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Impact of esketamine intravenous analgesic pump on pain and depression post-cesarean

Xiao-Qiang Zhang[1*], Shuang Li[1] and Xiao-Lin Qin[1]

Abstract

Background Postoperative pain and psychological well-being in postpartum women following cesarean section are critical for optimal maternal recovery. Traditional analgesics often have limitations and side effects, prompting the need for alternative solutions. This study evaluates the impact of an esketamine intravenous analgesic pump on postoperative pain and psychological status in postpartum women following cesarean section.

Methods A comprehensive retrospective evaluation was conducted at our institution from October 2021 to July 2023, including 168 patients who underwent cesarean delivery. The observation group ($n=82$) received esketamine via an intravenous analgesic pump, while the control group ($n=86$) received traditional analgesic therapy. Data collected included demographic information, surgical details, postoperative pain (assessed using the Visual Analog Scale, VAS), psychological status (assessed using the Edinburgh Postnatal Depression Scale, EPDS), recovery metrics, and adverse reactions.

Results The observation group demonstrated consistently lower VAS scores at all postoperative time points compared to the control group, indicating superior pain control. EPDS scores were significantly lower in the observation group at 3, 5, and 14 days postoperatively, suggesting better psychological outcomes. The incidence of postpartum depression was also lower in the observation group at 3, 5, and 14 days. Recovery metrics such as time to first ambulation, first flatus, and initiation of lactation were significantly improved in the observation group. There were no significant differences in the incidence of adverse reactions between the groups.

Conclusions The use of the Esketamine Intravenous Analgesic Pump significantly reduces postoperative pain and the incidence of postpartum depression within the first 14 days. It promotes early recovery and breastfeeding in postpartum women without significant adverse reactions, making it a valuable addition to postoperative care.

Keywords Esketamine, Postoperative pain, Psychological status, Cesarean section, Postpartum depression

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Introduction

A cesarean section (CS) is a prevalent surgical intervention conducted to deliver an infant via incisions in the abdominal wall and uterus [1]. The prevalence of cesarean births has been consistently rising globally, prompting concerns regarding the related postoperative problems, including pain management and the psychological well-being of postpartum women [2]. Effective postoperative pain management is essential for improving patient comfort, promoting early mobilization, minimizing the risk of thromboembolic complications, and raising overall maternal satisfaction. Inadequate pain management may result in chronic pain problems, extended hospitalizations, and heightened healthcare expenses [3]. Esketamine, the S-enantiomer of ketamine, has emerged as a viable therapeutic drug for managing acute and chronic pain. Esketamine exhibits an improved pharmacokinetic profile and less psychotropic side effects compared to its racemic counterpart [4]. Esketamine primarily acts as an N-methyl-D-aspartate (NMDA) receptor antagonist, affecting central sensitization and providing analgesia by inhibiting excitatory neurotransmission [5]. Recent studies have highlighted its potential in perioperative pain management, suggesting that esketamine may offer improved analgesia with a reduced risk of opioid-related adverse effects [6, 7].

The use of an esketamine intravenous analgesic pump offers a new method for managing postoperative pain in postpartum women following cesarean procedures [8]. Conventional techniques, like epidural analgesia and systemic opioids, while efficacious, frequently entail considerable adverse effects such as nausea, vomiting, respiratory depression, and drowsiness [9]. The introduction of esketamine may alleviate these concerns, offering excellent pain management while preserving a positive safety profile [10]. Postoperative pain following cesarean section is not only a physical burden but also a significant psychological stressor, as it can trigger or exacerbate psychological disorders such as postpartum depression and anxiety [11]. The severity of pain encountered by postpartum women can profoundly affect their psychological health, resulting in disorders such as postpartum depression and anxiety [12, 13]. Persistent pain may impair sleep, hinder early bonding with the newborn, and reduce a mother's ability to perform daily tasks, which in turn exacerbates feelings of helplessness and anxiety, potentially leading to depression [14]. Consequently, appropriate pain management measures are essential for both physical recovery and the mental well-being of new moms. Esketamine may significantly boost analgesia while minimizing adverse effects, so enhancing postoperative results and quality of life for postpartum women.

Due to the rising frequency of cesarean sections and the resulting necessity for efficient postoperative pain management, it is essential to investigate and substantiate novel analgesic approaches. This study intends to assess the effects of an esketamine intravenous analgesic pump on postoperative pain and psychological well-being in postpartum women after cesarean delivery. This research aims to enhance the existing evidence for esketamine as a feasible pain management option in this population by analyzing pain scores, opioid usage, side effect profiles, and psychological outcomes.

Methods

Study design

A retrospective assessment was performed at our hospital to evaluate the impact of an esketamine intravenous analgesic pump on postoperative pain and psychological well-being in postpartum women after cesarean delivery. The review term extended from October 2021 to July 2023. This study comprised 168 patients who underwent cesarean delivery. The subjects were categorized into two groups according to the method of postoperative pain treatment administered. The observation group comprised 82 patients administered the esketamine intravenous analgesic pump. In contrast, the control group consisted of 86 individuals who underwent conventional analgesic treatments. The study's protocols and methodology were rigorously reviewed by our hospital's ethics committee, ensuring compliance with all applicable guidelines and the Declaration of Helsinki's principles for human research. Informed consent was obtained from all participants or their legal guardians, who also consented to the publication of their data in the study. All methods adhered to strict ethical standards, and data confidentiality was maintained by anonymizing personal identifiers before analysis to safeguard participant privacy.

Inclusion and exclusion criteria

The study's inclusion criteria comprised women aged 18 to 45 years who underwent elective or emergency cesarean sections, were capable of providing informed consent, had no previous adverse reactions to esketamine or analogous anesthetic agents, and possessed the ability to understand and respond to assessments of postoperative pain and psychological status.

The exclusion criteria included known allergy or hypersensitivity to esketamine or related anesthetics, pre-existing chronic pain conditions or ongoing use of chronic opioid therapy, presence of significant psychiatric or neurological disorders that could affect pain perception or psychological assessment, severe hepatic, renal, or cardiovascular disease that could complicate postoperative management, and obstetric complications requiring intensive postnatal care that would interfere with the standardized administration of the analgesic protocol.

Postoperative analgesia protocol

Observational group: esketamine intravenous analgesic pump

In the observational group, an intravenous analgesic pump delivering esketamine was employed for postoperative pain treatment. The analgesic solution comprised esketamine at a dosage of 0.5 mg/kg, in conjunction with 10 mg of tropisetron, diluted to a total volume of 150 ml. The analgesic pump was engaged promptly following the closure of the skin incision. The protocol for patient-controlled intravenous analgesia (PCIA) was delineated as follows: Loading Dose: 3 ml; Background Infusion Rate: 2 ml/hour; Bolus Dose: 2 ml per activation; Lockout Interval: 15 min; Maximum Dose: ≤10 ml/hour.

Control group: traditional analgesic regimen

In the control group, patients underwent conventional analgesic treatment for postoperative pain control. This regimen often comprised a mix of nonsteroidal anti-inflammatory medications (NSAIDs) and opioids, delivered in accordance with established clinical protocols. The drugs and dosages were tailored to each patient's need and clinical protocols, ensuring sufficient pain alleviation while observing for adverse reactions.

Comprehensive assessment of pathogens and antibiotic susceptibility

General Patient Information: For both groups, general patient demographics, surgical length, and intraoperative blood loss were recorded to assure baseline comparability and assess the influence of these variables on postoperative recovery.

Pain Assessment: Postoperative pain was evaluated with the Visual Analog Scale (VAS) [15] at many intervals: 6 h, 12 h, 24 h, and 48 h following surgery. The total amount of analgesic delivered through the intravenous pump was documented for the esketamine group.

Psychological Assessment: The psychological status was assessed utilizing the Edinburgh Postpartum Depression Scale (EPDS) [16] at multiple intervals: 1 day prior to surgery, and on the 3rd, 5th, 14th, and 28th days following the procedure. The EPDS has 10 questions, each rated from 0 to 3, yielding a maximum score of 30. Elevated scores signify an increased intensity of depressive symptoms. This study identified an EPDS score of ≥ 10 as suggestive of postpartum depression.

Postoperative Recovery: Several key indicators of postoperative recovery were recorded: Time to first ambulation; Time to first flatus; Time to first breastfeeding session; Number of breastfeeding sessions within the first 48 h post-surgery.

Adverse Reactions: Adverse effects such as headache, dizziness, nightmares, sleepiness, nausea, and vomiting were tracked and documented to assess the safety profile of the analgesic treatments.

Statistical analysis

Statistical analysis was meticulously performed using SPSS software, version 27.0. Data were first classified into quantitative or categorical variables, and subsequently subjected to normality testing to ascertain their distribution patterns. For quantitative data demonstrating a normal distribution, inter-group statistical comparisons were conducted using independent sample t-tests, with findings presented as mean ± standard deviation. When quantitative data deviated from a normal distribution, the median and interquartile range (M[P25, P75]) were employed for data representation, and inter-group comparisons were performed using the Mann-Whitney U test. Categorical variables were summarized using frequencies and percentages. The interdependencies or independence of these categorical variables were assessed using Chi-square (χ^2) testing. All statistical tests were conducted as two-tailed, with a p-value of less than 0.05 being indicative of statistical significance.

Results

Demographic and clinical characteristics

The demographic and clinical characteristics of the patients in the observation group ($n = 82$) and the control group ($n = 86$) are summarized in Table 1. Statistical analysis revealed no significant differences between the two groups across various parameters, confirming the comparability of the groups. The mean age of patients in the observation group was 27.56 ± 3.12 years, while in the control group it was 28.04 ± 3.18 years. Similarly, the

Table 1 Demographic and clinical characteristics of patients in the observation and control groups

Characteristic	Observation Group ($n = 82$)	Control Group ($n = 86$)	t Value	p Value
Age (years)	27.56 ± 3.12	28.04 ± 3.18	0.509	0.613
Weight (kg)	72.34 ± 7.88	72.21 ± 8.25	0.118	0.907
Gestational Age (weeks)	39.17 ± 1.44	39.45 ± 1.36	0.845	0.402
BMI (kg/m^2)	26.54 ± 3.25	25.68 ± 1.15	1.031	0.307
Surgery Time (min)	54.29 ± 12.53	56.75 ± 13.03	1.108	0.272
Blood Loss (ml)	290.57 ± 72.50	301.78 ± 68.41	0.271	0.787
Preoperative EPDS Scores	3.89 ± 1.06	3.76 ± 0.98	0.658	0.663

EPDS: Edinburgh Postpartum Depression Scale; BMI: Body Mass Index

Table 2 Comparison of postoperative VAS scores between observation and control groups at different time points

Group	6 h	12 h	24 h	48 h
Observation Group ($n=82$)	1.46 ± 0.39	1.81 ± 0.40	1.86 ± 0.31	1.38 ± 0.37
Control Group ($n=86$)	1.72 ± 0.49	1.92 ± 0.32	2.15 ± 0.41	1.61 ± 0.35
t Value	4.132	3.789	4.532	3.212
p Value	< 0.01	< 0.01	< 0.01	< 0.01

Visual Analog Scale (VAS)

Table 3 Comparison of preoperative and postoperative EPDS scores between observation and control groups

Group	Preoperative (1 d)	Postoperative (3 d)	Postoperative (5 d)	Postoperative (14 d)	Postoperative (28 d)
Observation Group ($n=82$)	7.56 ± 2.48	7.15 ± 3.12	7.68 ± 2.43	7.01 ± 1.89	7.65 ± 1.68
Control Group ($n=86$)	7.62 ± 2.38	8.53 ± 3.28	9.46 ± 2.18	8.18 ± 2.26	7.92 ± 1.75
t Value	0.102	2.122	3.126	2.529	0.382
p Value	0.92	< 0.05	< 0.01	< 0.05	0.685

EPDS: Edinburgh Postnatal Depression Scale

mean weight was 72.34 ± 7.88 kg in the observation group and 72.21 ± 8.25 kg in the control group. Gestational age averaged 39.17 ± 1.44 weeks in the observation group and 39.45 ± 1.36 weeks in the control group.

BMI was comparable between the two groups, with a mean of 26.54 ± 3.25 kg/m² in the observation group and 25.68 ± 1.15 kg/m² in the control group. Surgery time was also similar, averaging 54.29 ± 12.53 min in the observation group and 56.75 ± 13.03 min in the control group. Blood loss during surgery was 290.57 ± 72.50 ml in the observation group and 301.78 ± 68.41 ml in the control group. Preoperative EPDS scores, indicating the baseline psychological state, were 3.89 ± 1.06 in the observation group and 3.76 ± 0.98 in the control group. These results indicate that there were no significant differences in demographic or baseline clinical characteristics between the observation and control groups, ensuring that subsequent analyses of postoperative outcomes could be attributed to the intervention rather than preexisting differences.

Comparison of postoperative VAS scores at different time points

The results demonstrated a consistent pattern of lower pain scores in the observation group compared to the control group across all time points (Table 2). At 6 h post-surgery, the observation group had a mean VAS score of 1.46 ± 0.39, significantly lower than the control group's mean score of 1.72 ± 0.49. Similarly, at 12 h post-surgery, the observation group reported a mean VAS score of 1.81 ± 0.40, compared to 1.92 ± 0.32 in the control group. The trend continued at 24 h post-surgery, where the observation group had a mean VAS score of 1.86 ± 0.31, while the control group had a higher mean score of 2.15 ± 0.41. By 48 h post-surgery, the mean VAS scores were 1.38 ± 0.37 for the observation group and 1.61 ± 0.35 for the control group, again showing a significant difference. These results indicate that the use of esketamine in the observation group provided superior pain control in the immediate postoperative period compared to the traditional analgesic regimen used in the control group.

Comparison of preoperative and postoperative EPDS scores

The EPDS scores were assessed preoperatively and at 3, 5, 14, and 28 days postoperatively for the observation group ($n=82$) and the control group ($n=86$) (Table 3). Preoperatively, there was no significant difference between the groups, indicating comparable baseline psychological states. Postoperatively, the observation group exhibited significantly lower EPDS scores at 3 days (7.15 ± 3.12 vs. 8.53 ± 3.28) and 5 days (7.68 ± 2.43 vs. 9.46 ± 2.18) compared to the control group, suggesting better early psychological outcomes. At 14 days, the observation group continued to have lower scores (7.01 ± 1.89 vs. 8.18 ± 2.26), indicating sustained benefits. By 28 days, the scores between the groups were similar (7.65 ± 1.68 vs. 7.92 ± 1.75). These results suggest that esketamine use in the observation group is associated with improved early postoperative psychological outcomes, with benefits becoming less pronounced by 28 days.

Comparative analysis of postpartum depression incidence

The incidence of postpartum depression, as measured by the EPDS, was evaluated preoperatively and at 3, 5, 14, and 28 days postoperatively for both the observation group ($n=82$) and the control group ($n=86$) (Table 4). Preoperatively, there was no significant difference in the incidence of postpartum depression between the observation group (19.5%) and the control group (16.3%). However, significant differences were noted postoperatively. At 3 days post-surgery, the observation group had a significantly lower incidence of postpartum depression (26.8%) compared to the control group (44.2%). This pattern persisted at 5 days post-surgery, with the observation group showing an incidence of 22.0% versus 41.9% in

Table 4 Comparative analysis of postpartum depression incidence between observation and control groups

Group	Preoperative (1 d)	Postoperative (3 d)	Postoperative (5 d)	Postoperative (14 d)	Postoperative (28 d)
Observation Group ($n=82$)	16 (19.5%)	22 (26.8%)	18 (22.0%)	20 (24.4%)	12 (14.6%)
Control Group ($n=86$)	14 (16.3%)	38 (44.2%)	36 (41.9%)	34 (39.5%)	18 (20.9%)
χ^2 Value	0.176	4.236	4.572	4.971	1.476
P Value	0.675	< 0.05	< 0.05	< 0.05	0.225

Table 5 Comparative analysis of postoperative recovery metrics between observation and control groups

Group	First Ambulation Time (h)	First Flatus Time (h)	Initiation of Lactation (h)
Observation Group ($n=82$)	11.89 ± 2.26	20.92 ± 5.32	21.56 ± 5.14
Control Group ($n=86$)	15.23 ± 3.00	25.37 ± 4.85	29.52 ± 5.91
t Value	3.511	3.467	7.035
p Value	< 0.01	< 0.01	< 0.01

Table 6 Comparative analysis of adverse reactions between observation and control groups

Group	Headache	Drowsiness	Vomiting	Total
Observation Group ($n=82$)	4 (4.9%)	6 (7.3%)	8 (9.8%)	18 (22.0%)
Control Group ($n=86$)	5 (5.8%)	4 (4.7%)	10 (11.6%)	19 (22.1%)
χ^2 Value	0.08	0.15	0.12	0.005
P Value	0.815	0.563	0.729	0.941

the control group. At 14 days, the trend continued, with the observation group having a lower incidence (24.4%) compared to the control group (39.5%). By 28 days post-surgery, the difference in incidence between the groups was no longer statistically significant, with 14.6% in the observation group and 20.9% in the control group. These findings suggest that the esketamine intervention in the observation group significantly reduced the incidence of postpartum depression in the early postoperative period. However, by 28 days post-surgery, the incidence rates between the groups had converged, indicating the importance of continued monitoring for long-term psychological outcomes.

Comparative analysis of postoperative recovery metrics

Postoperative recovery metrics, including time to first ambulation, first flatus, and initiation of lactation, were significantly improved in the observation group ($n=82$) compared to the control group ($n=86$) (Table 5). The observation group ambulated earlier, with an average time of 11.89 ± 2.26 h versus 15.23 ± 3.00 h in the control group. Similarly, the time to first flatus was shorter in the observation group, averaging 20.92 ± 5.32 h, compared to 25.37 ± 4.85 h in the control group. Additionally, the initiation of lactation occurred sooner in the observation group, with an average time of 21.56 ± 5.14 h, compared to 29.52 ± 5.91 h in the control group. These differences were all statistically significant ($p<0.01$), suggesting that the use of esketamine enhances postoperative recovery by promoting earlier mobility and breastfeeding, critical factors for maternal and neonatal health.

Comparative analysis of adverse reactions

Headaches were reported by 4.9% of patients in the observation group and 5.8% in the control group. Drowsiness occurred in 7.3% of the observation group compared to 4.7% in the control group. Vomiting was reported by 9.8% of the observation group and 11.6% of the control group. The total incidence of adverse reactions was 22.0% in the observation group and 22.1% in the control group (Table 6). There were no statistically significant differences in the incidence of any individual adverse reactions or the total adverse reactions between the groups. These findings suggest that the use of esketamine for postoperative pain management does not increase the risk of adverse reactions compared to traditional analgesic methods, affirming its safety for use in patients undergoing cesarean sections.

Post-Hoc power analysis

A post-hoc power analysis was conducted to assess the statistical power of the study, incorporating key outcomes including VAS scores, EPDS scores, postpartum depression incidence, postoperative recovery metrics, and adverse reactions. The weighted Cohen's d was calculated to be 0.78, indicating a moderate to large effect size across the primary outcomes. Using this effect size and the total sample size of 168, the power analysis revealed a post-hoc power estimate of approximately 0.90 for a two-tailed test at a significance level of $\alpha=0.05$.

Discussion

The management of postoperative pain and psychological well-being in postpartum mothers after cesarean surgery is essential to maternal care. Effective pain management

not only improves patient comfort but also promotes early mobilization, diminishes the likelihood of postoperative complications, and fosters a favorable psychological state, which is crucial for mother-infant attachment. Conventional analgesic protocols, predominantly reliant on opioids, although efficacious, are accompanied by numerous adverse effects including nausea, vomiting, and a risk of addiction, complicating postoperative care for these patients [17–19]. Esketamine, a powerful NMDA receptor antagonist, has attracted interest for its swift analgesic and antidepressant effects. In contrast to conventional opioids, esketamine offers excellent analgesia through an alternative mechanism of action, potentially mitigating the adverse effect burden linked to opioids [9, 20]. Its function in regulating glutamatergic neurotransmission and augmenting synaptic plasticity has demonstrated potential not just in pain alleviation but also in promoting psychological outcomes, especially in mitigating depressive symptoms.

Our study demonstrated a continuous trend of reduced VAS scores in the observation group at all postoperative intervals in comparison to the control group. This signifies that esketamine offers enhanced pain management. Esketamine's effectiveness in pain management is attributed to its role as an N-methyl-D-aspartate (NMDA) receptor antagonist. Esketamine mitigates central sensitization and hyperalgesia, prevalent postoperative pain pathways, by inhibiting NMDA receptors. Moreover, esketamine demonstrates a quick onset of action and extended analgesic effects, which are especially advantageous in the acute postoperative context [21, 22]. The reduced VAS scores in the esketamine group at 6, 12, 24, and 48 h post-surgery indicate that esketamine offers both rapid pain alleviation and sustained efficacy over time. Consistent pain management can result in better patient outcomes, including a decreased requirement for supplementary analgesics, increased patient comfort, and potentially a reduced occurrence of chronic pain development [23].

The notable decrease in EPDS scores at 3, 5, and 14 days postoperatively in the observation group indicates that esketamine positively influences early postpartum psychological outcomes. Esketamine's antidepressant effects are well-established, mainly due to its regulation of glutamatergic neurotransmission and swift augmentation of synaptic plasticity. These processes may enhance its capacity to mitigate symptoms of postpartum depression, which is essential for the overall well-being of new mothers and their capacity to care for their infants [24, 25]. The noted advantages in psychological outcomes may possibly be indirectly associated with the enhanced pain management afforded by esketamine. Efficient pain treatment can alleviate the stress and anxiety linked to surgical recovery, consequently enhancing mood and diminishing the likelihood of depression. Esketamine facilitates a comprehensive approach to postpartum care by alleviating both physical and psychological stressors [26].

The prevalence of postpartum depression was markedly reduced in the observation group at 3, 5, and 14 days post-surgery, suggesting that esketamine may be essential in alleviating early postpartum depression. This reduction is clinically relevant as early management in postpartum depression can avert the escalation to more severe and chronic forms of depression, which can negatively impact both the mother and the child [27, 28]. Although the disparities in depression incidence across the groups diminished by 28 days post-surgery, the initial advantages associated with esketamine underscore the significance of prompt and efficacious management. Future study should investigate the enduring psychological advantages of esketamine and the possible necessity for ongoing therapy or supplementary assistance to maintain these benefits over time.

The improved postoperative recovery indicators noted in the esketamine group, including earlier ambulation, faster restoration of gastrointestinal function, and prompt commencement of milk, highlight the extensive advantages of proficient pain management. Prompt mobilization and breastfeeding are essential for averting problems such as deep vein thrombosis, pulmonary embolism, and lactation failure, which may have considerable long-term health consequences for both mother and infant. The expedited recovery times linked to esketamine usage are likely attributable to its powerful analgesic properties, which allow patients to mobilize and operate with greater comfort and confidence [29, 30]. This may result in abbreviated hospitalizations, diminished healthcare expenditures, and enhanced overall patient contentment. The similar occurrence of adverse reactions in both the observation and control groups indicates that esketamine is safe for postoperative pain management following cesarean procedures. The absence of notable disparities in the occurrence of headaches, sleepiness, and vomiting suggests that esketamine does not pose extra hazards relative to conventional analgesics. This is especially critical in postpartum care, where the safety and welfare of both the mother and the newborn are of utmost importance.

This research possesses multiple limitations. While the sample size in this study is adequate, it may not be large enough to generalize the findings to all postpartum women undergoing cesarean sections. Additionally, the retrospective design introduces the potential for selection bias, limiting the ability to establish causality. The 28-day follow-up period may also be insufficient for fully assessing the long-term effects on both psychological and physical recovery. Future research should prioritize

larger, multicenter, randomized controlled trials to confirm these findings and enhance their generalizability. Moreover, extended follow-up periods are necessary to evaluate the sustained impact of esketamine on postoperative pain and psychological health. Investigating optimal dosing regimens and potential combinations with other analgesics could further refine its clinical application.

Conclusions

The application of the Esketamine Intravenous Analgesic Pump for postoperative pain management in cesarean sections markedly diminishes postoperative pain and the occurrence of postpartum depression over the initial 14 days. It facilitates early healing and lactation in postpartum women without notable side responses, rendering it a substantial enhancement to postoperative care.

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Author contributions
Xiao-Qiang Zhang, Shuang Li, and Xiao-Lin Qin were the guarantors of the integrity of the entire study. The study concepts were developed by Xiao-Qiang Zhang, Shuang Li, and Xiao-Lin Qin, with the study design and definition of intellectual content led by Xiao-Qiang Zhang. Shuang Li was responsible for literature research, while Xiao-Qiang Zhang oversaw the clinical studies. Experimental studies were conducted by Xiao-Qiang Zhang, Shuang Li, and Xiao-Lin Qin, with data acquisition handled by Xiao-Lin Qin. Shuang Li conducted the data analysis and statistical analysis. Xiao-Lin Qin was responsible for manuscript preparation, while Xiao-Qiang Zhang handled manuscript editing. The manuscript was reviewed by Xiao-Qiang Zhang and Shuang Li.

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Data availability
The datasets generated and analyzed during this study are available upon reasonable request. To request access to the raw data, please contact Xiao-Qiang Zhang at xqZhang_AH@163.com. Access to the data will be provided in accordance with institutional and ethical guidelines.

Declarations

Ethics approval and consent to participate
This study was approved by the Ethics Committee of Mengcheng County No. 1 People's Hospital, with the ethics approval number MYL21002. All study procedures complied with the ethical standards of the institutional and national committees and the Helsinki Declaration. Informed consent was obtained from all participants or their legal guardians.

Clinical trial
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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