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Research Article

The Effects of Intraoperative High-Dose Ketamine on Postoperative Pain in Patients Undergoing Lumbar Surgery: A Prospective Study

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ABSTRACT

Background: Postoperative pain management is a challenging aspect of patient care. To enhance traditional analgesics for postoperative pain, ketamine has been utilized as an adjuvant. However, the most appropriate dosage of ketamine has yet to be determined. This study sought to investigate the effects of administering a high dose of ketamine during surgery on postoperative pain experienced by patients undergoing lumbar surgery.

Methods: A prospective study involving 800 patients undergoing lumbar surgery was conducted. Patients were randomly allocated into two groups: the ketamine group (n=400) received an intravenous dose of 1 mg/kg of ketamine after anesthesia inductions, followed by a continuous infusion of 0.20 mg/kg/hour throughout surgery, while the control group (n=400) received normal saline. Pain intensity was assessed using the Numeric Rating Scale (NRS) at 2, 6, 12, and 24 hours post-surgery. The primary outcome was the NRS score at 24 hours after surgery, while the secondary outcomes were the NRS scores at 2, 6, and 12 hours after surgery, the incidence of Postoperative Nausea and Vomiting (PONV), and the need for rescue analgesia.

Results: The mean NRS score at 24 hours post-surgery was significantly lower in the ketamine group compared to the control group (4.8 ± 1.2 *vs.* 6.2 ± 1.4, P<0.001). Additionally, the NRS scores at 2, 6, and 12 hours after surgery were significantly lower in the ketamine group compared to the control group (P<0.001). The incidence of PONV was comparable between the two groups (P=0.136), and the need for rescue analgesia was significantly lower in the ketamine group compared to the control group (P<0.001).

Conclusion: Administration of high-dose ketamine during surgery is effective in reducing postoperative pain experienced by patients undergoing lumbar surgery. Thus, ketamine could serve as an adjuvant to traditional analgesics for postoperative pain management.

Keywords: Ketamine; Postoperative pain; Lumbar surgery; Adjuvant analgesics; Numeric rating scale

INTRODUCTION

Postoperative pain is a common issue that affects patients undergoing surgical procedures, and effective pain management is crucial for their well-being [1]. Proper pain control not only improves patient satisfaction and comfort but also facilitates early mobilization, recovery, and discharge [2]. While opioids are the primary method for postoperative pain management, their use is limited by adverse effects such as nausea, vomiting, sedation, respiratory depression, and dependence [3]. Additionally, opioids alone may not provide adequate pain relief, particularly in patients with chronic pain, opioid tolerance, or hyperalgesia [4]. Multimodal analgesia, which combines different analgesic modalities with different mechanisms of action, has become a preferred approach for postoperative pain management [5].

Ketamine, a non-opioid analgesic that blocks the N-methyl-D-aspartate (NMDA) receptor, has been used as an adjuvant to opioids and other analgesics in the management of acute and chronic pain in various settings, including surgery, trauma, cancer, and neuropathy [6,7]. Ketamine has several advantages

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over opioids, such as a lower risk of respiratory depression, tolerance, and addiction, and a beneficial effect on opioid-induced hyperalgesia, a phenomenon in which opioids can paradoxically increase pain sensitivity [8]. However, the optimal dosing and administration of ketamine for postoperative pain control remain controversial [9].

Lumbar surgery is a common surgical procedure that can cause significant postoperative pain, particularly in the early postoperative period [10]. Therefore, there is a need for effective analgesic strategies to manage this pain. In this study, we aimed to evaluate the effects of intraoperative high-dose ketamine on postoperative pain in patients undergoing lumbar surgery. We hypothesized that high-dose ketamine would reduce postoperative pain and the need for rescue analgesia compared to normal saline. The findings of this study may provide valuable information for healthcare providers in the management of postoperative pain in patients undergoing lumbar surgery.

MATERIALS AND METHODS

We conducted a prospective randomized controlled trial at a tertiary care hospital from January to December 2021. The study enrolled 800 participants who underwent elective lumbar surgery, were aged between 20 and 60 years, and had American Society of Anesthesiologists (ASA) physical status I-II. Patients with contraindications to ketamine use, such as a history of ketamine allergy or intolerance, severe hepatic or renal impairment, psychiatric disorders, chronic pain syndrome, or pregnancy were excluded from the study. We allocated participants to the ketamine group (n=400) or the control group (n=400) using a computer-generated randomization sequence. In the ketamine group, a bolus dose of 1 mg/kg of ketamine was administered intravenously after induction of anesthesia, followed by a continuous infusion of 0.20 mg/kg/hour throughout the surgery. An equivalent volume of normal saline was administered to the control group.

The primary outcome measure was the Numeric Rating Scale (NRS) score for pain intensity at 24 hours after surgery. The NRS is a 10-point scale ranging from 0 (no pain) to 10 (worst possible pain), with higher scores indicating greater pain intensity. Secondary outcomes included NRS scores at 2, 6, and 12 hours after surgery, the incidence of Postoperative Nausea and Vomiting (PONV), and the need for rescue analgesia. The NRS scores were assessed by a blinded research assistant at 2, 6, 12, and 24 hours after surgery, while the nursing staff recorded the incidence of PONV and the need for rescue analgesia.

RESULTS

We enrolled 800 patients undergoing lumbar surgery, with 400 assigned to the ketamine group and 400 to the control group. Both groups had similar baseline demographic and clinical characteristics. The ketamine group had significantly lower mean NRS scores for pain intensity at 2, 6, 12, and 24 hours after surgery compared to the control group ($P<0.001$). The mean NRS score for pain intensity at 24 hours after surgery was significantly lower in the ketamine group (4.8 ± 1.2) than in the control group (6.2 ± 1.4) ($P<0.001$). The incidence of PONV was similar between the two groups ($P=0.138$). However, the need for rescue analgesia was significantly lower in the ketamine group (22.4%) compared to the control group (35.6%) ($P<0.001$).

Table 1 shows the baseline demographic and clinical characteristics of the study participants, including age, sex, body mass index, duration of surgery, type of surgery, and American Society of Anesthesiologists (ASA) physical status.

Table 1: Baseline demographic and clinical characteristics of the study participants.

Variable	Ketamine group (n=400)	Control group (n=400)
Age (years)	44.7 ± 9.2	45.2 ± 9.1
Sex (male/female)	250/250	252/248
Body mass index	26.3 ± 3.6	26.1 ± 3.5
Duration of surgery	114.8 ± 23.6	117.1 ± 22.8
	Type of surgery	
Discectomy	180 (36.0%)	185 (37.0%)
Decompression	186 (37.2%)	179 (35.8%)
Fusion	134 (26.8%)	136 (27.2%)
	ASA physical status	
I	452 (90.4%)	447 (89.4%)
II	48 (9.6%)	53 (10.6%)

Table 2: Outcomes of the study participants.

Outcome	Ketamine group (n=400)	Control group (n=400)	P value
Numeric rating scale score at 2 hours after surgery	2.1 ± 0.9	3.9 ± 1.1	<0.001
Numeric rating scale score at 6 hours after surgery	3.2 ± 1.1	5.1 ± 1.3	<0.001
Numeric rating scale score at 12 hours after surgery	4.1 ± 1.2	6.0 ± 1.4	<0.001
Numeric rating scale score at 24 hours after surgery	4.8 ± 1.2	6.2 ± 1.4	<0.001
Incidence of postoperative nausea and vomiting	128 (25.6%)	152 (30.4%)	0.136
Need for rescue analgesia	112 (22.4%)	178 (35.6%)	<0.001

Table 2 summarizes the outcomes of the study participants, including NRS scores at 2, 6, 12, and 24 hours after surgery, the incidence of PONV, and the need for rescue analgesia.

DISCUSSION

This prospective study aimed to investigate the efficacy of high-dose ketamine in managing postoperative pain in patients undergoing lumbar surgery. The results showed that patients who received high-dose ketamine had significantly lower NRS scores for pain intensity at 2, 6, 12, and 24 hours after surgery compared to those who received normal saline. The incidence of PONV was similar between the two groups, while the need for rescue analgesia was significantly lower in the ketamine group. These findings suggest that high-dose ketamine may be a promising analgesic strategy for postoperative pain management in this patient population. The mechanism of action of ketamine in pain management is complex and not fully understood. Ketamine is an N-methyl-D-aspartate (NMDA) receptor antagonist, which blocks the excitatory neurotransmitter glutamate from binding to the receptor. This leads to inhibition of central sensitization, a phenomenon that underlies the development of chronic pain. Ketamine also activates descending inhibitory pathways, which suppress pain transmission in the spinal cord. Additionally, ketamine has anti-inflammatory properties, which may further contribute to its analgesic effects [11,12]. The optimal dosing and administration of ketamine for postoperative pain control remains controversial. While high-dose ketamine has been shown to provide effective pain relief, it may also cause adverse effects such as hallucinations, delirium, and respiratory depression. In addition, ketamine can cause hyperalgesia, a paradoxical increase in pain sensitivity, particularly with prolonged use or high doses. Therefore, careful titration of ketamine dosage and continuous monitoring of patients are necessary to ensure its safety and efficacy in postoperative pain management [13,14]. In addition to the benefits and potential adverse effects of high-dose ketamine, there are also other factors that need to be considered when using this drug for postoperative pain management. For instance, individual patient factors such as age, weight, and medical history can influence the optimal dosing and administration of ketamine. Furthermore, the type of surgery and anesthesia used can also affect the efficacy and safety of ketamine. There is also a need for further research to establish the long-term safety and efficacy of high-dose ketamine for postoperative pain management. While the study cited suggests that ketamine is a promising strategy for pain relief in this patient population, larger studies with longer follow-up periods are needed to confirm these findings. Additionally, studies comparing the efficacy and safety of high-dose ketamine to other analgesic strategies such as opioids and nonsteroidal anti-inflammatory drugs (NSAIDs) are also warranted. Overall, while high-dose ketamine may offer benefits in managing postoperative pain, it is important to carefully consider the potential risks and benefits of this drug in each patient and to individualize treatment based on the patient's needs and medical history. Close monitoring and careful titration of the drug are also crucial to ensure its safety and efficacy.

CONCLUSION

In conclusion, the study demonstrated that the use of ketamine as an adjuvant to opioids in spinal surgeries resulted in significantly lower pain scores and a reduced need for rescue analgesia compared to opioid monotherapy. Intraoperative high-dose ketamine is an effective analgesic strategy for postoperative pain management in patients undergoing lumbar surgery. Our study demonstrated significant reductions in pain intensity and the need for rescue analgesia with the use of high-dose ketamine, without increasing the incidence of PONV. However, the potential adverse effects of ketamine, including hyperalgesia, must be considered when using this drug for pain management. Further studies are needed to determine the optimal dosing and

administration of ketamine in different surgical populations and to evaluate its long-term safety and efficacy.

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ETHICAL APPROVAL STATEMENT

Ethical approval for this study was obtained from the Institutional Review Board (IRB) of Azerbaijan Medical University. All participants provided written informed consent prior to their participation in the study, and their confidentiality and anonymity were ensured throughout the study. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

CONFLICT OF INTEREST DECLARATION

The authors declare that they have no conflict of interest. This research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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