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Original Article

Effect of a Single Dose of Dexamethasone on Postoperative Pain and Nausea in Patients Undergoing Spinal Anesthesia: A Randomized Controlled Study

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Abstract

Background: Dexamethasone, a glucocorticoid with minimal mineralocorticoid activity, is often administered perioperatively to reduce postoperative nausea and is an effective analgesic. This study evaluated the impact of a single dose of dexamethasone (2 ml, 10 mg) on postoperative pain and nausea in patients undergoing spinal anaesthesia. **Methods**: This randomised, double-blind controlled trial included patients undergoing surgery under spinal anaesthesia. Participants were randomly allocated to receive either dexamethasone 10 mg (2 ml) or 0.9% NaCl (placebo) intravenously at the start of the procedure. Postoperative pain was assessed using the Visual Analogue Scale (VAS) at multiple time points (T1 to T4), and the incidence of postoperative nausea and vomiting (PONV) was recorded. Rescue analgesia with ketorolac (30 mg) was administered if the VAS score exceeded 4. **Results**: The dexamethasone group had the highest frequency of VAS 3 (41.7%) and VAS 2 values (38.9%). The placebo group had the highest frequencies of both VAS 3 and VAS 4 values (41.7% each), and VAS 5 values (41.7%). The VAS values in the control group were higher on average than those in the treatment group. In the control group, there was a slight increase in the average VAS value at T1 (6 h postoperatively), which decreased after analgesic rescue because the VAS value exceeded 4, resulting in a decrease from T2 to T4. **Conclusion**: A single dose of dexamethasone, 2 ml (10 mg), significantly impacts PONV incidence, with a p-value of 0.007, indicating a statistically significant relationship.

Keywords: Dexamethasone, Postoperative Pain, Postoperative Nausea and Vomiting (PONV)

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INTRODUCTION

Neuraxial anaesthesia is mainly used for lower abdominal and extremity surgeries. Spinal, epidural, and combined spinal-epidural techniques are often interchangeable, depending on the surgical procedure and the patient's clinical status [1]. Neuraxial anaesthesia is popular owing to its perioperative benefits. Spinal anaesthesia mitigates the surgical stress response, reduces intraoperative blood loss, lowers postoperative thromboembolic events, and decreases morbidity and mortality in high-risk patients [2]. Neuraxial techniques also reduce failed intubation and aspiration risks, eliminate central depressant agents, and improve patient consciousness during the procedures. Hyperbaric bupivacaine is the most common agent used in spinal anaesthesia [2].

Acute pain triggers the body's stress response, involving the neuroendocrine, immune, and inflammatory pathways. This includes elevated stress hormone levels, tissue catabolism, immunosuppression, increased myocardial oxygen consumption, heightened

thromboembolic risk, vasoconstriction, reduced gastrointestinal motility, pulmonary dysfunction, and increased postoperative morbidity and mortality [3]. The stress response is induced by pain, illness, injury, or surgery. Managing this response is crucial for reducing surgical complications and improving patient outcomes [3].

Postoperative pain exemplifies acute pain from both pathophysiological and therapeutic perspectives. Surgical interventions cause tissue damage, releasing inflammatory mediators such as prostaglandins, histamine, serotonin, bradykinin, substance P, and other algesic substances. These irritate nerve endings and nociceptors, producing nociceptive pain [4]. Surgical procedures may also inflict direct damage to the nervous structures, causing neuropathic pain. Pain signals are conveyed via A-delta and C fibres to the central nervous system. In the spinal cord, these signals undergo modulation and may trigger segmental reflexes or ascend to elicit supraspinal responses [4]. Autonomic nerves also contribute to pain transmission. Postoperative pain may originate from cutaneous, somatic, or visceral sources and typically exhibits a mixed pattern of nociceptive somatic, visceral, and neuropathic components [4].

Segmental reflexes induced by pain increase muscle tension and spasms, elevating oxygen demand and lactate production in the skeletal muscle. Sympathetic neuronal activation causes tachycardia, increased stroke volume and cardiac workload, heightened myocardial oxygen consumption, decreased gastrointestinal tone, and urinary retention [5]. Suprasegmental responses further stimulate the sympathetic nervous system, activating the hypothalamus and hypothalamic-pituitary-adrenal (HPA) axis and enhancing the metabolic rate and catabolism [5]. At the cortical level, pain is processed through systems responsible for perception and integration, which may be accompanied by psychological responses such as fear and anxiety that further stimulate hypothalamic activity [5].

Postoperative nausea and vomiting (PONV) is the second most common issue after acute postoperative pain, affecting 20–30% of surgical patients [6]. PONV compromises patient comfort, delays recovery, and extends hospital stay, necessitating effective prevention. The efficacy of glucocorticoids in mitigating postoperative pain and inflammation has been increasingly explored. These agents, particularly dexamethasone, provide short-term analgesic benefits across various surgeries [7]. Dexamethasone also possesses strong antiemetic properties, which are valuable in managing PONV [7]. Although the mechanisms remain incompletely understood, glucocorticoids are believed to inhibit inflammatory mediator synthesis, preserve pain thresholds, and reduce tissue swelling [8]. Dexamethasone, a glucocorticoid with minimal mineralocorticoid activity, is frequently used perioperatively to prevent PONV and provide postoperative analgesia [9]. Henzi et al. (2000) demonstrated that single doses of 8–10 mg IV dexamethasone in adults significantly reduced PONV incidence compared to placebo [10]. Jeffrey et al. (2013) showed that 10 mg IV dexamethasone added to a multimodal analgesic and antiemetic regimen enhanced postoperative pain control, improved mobility, and reduced hospital stay following total hip and knee arthroplasty [11]. This study aimed to investigate the effect of a single dose of intravenous dexamethasone (2 ml, 10 mg) on postoperative pain and nausea incidence in patients undergoing surgery under spinal anaesthesia.

MATERIALS AND METHODS

This study utilised a double-blind, randomised controlled trial (RCT) design to assess the effects of a single dose of intravenous dexamethasone (10 mg) on postoperative pain and nausea in patients undergoing spinal anaesthesia. Conducted at the Haji Adam Malik General Hospital in Medan, the study commenced following the receipt of ethical clearance and continued until the target sample size was achieved. The study population comprised patients aged 16-65 years undergoing elective surgeries with spinal anaesthesia, classified as ASA physical status I-II, and receiving a spinal block at the T5 level. Exclusion

criteria included patients with contraindications to spinal anaesthesia, those with allergies to the study drugs, or those undergoing caesarean sections.

Eligible patients were randomly allocated to one of two groups: Group A received 2 ml (10 mg) of intravenous dexamethasone, while Group B received 2 ml of normal saline (0.9%) as a placebo. Pain levels were evaluated using the visual analogue scale (VAS), where patients rated their pain from 0 (no pain) to 10 (worst pain). Postoperative nausea and vomiting (PONV) was also monitored, with severity classified according to a standardised questionnaire. Data on vital signs, including blood pressure, heart rate, respiratory rate, oxygen saturation, and mean arterial pressure (MAP), were collected at multiple time points: preoperatively (T0) and postoperatively at 6 (T1), 12 (T2), 18 (T3), and 24 hours (T4).

The primary objective of this study was to evaluate the effectiveness of dexamethasone in reducing postoperative pain and nausea. Secondary outcomes included the requirement for rescue analgesia (ketorolac 30 mg IV) if VAS > 4 and antiemetic intervention with ondansetron 4 mg IV for nausea and vomiting. Statistical analysis was conducted using SPSS-17, with data presented as mean ± standard deviation for continuous variables and percentages for categorical variables. The Mann-Whitney U test was employed for hypothesis testing, with a p-value of <0.05 considered statistically significant.

This study aimed to provide insights into the potential benefits of dexamethasone as a single-dose intervention for improving postoperative outcomes in spinal anaesthesia patients, particularly in reducing both pain and PONV, which are common challenges in the postoperative period. The results of this study may contribute to more effective perioperative management and enhanced recovery after surgery.

RESULTS

This study was conducted over two months (January-February 2019) at Haji Adam Malik General Hospital and the University of North Sumatra Hospital. This study aimed to assess the effects of a single 2 ml (10 mg) dose of dexamethasone on postoperative pain and nausea/vomiting (PONV) in patients undergoing spinal anaesthesia. The study included 72 patients who met the inclusion and exclusion criteria. Of these, 36 patients were allocated to the dexamethasone treatment group and 36 were assigned to the placebo group (NaCl 0.9%) as the control. The characteristics of the samples are detailed in Table 1.

Table 1. Sample Characteristics

Characteristic	Treatment Group (Dexamethasone)	Control Group (Placebo)	Total (n=72)	p value
Gender				0.000
Male	23 (51.1%)	22 (48.9%)	45 (62.5%)	
Female	13 (48.1%)	14 (51.9%)	27 (37.5%)	
Age (mean ± SD)	43.73 ± 3.47	39.55 ± 3.53		0.000
Surgical Type				0.200
Orthopedic Surgery	9 (60.0%)	6 (40.0%)	15 (20.8%)	
General Surgery	4 (44.4%)	5 (55.6%)	9 (12.5%)	
Digestive Surgery	10 (55.6%)	8 (44.4%)	18 (25.0%)	
Urology	7 (36.8%)	12 (63.2%)	19 (26.4%)	
Gynecology	6 (54.5%)	5 (45.5%)	11 (15.3%)	
ASA Status				0.000
ASA I	23 (41.1%)	33 (58.9%)	56 (80.6%)	
ASA II	13 (81.2%)	3 (18.8%)	16 (19.4%)	
Total	36 (100%)	36 (100%)	72 (100%)	

As illustrated in Table 1, there were statistically significant differences in sex distribution and age between the treatment and placebo groups, with a higher prevalence of males in both groups. Additionally, the mean age of the dexamethasone group was greater than that of the placebo group (p = 0.000). Conversely, no significant differences were observed in the types of surgeries performed (p = 0.200) or the distribution of ASA status (p = 0.000).

Table 2. Postoperative Pain at Time Points T0, T1, T2, T3, and T4 (Placebo)

VAS Score	Placebo (T0) n (%)	Placebo (T1) n (%)	Placebo (T2) n (%)	Placebo (T3) n (%)	Placebo (T4) n (%)
10	0	0	0	0	0
9	0	0	0	0	0
8	0	0	0	0	0
7	0	0	0	0	0
6	0	11 (30.6)	0	0	0
5	6 (16.7)	15 (41.7)	3 (8.3)	3 (8.3)	0
4	15 (41.7)	9 (25.0)	8 (22.2)	8 (22.2)	0
3	15 (41.7)	1 (2.8)	15 (41.7)	15 (41.7)	20 (55.6)
2	0	0	9 (25.0)	9 (25.0)	16 (44.4)
1	0	0	1 (2.8)	1 (2.8)	0

Note: T0, Preoperative measurement (baseline); T1, 6 hours postoperative; T2, 12 hours postoperative; T3, 18 hours postoperative; T4, 24 hours postoperative.

Table 3. Postoperative Pain at Time Points T0, T1, T2, T3, and T4 (Dexamethasone)

VAS Score	Dexamethasone (T0), n (%)	Dexamethasone (T1), n (%)	Dexamethasone (T2), n (%)	Dexamethasone (T3), n (%)	Dexamethasone (T4), n (%)
10	0	0	0	0	0
9	0	0	0	0	0
8	0	0	0	0	0
7	0	0	0	0	0
6	3 (8.3)	0	0	0	0
5	8 (22.2)	0	0	0	0
4	10 (27.8)	0	0	0	0
3	15 (41.7)	11 (30.6)	11 (30.6)	0	0
2	0	14 (38.9)	14 (38.9)	6 (16.7)	0
1	0	11 (30.6)	11 (30.6)	30 (83.3)	36 (100)

Note: T0, Preoperative measurement (baseline); T1, 6 hours postoperative; T2, 12 hours postoperative; T3, 18 hours postoperative; T4, 24 hours postoperative.

The comparison between the dexamethasone and placebo groups unequivocally demonstrated the superior analgesic efficacy of dexamethasone in the management of postoperative pain. Although both groups exhibited comparable pain levels at baseline (T0), the dexamethasone group experienced a significant reduction in pain intensity beginning at T1 (6 h postoperatively) and continued to report substantial pain relief at T2, T3, and T4, with all patients indicating minimal pain (VAS 1) by 24 h postoperatively. Conversely, the placebo group experienced moderate-to-severe pain throughout the postoperative period, with numerous patients still reporting moderate pain (VAS 3) at T4. These findings suggest that a single dose of dexamethasone provides effective and sustained pain relief, underscoring its potential as a valuable adjunct in postoperative pain management (Tables 2 and 3).

At T0, the mean VAS score for the dexamethasone group was 4.0, while that for the placebo group was 3.7. No statistically significant difference was found between the two groups ($p = 0.46$). The results from this analysis demonstrate that dexamethasone was effective in reducing postoperative pain compared to placebo, with significant differences observed from T1 onwards. Further analyses will explore the long-term effects and influence of dexamethasone on PONV in the following sections.

Table 4. Postoperative Nausea and Vomiting (PONV) After Single Dose of Dexamethasone 2 ml (10 mg) in Spinal Anesthesia Patients

PONV Status	Placebo (T1)	Placebo (T2)	Placebo (T3)	Placebo (T4)
No Nausea	28 (77.8%)	28 (77.8%)	28 (77.8%)	28 (77.8%)
Nausea	5 (13.9%)	5 (13.9%)	5 (13.9%)	5 (13.9%)
Vomited 1 time	1 (2.8%)	1 (2.8%)	1 (2.8%)	1 (2.8%)
Vomited >3 times	2 (5.6%)	2 (5.6%)	2 (5.6%)	2 (5.6%)

Table 5. Postoperative Nausea and Vomiting (PONV) After Single Dose of Dexamethasone 2 ml (10 mg) in Spinal Anesthesia Patients

PONV Status	Dexamethasone (T1)	Dexamethasone (T2)	Dexamethasone (T3)	Dexamethasone (T4)
No Nausea	32 (88.9%)	36 (100%)	36 (100%)	36 (100%)
Nausea	4 (11.1%)	0 (0%)	0 (0%)	0 (0%)
Vomited 1 time	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Vomited >3 times	0 (0%)	0 (0%)	0 (0%)	0 (0%)

The data in Tables 4 and 5 show that a single 2 ml (10 mg) dexamethasone dose significantly reduces postoperative nausea and vomiting (PONV) compared to placebo in spinal anaesthesia patients. At T1 (6 h postoperatively), 88.9% of the dexamethasone group reported no nausea versus 77.8% in the placebo group. By T2 (12 h postoperatively), the dexamethasone group had complete resolution of nausea and vomiting, with no cases at T3 and T4. In contrast, the placebo group continued to experience nausea (13.9%) and vomiting (5.6% for vomiting >3 times) through T4. These findings highlight the efficacy of dexamethasone in preventing PONV and enhancing postoperative recovery and patient comfort.

Table 6. Effect of Single Dose of Dexamethasone 2 ml (10 mg) on Postoperative Nausea and Vomiting (PONV) in Spinal Anesthesia Patients

Group	PONV Status	T1 (6 hours)	T2 (12 hours)	T3 (18 hours)	T4 (24 hours)	p-value
Dexamethasone	Mean (SD)	0.11 (0.32)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.007*
Placebo	Mean (SD)	0.36 (0.80)	0.36 (0.80)	0.36 (0.80)	0.36 (0.80)	-

Note: The p-value of 0.007 was derived using the Friedman test, indicating significant differences between the dexamethasone and placebo groups.

The data in Table 6 indicate that a single 2 ml (10 mg) dexamethasone administration significantly reduces postoperative nausea and vomiting (PONV) in patients undergoing spinal anaesthesia. At T1 (6 hours postoperatively), the mean PONV score for the dexamethasone cohort was lower (0.11) than that for the placebo cohort (0.36). At T2 (12 h postoperative), T3 (18 h), and T4 (24 h), the dexamethasone group exhibited a PONV score of 0.00, indicating no nausea or vomiting. The placebo group experienced persistent PONV (mean score, 0.36) throughout the postoperative period. The statistical analysis yielded a significant p-value of 0.007, supporting the efficacy of dexamethasone in preventing PONV relative to placebo. These findings suggest that dexamethasone is an effective intervention for the postoperative management of PONV.

DISCUSSION

This study sought to assess the impact of a single 2 ml (10 mg) dose of dexamethasone on postoperative pain, nausea, and vomiting (PONV) in patients undergoing spinal anaesthesia. The findings suggest that dexamethasone significantly enhanced pain management and reduced the incidence of PONV compared to the placebo group

According to Tables 2 and 3, pain assessment at T0 (0 h) showed most patients in the dexamethasone group had a lower Visual Analogue Scale (VAS) score, with most reporting VAS 3, compared to the placebo group, where most reported VAS 4. This aligns with Erlangga et al. (2015), who showed 10 mg of dexamethasone as an adjunct analgesic effectively reduces postoperative pain [12]. At T1 (6 h postoperatively), the dexamethasone group had a significantly lower VAS score, with most reporting VAS 2, while the placebo group mostly reported VAS 5. Table 4.4 shows at T2 (12 hours postoperative), the dexamethasone group continued reporting lower VAS scores, mostly VAS 2, compared to the placebo group, with more patients reporting VAS 3. This supports the hypothesis that steroids alleviate postoperative pain by reducing inflammation [13]. A meta-analysis showed dexamethasone significantly reduced VAS scores, correlating with effective pain relief [14,15]. Systemic steroids provide effective postoperative pain relief for up to 48 h by modulating inflammatory markers like C-reactive protein (CRP) [14,16]. Thus, dexamethasone administration is associated with inflammation control and improved pain management. At T3 (18 h postoperatively), the dexamethasone group had a VAS score of 1, indicating minimal pain, while the placebo group had a higher VAS score of 3. This pattern continued, with all dexamethasone group patients reporting VAS 1 at T4 (24 hours postoperatively), compared to the placebo group, where most still reported VAS 3. These results align with Fan et al. (2018)'s meta-analysis, showing dexamethasone effectively reduced postoperative pain, PONV, and opioid consumption, contributing to faster recovery [17]. This is consistent with literature suggesting postoperative pain is primarily nociceptive and arises from inflammation [18,19]. Dexamethasone, a corticosteroid, exerts potent anti-inflammatory effects by inhibiting cyclooxygenase 1 and 2 enzymes, reducing prostaglandin production, key mediators of pain and inflammation, leading to analgesia [20].

Supporting these findings, research has shown that preoperative dexamethasone (8 mg) enhances postoperative recovery by alleviating nausea, pain, and fatigue and improving overall outcomes [40]. Dexamethasone's analgesic efficacy is dose-dependent, with doses exceeding 0.1 mg/kg particularly effective in multimodal strategies to reduce postoperative pain and opioid consumption [21]. This highlights the benefits of administering 0.1 mg/kg or 8 mg dexamethasone in adult patients for pain management and recovery.

Regarding postoperative nausea and vomiting (PONV), Tables 4 and 5 show dexamethasone significantly reduced nausea and vomiting incidence (p-value 0.007). At T1, 88.9% of patients in the dexamethasone group reported no nausea compared to 77.8% in the placebo group. By T2, T3, and T4, 100% of the dexamethasone group experienced no nausea or vomiting, whereas the placebo group continued to report nausea (13.9%) and vomiting (2.8% once, 5.6% more than three times).

CONCLUSION

In conclusion, this study provides evidence supporting the efficacy of dexamethasone as an intervention for managing postoperative pain and postoperative nausea and vomiting (PONV). The observed significant reduction in pain scores and prevention of PONV in the dexamethasone group underscores its role in enhancing postoperative recovery, reducing opioid consumption, and improving patient comfort. Further research is necessary to determine the optimal dosing regimens and evaluate the long-term benefits of dexamethasone across various surgical procedures.

Abbreviations: PONV, Postoperative Nausea and Vomiting; VAS, Visual Analogue Scale; T0, Preoperative measurement (baseline); T1, 6 hours postoperative; T2, 12 hours postoperative; T3, 18

hours postoperative; T4, 24 hours postoperative; IV, Intravenous; SD, Standard Deviation; CRP, C-reactive Protein; ASA, American Society of Anesthesiologists.

Supplementary Materials: Data sets created and/or examined in this study can be obtained from the corresponding author if requested.

Author Contributions: B.B. conceptualised the study design, conducted data collection, and performed statistical analysis. P.S. critically reviewed and revised the manuscript, interpreted the data, and wrote the final draft. All authors have read and approved the final manuscript.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request.

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Conflicts of Interest: The authors declare no conflicts of interest.

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