spinal anesthesia techniques according to clinical practice, namely spinal anesthesia without adjuvant and spinal anesthesia combined with fentanyl 25 µg and morphine 100 µg. The study was conducted at the Central Surgical Installation of RSUD R. Syamsudin, SH, Sukabumi City, from June 2025 to April 2026.

The population consisted of patients undergoing surgical procedures with spinal anesthesia techniques at RSUD R. Syamsudin, SH, Sukabumi City. Population refers to the total number of analytical units whose characteristics are to be estimated (Setyawan et al., 2021). Sample size calculation was performed using the Cohen formula with finite population correction, resulting in a total sample of 84 respondents, divided into two groups. Purposive sampling was used. A total of 42 respondents received 0.5% bupivacaine 12.5 mg without adjuvant, while 42 respondents received 0.5% bupivacaine 10 mg combined with fentanyl 25 µg and morphine 100 µg.

The inclusion criteria were adult patients aged ≥18 years undergoing elective surgery with spinal anesthesia, ASA physical status I–II, and willingness to sign informed consent. Exclusion criteria included patients with neurological abnormalities, contraindications to spinal anesthesia, psychiatric disorders interfering with Bromage Score assessment, critical conditions, decreased consciousness, or conversion from spinal anesthesia to general anesthesia.

Variables are variations operationalized quantitatively or qualitatively, depending on the characteristics of research subjects (Anggraeni & Saryono, 2015). The independent variable was the type of spinal anesthesia technique, while the dependent variable was motor recovery duration (Primandita Fitriandi & Rachbini, 2022). Motor recovery was measured from intrathecal injection until Bromage Score 0 was achieved using a wristwatch and Bromage Score assessment (Sandra et al., 2023).

Data were analyzed using computerized statistical software.

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Normality testing was performed using the Shapiro–Wilk test because the sample size in each group was less than 50 (Sutriyawan et al., 2023). Since one group showed a non-normal distribution, data were analyzed using the Mann–Whitney U test to compare motor recovery duration between groups.

3. RESULTS

The results of this study are presented in the following tables, including respondent characteristics, motor recovery duration, and statistical analysis between the study groups.

Table 1. Respondent Characteristics

Respondent Characteristics	Frequency (f)	Percentage (%)
Age:		
Adolescents	1	1.1%
Young Adults	68	81.0%
Middle-Aged Adults	15	17.9%
Early Elderly	0	0.0%
Late Elderly	0	0.0%
Gender:		
Male	24	28.6%
Female	60	71.4%
ASA Physical Status:		
ASA I	51	60.7%
ASA II	33	39.3%
Body Mass Index:		
Underweight	7	8.3%
Normal	37	44.0%
Overweight at Risk	10	11.9%
Obesity I	19	22.6%
Obesity II	11	13.1%
History of Comorbidities:		
None	60	71.4%
Present	24	28.6%
Type of Surgery:		
Hemorrhoid Surgery	2	2.4%
Lower Extremity Surgery	11	13.1%
Hip and Urologic Surgery	4	4.8%
Lower Abdominal Surgery	21	25.0%
Upper Abdominal Surgery/Cesarean Section	46	54.8%
Duration of Surgery:		
Short	57	67.9%
Moderate	27	32.1%
Long	0	0.0%

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Table 1 shows that most respondents were young adults (81.0%), female (71.4%), had ASA physical status I (60.7%), normal body mass index (44.0%), no history of comorbidities (71.4%), underwent upper abdominal surgery or cesarean section (54.8%), and had short duration of surgery (67.9%).

Table 2. Frequency Distribution of Motor Recovery Duration in Spinal Anesthesia Without Adjuvant

Motor Recovery Duration (minutes)	Frequency (f)	Percentage (%)
130	1	2.38%
135	3	7.14%
140	5	11.90%
145	3	7.14%
150	3	7.14%
155	5	11.90%
160	3	7.14%
165	4	9.52%
168	1	2.38%
170	1	2.38%
175	2	4.76%
185	2	4.76%
190	2	4.76%
195	1	2.38%
205	2	4.76%
210	3	7.14%
220	1	2.38%
Total	42	100%

Table 2 shows that the motor recovery duration in the spinal anesthesia without adjuvant group was most frequently observed at 140 and 155 minutes, each accounting for 11.90% of respondents, while the least frequent durations were 130, 168, 170, 195, and 220 minutes, each accounting for 2.38% of respondents.

Table 3. Mean Motor Recovery Duration in Spinal Anesthesia Without Adjuvant

	Minimum	Maximum	Mean	Std. Deviation
Motor Recovery Duration (minutes)	130	220	164.95	24.685

Table 3 shows that the mean motor recovery duration in the spinal anesthesia without adjuvant group was 164.95 ± 24.685 minutes, with a minimum recovery time of 130 minutes and a maximum recovery time of 220 minutes.

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Table 4. Frequency Distribution of Motor Recovery Duration in Spinal Anesthesia with Fentanyl 25 µg and Morphine 100 µg

Motor Recovery Duration (minutes)	Frequency (f)	Percentage (%)
75	1	2.38%
80	1	2.38%
90	3	7.14%
100	3	7.14%
105	3	7.14%
110	4	9.52%
115	6	14.29%
120	5	11.90%
125	4	9.52%
130	2	4.76%
135	6	14.29%
140	3	7.14%
150	1	2.38%
Total	42	100%

Table 4 shows that the motor recovery duration in the spinal anesthesia group with fentanyl 25 µg and morphine 100 µg was most frequently observed at 115 and 135 minutes, each accounting for 14.29% of respondents, while the least frequent durations were 75, 80, and 150 minutes, each accounting for 2.38% of respondents.

Table 5. Mean Motor Recovery Duration in Spinal Anesthesia with Fentanyl 25 µg and Morphine 100 µg

	Minimum	Maximum	Mean	Std. Deviation
Motor Recovery Duration (minutes)	75	150	116.90	17.177

Table 5 shows that the mean motor recovery duration in the spinal anesthesia group with fentanyl 25 µg and morphine 100 µg was 116.90 ± 17.177 minutes, with a minimum recovery time of 75 minutes and a maximum recovery time of 150 minutes.

Table 6. Analysis of Differences in Motor Recovery Duration Between Patients Receiving Spinal Anesthesia Without Adjuvant and Spinal Anesthesia with Fentanyl 25 µg and Morphine 100 µg.

Group	n	Mean ± SD (min)	p
Without adjuvant	42	164.95 ± 24.69	< 0.001*
Fentanyl 25 µg + morphine 100 µg	42	116.90 ± 17.18	

**Mann-Whitney U test, two-tailed.*

Table 6 shows that the mean motor recovery duration in the spinal anesthesia without adjuvant group was 164.95 ± 24.685 minutes, whereas the spinal anesthesia group with fentanyl 25 µg and morphine 100 µg showed a shorter mean recovery duration of 116.90 ± 17.177 minutes. The Mann–Whitney U test demonstrated

a statistically significant difference between both groups (p = 0.000).

4. DISCUSSION

Based on the results presented in Table 1, the majority of respondents were classified as young adults, accounting for 68 respondents (81.0%), female respondents totaling 60 respondents (71.4%), respondents with ASA physical status I totaling 51 respondents (60.7%), respondents with normal Body Mass Index totaling 37 respondents (44.0%), respondents without a history of comorbidities totaling 60 respondents (71.4%), respondents undergoing upper abdominal surgery or cesarean section totaling 46 respondents (54.8%), and respondents undergoing short-duration surgery totaling 57 respondents (67.9%). Theoretically, factors such as age, gender, ASA physical status, Body Mass Index (BMI), type of surgery, and duration of surgery may influence the duration of motor recovery; however, this study did not perform further analysis of the effect of each factor individually.

Based on age characteristics, respondents classified as elderly (>45 years old) have a greater likelihood of achieving Bromage Score 0 more slowly due to increased sensitivity to anesthetic agents in older age (Fitria et al., 2018). Based on gender, male respondents were known to experience faster motor recovery than female respondents due to the influence of androgens, including testosterone, in males (Karnina et al., 2022). Based on ASA physical status, higher ASA classifications were associated with longer motor recovery duration, as they are associated with systemic diseases (Fitria et al., 2018). Based on Body Mass Index (BMI), respondents with BMI ‹30 kg/m² were more likely to achieve a Bromage Score of 0 than those with BMI ›30 kg/m², which may be related to additional anesthetic dosing in respondents with higher BMI values. Based on the type of surgical procedure, respondents were categorized according to the level of spinal block and the injection site of local anesthetic agents. Higher spinal block levels generally require additional doses of local anesthetic agents (Supriyatin et al., 2022). Based on surgery duration, the researcher assumed that procedures predicted to last longer would require additional anesthetic dosing, thereby contributing to delayed motor recovery. Differences in local anesthetic dosage are also known to influence spinal anesthesia recovery time (Kurniawan et al., 2025).

Based on the results presented in Tables 2 and 3, respondents receiving spinal anesthesia without adjuvant, using

bupivacaine 12.5 mg, demonstrated motor recovery durations ranging from 130–220 minutes, with a mean ± standard deviation of 164.95 ± 24.685 minutes. The most frequent recovery times were observed at 140 and 155 minutes, with 5 respondents achieving Bromage Score 0 at each time interval. These findings differ from those of Rusmawati et al. (2024), who reported that the highest frequency of respondents in the non-ERACS group receiving bupivacaine 12.5 mg achieved a Bromage Score of 0 within 126–135 minutes.

The difference between the present findings and those of Rusmawati et al. (2024) may be associated with differences in the calculation methods used to determine motor recovery duration, as the previous study did not provide a specific explanation of the calculation method. Furthermore, the present study involved several surgical procedures, including hemorrhoid surgery, lower extremity surgery, hip and urologic surgery, lower abdominal surgery, upper abdominal surgery, or cesarean section, which may have resulted in different spinal block levels. In contrast, Rusmawati et al. (2024) only involved cesarean section patients. The spinal block level, determined by the distribution of local anesthetic agents within the subarachnoid space via cerebrospinal fluid, and the puncture site level indirectly influenced motor recovery duration. However, this study did not further evaluate spinal block height or puncture site level. Theoretical review states that the duration of spinal anesthesia generally ranges from 90 to 150 minutes (Prihatno, 2024).

Based on the results presented in Tables 4 and 5, respondents receiving spinal anesthesia using bupivacaine 10 mg combined with fentanyl 25 µg and morphine 100 µg demonstrated motor recovery duration ranging from 75–150 minutes, with a mean ± standard deviation of 116.90 ± 17.177 minutes. The most frequent recovery times were observed at 115 and 135 minutes, with 6 respondents achieving a Bromage Score of 0 at each time interval.

These findings differ from those of Rusmawati et al. (2024), in which spinal anesthesia with bupivacaine 7.5 mg combined with fentanyl 25 µg and morphine 100 µg showed that the highest number of respondents achieved a Bromage Score of 0 within 26–35 minutes. Meanwhile, Utami et al. (2024) reported that respondents receiving spinal anesthesia with bupivacaine 7.5 mg combined with fentanyl 25 µg and morphine 100 µg demonstrated a motor block duration of approximately 118.13 ± 33.36 minutes. The difference between the

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current findings and those of Rusmawati et al. (2024) may be attributable to differences in the calculation methods for motor recovery duration, as the previous study did not provide a specific explanation of the calculation procedure. In contrast, the comparison with the findings of Utami et al. (2024) showed only a slight difference of approximately 2 minutes despite differences in the administered bupivacaine dosage.

Based on the results presented in Table 6, there was a difference in motor recovery duration between respondents receiving spinal anesthesia without adjuvant using 0.5% bupivacaine 12.5 mg and respondents receiving spinal anesthesia using 0.5% bupivacaine 10 mg combined with fentanyl 25 µg and morphine 100 µg. This finding was supported by the Mann–Whitney U test, which yielded $p < 0.001$, indicating a statistically significant difference between the two groups.

In this study, respondents receiving 0.5% bupivacaine 10 mg combined with fentanyl 25 µg and morphine 100 µg demonstrated faster motor recovery compared with respondents receiving 0.5% bupivacaine 12.5 mg without adjuvant. These findings may inform anesthesiologists' decisions about adjuvant use based on patient needs and surgical procedures. In addition, the results of this study may provide a basis for future studies investigating other types of adjuvants and broader clinical outcomes.

5. CONCLUSION

There was a statistically significant difference in motor recovery duration between patients receiving spinal anesthesia without adjuvant and those receiving spinal anesthesia combined with fentanyl 25 µg and morphine 100 µg. Patients receiving 0.5% bupivacaine 10 mg with fentanyl and morphine demonstrated faster motor recovery compared with patients receiving 0.5% bupivacaine 12.5 mg without adjuvant. These findings suggest that the use of opioid adjuvants in low-dose spinal anesthesia may support faster postoperative motor recovery.

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AUTHOR CONTRIBUTIONS

AN contributed to article preparation, data collection, data analysis, manuscript writing, and article revision. MBY served as the first supervisor, providing research guidance, reviewing the manuscript, and approving the final article. SMB contributed to manuscript review and final approval of the article.

CONFLICT OF INTEREST

The author declares no conflict of interest related to this study.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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