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Technical Note

Impact of segmented pain management on postoperative pain control and serum inflammation and stress factor levels in Caesarean section patients

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Abstract: The Caesarean section, a surgical delivery method through an abdominal incision for childbirth, is often clinically employed to address health issues for the foetus or the mother. The current study aims to explore the impact of segmented pain management on post-Caesarean section women, to provide effective clinical care strategies. Sixty-nine Caesarean section cases were divided into three groups (A, B and C) receiving different pain management modalities. For group A, conventional postpartum care management for women was implemented; for group B, operating room pain management intervention was applied, and for group C, segmented pain management was implemented. Pain levels were assessed, and serum levels of interleukin (IL)-1β, IL-6, high-sensitivity C-reactive protein, cortisol, norepinephrine and epinephrine were analysed. The subjects in group C had better pain control than group A and B, with lower numeric rating scale scores (P<0.05). In group C inflammatory and stress factor levels were lower compared to those in groups A and B (P<0.05). Overall care satisfaction and sleep index scores in group C were also superior (P<0.05). The segmented pain management thus demonstrates distinct pain relief effects in post-Caesarean women, enhancing biological indicators' equilibrium by modulating inflammation and stress factor levels. Therefore, segmented pain management may serve as an effective care strategy for Caesarean patients.

Keywords: Caesarean section, segmented pain management, postoperative pain control, serum inflammation

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INTRODUCTION

The Caesarean section is a surgical delivery method done through an abdominal incision, which is often clinically employed to address health issues of either the foetus and/or the mother. Countries with high, middle and poor incomes all continue to see a rise in the number of Caesarean sections performed. A percentage of 21.1% of women globally from 154 countries gave birth by Caesarean section, encompassing 94.5% of live births worldwide in 2010-2018. Projections indicate that by 2030, 28.5% of women worldwide will give birth via Caesarean section [1]. While necessary for some, many women experience varying degrees of pain in post-Caesarean section [2, 3]. According to a US Institute of Medicine study, less than 50% of surgery patients report having effective pain control, despite the fact that postoperative pain is a prevalent but frequently undertreated disease that affects 80% of patients [4]. Sensitivity to post-Caesarean pain differs among individuals, with some experiencing mild discomfort while others undergo more intense sensations. Additionally, the duration of postoperative pain varies; some women experience significant relief within days while others may require more extended recovery periods [5-7]. Intense postoperative pain can limit a mother's mobility during recovery, affecting her daily life and speed of physical recuperation. Pain may hinder deep breathing, potentially leading to inadequate lung ventilation and an increased risk of respiratory complications [8, 9]. Additionally, elevated serum inflammatory markers due to prolonged pain may increase the risk of infections and other inflammation-related complications. This may activate stress response, leading to the release of adrenal hormones, influencing metabolism and cardiovascular function [10, 11]. Thus, effective pain management plays a pivotal component of postoperative care. .

Current management strategies involve the use of medications, physical therapy and psychological support. However, the conventional cornerstone of postoperative pain management, opioid drugs, is linked to serious short- and long-term side effects, and numerous patients did not conduct the correct and beneficial physical training [12, 13]. Gradually increasing activity levels through a well-structured rehabilitation plan can aid mothers in overcoming pain and promoting early recovery. Segmented pain management is a nursing strategy that involves employing different methods of managing pain at various stages. Typically, in the early postoperative phase, potent analgesics are used to control severe post-Caesarean pain, ensuring effective pain relief within the first 24-48 hr [14, 15]. As patients recover, there is a gradual reduction in analgesic medication with introduction of non-pharmacological interventions such as physical therapy, heat therapy and rehabilitation exercises to facilitate recovery and reduce dependency. Segmented pain management emphasises the patient's self-management and long-term recovery, involving regular rehabilitation exercises, dietary management and psychological support for coping with chronic pain [16, 17]. Widely utilised in clinical practice for post-Caesarean pain, the segmented pain management offers more personalised and comprehensive pain control plans, ensuring adequate relief during crucial postoperative periods. Gradually reducing medication use during recovery and introducing non-pharmacological interventions can decrease Caesarean patients' reliance on medications and mitigate potential medication-related risks [18, 19]. Furthermore, it emphasises ongoing treatment throughout the recovery phase, aiding in recovery of Caesarean patients and alleviating the adverse effects of pain on physiological and psychological aspects. Comprehensive care not only alleviates pain but also contributes to overall recovery and well-being of mothers.

Therefore, this study aims to delve into the impact of the segmented pain management model on post-Caesarean section pain control, biological markers and overall care satisfaction among

women. Different assessment methods were employed, including numeric rating scale (NRS) scoring [20], biological marker analyses, and Houston pain outcome instrument (HPOI) survey [21]., to observe the effectiveness of segmented pain management comprehensively and objectively. The focus is to unveil the advantages of segmented pain management in postoperative pain control and its regulatory effects on inflammatory and stress factors, and to offer a more scientifically guided and effective approach for the clinical care of future Caesarean section patients.

MATERIALS AND METHODS

Research Subjects

The collected data from 69 cases of postpartum women admitted to Obstetrics and Gynecology Department, Lixin County Traditional Chinese Medicine Hospital between February and October 2023 were randomly enrolled into groups A, B and C, each comprising 23 cases. The demographic details such as age, gestational days, obstetric history and body mass index demonstrated negligible differences among all the participants, ensuring comparability (P>0.05). The research study was approved by the Ethics Committee of Lixin County Traditional Chinese Medicine Hospital (Approval No. LCTCMH20221202）.

Inclusion criteria encompassed postpartum women undergoing Caesarean section, aged between 23-40 years and exclusively full-term pregnant (37 weeks' gestation or beyond); participants capable of comprehending and cooperating with the entire study process without cognitive impairments or communication difficulties; and women voluntarily participating in the study by signing the informed consent

Exclusion criteria involved women requiring Caesarean section due to emergency situations; women with multiple pregnancies; those experiencing significant clinical complications such as severe bleeding and infections; individuals with chronic pain symptoms or other chronic illnesses; women on prolonged use of analgesics or other medications potentially affecting pain perception and inflammatory levels; and women with severe psychological illnesses or depressive symptoms.

Nursing Plans

For group A, conventional postpartum care management for women was implemented. Post-operation and analgesic medications were administered to alleviate postoperative pain. Vital signs including blood pressure, heart rate and respiratory rate were monitored. Surgical incisions were examined to ensure there was no infection. Routine postpartum care was provided, encompassing postpartum hygiene, dietary guidance, breast care, and basic contraception and family planning advice.

For group B, operating room pain management intervention was applied. Local anesthesia techniques were used during the procedure to alleviate intraoperative pain. Continuous analgesic pumps were set up intraoperatively to ensure immediate and effective postoperative pain relief. Postoperatively, continuous monitoring of pain levels was conducted, and medication dosages were adjusted to maintain effective pain control. Patients were encouraged to perform deep breathing exercises and coughing exercises to facilitate respiratory system recovery. Guidance was provided to gradually reduce analgesic medication usage, transitioning to oral medications. Physical therapy including rehabilitative exercises was performed to promote recovery and reduce reliance on medications.

For group C, segmented pain management was implemented as follows.

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I. Pre-operation

i) *Pain education*

Prior to surgery the Caesarean section process was explained to the patient using professional terms and diagrams, emphasising potential sources of pain and normal physiological reactions to postoperative pain. The impact of individual differences on pain perception was described, emphasising that each patient's pain experience is unique. Different pain management methods that might be used pre-, intra- and post-operatively, including drug treatments, local anesthesia and non-pharmacological therapies, were introduced to enhance the patient's understanding of pain management.

ii) Professional pain prevention training before surgery was conducted, and deep breathing and coughing exercises were taught to maintain respiratory system clearance and reduce postoperative pulmonary complications. Correct guidance on body positioning was provided to reduce abdominal post-surgery tension and alleviate pain.

iii) Psychological support was given to help the patient understand the necessity of the surgery and to cope with anxiety and tension.

II. Post-operation

i) Pain assessment

Using pain assessment tools, the patient expressed her pain level through numerical scores, facial expressions, etc. Detailed inquiries about the location and nature of pain were made to determine potential sources such as surgical incisions or muscle pain. Understanding the pain's impact on the patient's daily activities, sleep and emotional state facilitated a comprehensive assessment of its effects. Observing the patient's facial expressions including frowning or tears served as a mode of pain expression. Encouraging verbal descriptions of pain sensations such as stabbing or throbbing, aimed to obtain more detailed information. Observing the patient's body language and behaviours such as difficulty in repositioning or refusal to eat assisted in determining the degree of pain.

ii) Specialised pain care interventions

In the early postoperative phase, comprehensive pain relief was provided using methods such as local anesthesia and analgesic pumps. During the recovery period, medication dosages were adjusted based on pain assessments, gradually transitioning to oral medication and reducing reliance on opioid medications. Physical therapy including rehabilitative exercises and heat application was provided to promote recovery and pain alleviation. Professional psychological support involving cognitive-behavioural therapy and relaxation techniques was offered to help the patient cope up with psychological stress induced by pain. Personalised long-term rehabilitation plans encompassing postnatal exercises and dietary management were developed holistically to facilitate recovery.

Detection of Inflammatory and Stress Factors

Inflammatory factor detection was implemented. Blood samples (3 mL) were collected via the patient's cubital vein. The collected blood samples were centrifuged at 4°C for 10 min. to isolate the serum, which was then stored at -75°C in the refrigerator for further use. Enzyme-linked immunosorbent assay (ELISA) kits (Shanghai Enzyme-linked Biotechnology Co., China) were utilised to measure the levels of interleukin (IL)-1β, IL-6 and high-sensitivity C-reactive protein (hs-CRP) in the serum.

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Stress response detection was implemented. Blood collection procedure was the same as that used for inflammatory factor detection. Radioimmunoassay was employed to assess the levels of cortisol (Cor), norepinephrine (NE) and epinephrine (E).

Observation and Evaluation Indicators

I. Numeric rating scale (NRS) was used to compare the postoperative pain assessments among groups A, B and C at 1, 3 and 5 days after operation. The NRS pain assessment method is commonly employed to measure pain intensity. Patients select a number from 0 to 10 to express their pain level, with 0 indicating no pain, 1-3 representing mild pain, 4-6 indicating moderate pain, and 7-10 signifying severe pain. When the NRS score is less than 5, the parturients are within the range of mild to moderate pain and the following coping measures can be adopted: i) Non-pharmacological pain management, employing physical therapies such as heat or cold application for localised pain relief; ii) Deep breathing and relaxation techniques, easing physical tension to promote pain relief; iii) Gentle exercises such as walking and simple stretching exercises which help improve blood circulation and alleviate mild pain. When the NRS score exceeds 5, the parturients experience moderate to severe pain and require more proactive measures: i) Timely administration of appropriate analgesics (such as opioids) as advised by physician to effectively control pain; ii) Resting in bed; iii) Specialised nursing support provided by professional nursing staff, including physical therapy and psychological support, to enhance the parturients' pain coping abilities.

II. The levels of inflammatory factors IL-1β, IL-6 and hs-CRP in groups A, B and C were assessed and recorded before delivery (cervical dilation up to 2-3 cm) and at 1- and 3-days' post-nursing intervention. Additionally, the levels of stress factors Cor, NE and E in the three groups of parturient were measured and recorded before delivery and at 1-hour post-delivery.

III. The anxiety visual analog test (AVAT) scores were recorded for groups A, B and C of parturients before delivery and at 7- and 15-day post-intervention. The AVAT is a tool used to assess individual anxiety levels [22]. It constitutes a visual analog scale where the evaluated individuals mark their anxiety levels on a 100-mm horizontal line. The extremes of the line are labelled as 'no anxiety' and 'maximum anxiety,' and the assessed individual places a mark on the Visual Analog Scale for Anxiety to indicate the current anxiety level. The scale ranges from 0, signifying complete absence of anxiety, to 100, indicating the most severe anxiety. The length (in mm) on the line is recorded based on the individual's self-perceived level of anxiety.

IV. The Pittsburgh sleep quality index (PSQI) [23] scores were recorded for groups A, B and C of parturients before delivery and at 3-, 7- and 15-day post-intervention. The PSQI is a commonly used self-reported questionnaire for assessing an individual's sleep quality and sleep disturbances. It encompasses aspects including sleep duration, onset latency, sleep efficiency, sleep quality and sleep disturbances, offering a comprehensive evaluation suitable for assessing the sleep status of parturients in specific physiological and psychological states. The PSQI comprises 19 items, encompassing 7 sleep quality components and 3 potential sleep disturbance components. Each component is scored from 0 to 3 points, with a total score range of 0-21 points, higher scores indicating poorer sleep quality. Based on the total score, PSQI categorises sleep quality as 'good' (0-5 points), 'fair' (6-10 points) and 'poor' (11-21 points).

V. The HPOI is extensively used to assess patients' pain experiences, expectations related to pain, the impact of pain on daily life and emotions, as well as satisfaction with pain control and

education. This survey comprises 6 domains covering 14 questions, totaling 34 assessment items. Among these, 10 questions employ a 0-10 numerical rating, where higher scores indicate greater satisfaction. Records and comparisons were made among the three groups of parturient at 48-hr post-operation using the HPOI assessment.

Statistical Analysis

The statistical analysis of all experimental data was conducted using SPSS 24.0. Continuous variables were expressed as mean ± standard deviation ($\bar{x}\pm s$) and categorical data were subjected to statistical inference using the χ^2 test. Continuous variables followed a normal distribution and were assessed using the *t*-test. $P<0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

Comparison of Postoperative NRS Scores

In Figure 1 comparing the immediate postoperative NRS scores among the three groups of parturients does not show considerable differences ($P>0.05$). However, at postoperative days 1, 3 and 5, there are reductions of scores for all groups versus the immediate postoperative period ($P<0.05$). The NRS scores in group B are lowered compared to those in group A, but this difference is neglectable ($P>0.05$). Notably, the NRS scores in group C are drastically lowered compared to those in groups A and B ($P<0.05$). This indicates that the segmented pain management exhibits a relatively more pronounced early postoperative pain relief for parturients, potentially offering more effective pain management over time.

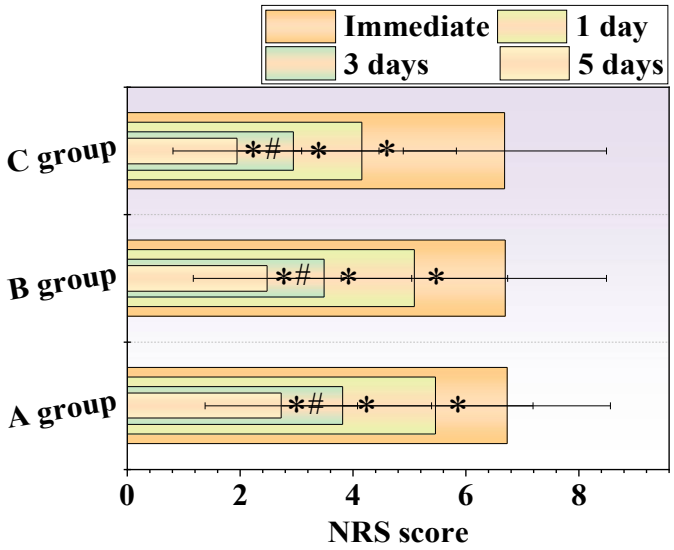

Figure 1. Comparison of postoperative NRS scores: *Significant reduction in NRS score compared to immediate postoperative period ($P < 0.05$); # Significant difference in NRS score compared to group A at the same time point ($P < 0.05$).

Comparison of Levels of Inflammatory and Stress Factors

In Figure 2, before delivery the three groups of parturients demonstrate slight differences in terms of inflammatory markers ($P>0.05$). However, at 1- and 3-days' post-intervention, there is drastic decrease in the biological indicators for all three groups ($P<0.05$). Particularly, the levels in group C are dramatically lower than those in groups A and B ($P<0.05$). This outcome suggests that

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segmented pain management greatly affects the levels of inflammatory markers in parturients. The early postoperative decline in inflammatory markers may reflect the positive impact of pain management, especially the segmented pain management, which effectively alleviates parturients' pain perceptions, thereby reducing the inflammatory levels.

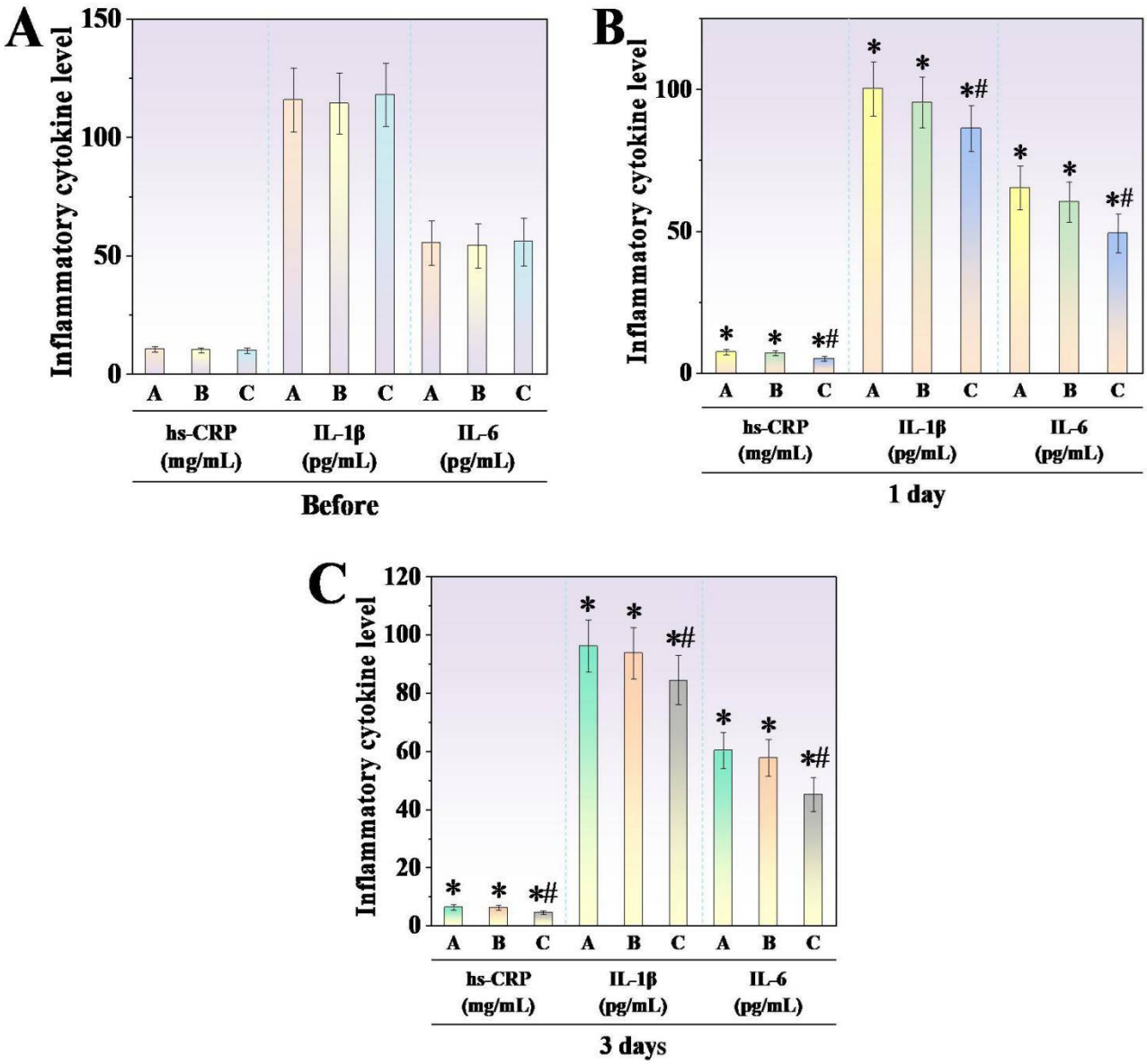

Figure 2. Comparison of levels of inflammatory factors. **P*<0.05 vs before delivery; $^{\#}$*P*<0.05 vs groups A and B

In Figure 3, stress factors cortisol, NE and E show no marked differences among the three groups of parturients before delivery (*P*>0.05). However, at 1-hour postoperation, there is a noticeable downward trend in stress factor levels among all three groups (*P*<0.05), with group C exhibiting a more prominent reduction relative to groups A and B (*P*<0.05). Thus, segmented pain management seems to demonstrate a remarkable effect on regulating stress factor levels, thereby reducing the physiological stimulation resulting from surgical trauma, and consequently alleviating parturients' physiological stress responses to a certain extent.

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AVAT Score Comparison

In Figure 4, before delivery there are no marked differences in the AVAT scores among the three groups of parturients (P>0.05). However, at 7 and 15 days' post-intervention, marked declines occur in the AVAT scores for all groups (P<0.05). Particularly, group C exhibits a more substantial decrease versus groups A and B, showing considerable differences (P<0.05). Thus, segmented pain management also demonstrates a remarkable effect on regulating stress factor levels. The reason for this may lie in the fact that segmented pain management in group C allows for a more detailed management of postoperative pain, which facilitates better adaptation of parturients to the physiological changes of post-surgery and mitigates the impact of postoperative pain, thereby enhancing quality of life and improving AVAT scores.

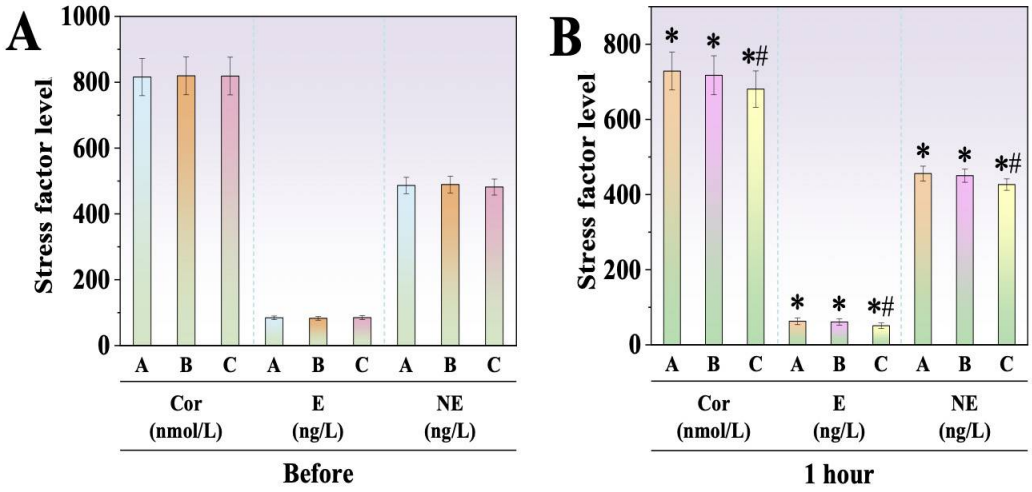

Figure 3. Comparison of stress factor levels: *P<0.05 vs before delivery; #P<0.05 vs groups A, B

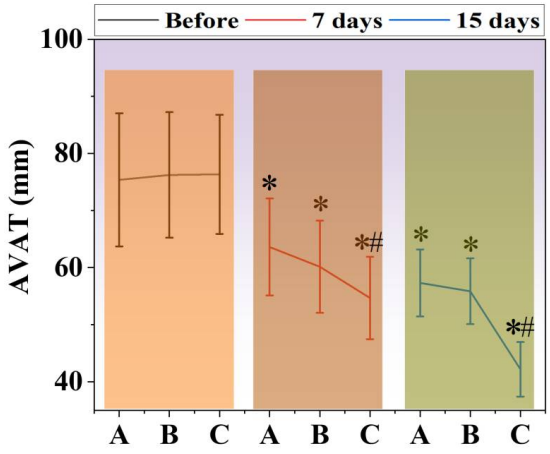

Figure 4. Comparison of AVAT scores: *P<0.05 vs before delivery; #P<0.05 vs groups A and B

PSQI Score Comparison

In Figure 5, before delivery the PSQI index demonstrates small differences among the three groups of parturients (P>0.05). Nevertheless, at 3-, 7- and 15-day post-intervention, there is decreased PSQI index for all three groups (P<0.05). Comparatively, group C exhibits a more substantial decrease in contrast to groups A and B (P<0.05). Due to the comprehensive nature of segmented pain management, it potentially facilitates better rest and recovery for parturients, aiding

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in improving sleep quality. Therefore, the decrease in the PSQI index may result from interrelation between pain relief, physiological improvement and enhanced sleep quality.

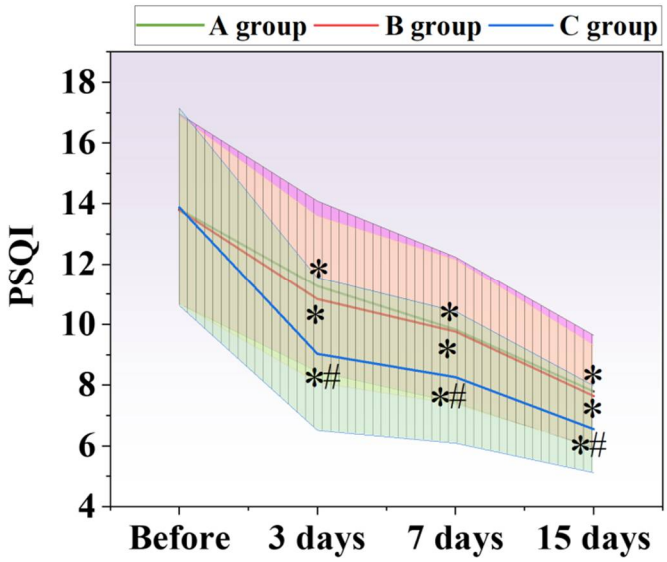

Figure 5. PSQI score comparison: *P<0.05 vs before delivery; #P<0.05 vs groups A and B (Vertical lines represent standard deviation of PSQI index values.)

Comparison of Pain Control Satisfaction

The pain control satisfaction of the three groups of parturients according to the HPOI survey is presented in Table 1. It is evident that in pain control education, postoperative pain management, nursing interventions and other aspects, the satisfaction in group C is markedly superior to that in groups A and B (P<0.05). It distinctly indicates the pivotal significance of comprehensive perioperative pain management in patient care and prognosis. This comprehensive intervention likely provides parturients with more meticulous and personalised care throughout the entire postoperative phase, thereby enhancing satisfaction with pain control and recovery. Furthermore, segmented pain management emphasises individual differences, tailoring personalised pain management strategies based on parturients' pain perceptions and physiological status. This approach potentially fosters a sense of being valued and care for parturients, thereby increasing their satisfaction with pain control. Group C likely enhances parturients' understanding of the significance of pain management through more effective educational activities, thereby elevating their satisfaction with the entire pain care process.

Table 1. Comparison of pain control satisfaction

Group	Satisfaction (points)		
	Pain control education	Postoperative pain management	Nursing interventions
Group A (n=23)	5.24±1.05	5.72±1.21	5.58±1.22
Group B (n=23)	5.33±0.98	5.85±1.34	5.77±1.26
Group C (n=23)	7.06±1.27*	7.55±1.46*	7.63±1.49*
F-value	43.12	39.55	56.78
P-value	<0.05	<0.05	<0.05

**P*<0.05 vs groups A and B

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CONCLUSIONS

Segmented pain management exhibits a significant alleviating effect among post-Caesarean section women. The notable reduction in NRS scores, balanced regulation of biological indicators, and enhanced overall satisfaction in maternal care indicate the affirmative role of this care model. Nevertheless, it is essential to note certain limitations in experimental design and execution, such as a relatively small sample size and short follow-up duration. Future research could focus on addressing these aspects to further validate and refine the conclusions. Encouraging healthcare practitioners to adopt segmented pain management in future clinical practice could elevate postpartum pain management effectiveness, thereby improving the surgical experience and overall health status of these women.

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