ORIGINAL RESEARCH

Assessing the Impact of Programmed Intermittent Pulse Injection on Pelvic Floor Function Following Childbirth

Xiaofang Shen, MM; Yanyi Xu, MM

ABSTRACT

Objective • This study aimed to assess the impact of different administration timings of Programmed Intermittent Pulse Injection (PIEB) on pelvic floor function and postpartum rehabilitation in patients who underwent analgesic delivery and received postpartum rehabilitation nursing.

Methods • An observational comparative study was conducted between January 2021 and October 2021. We enrolled 85 patients who received PIEB analgesia during delivery and postpartum rehabilitation nursing at our hospital. Among them, 39 women received PIEB (10 mL pulse dose) 60 minutes after analgesia, comprising group A. Additionally, 46 women received PIEB (15 mL pulse dose) 90 minutes after analgesia, forming group B. We assessed pain levels using the Visual Analogue Scale (VAS), recorded epidural drug dosage, counted the number of Patient-Controlled Epidural Analgesia (PCEA) compressions, noted cases of unilateral block, oxytocin (OT) usage, conversion to cesarean section, and adverse events (AEs). Furthermore, we evaluated pelvic floor muscle (PFM) recovery and assessed their quality of life using the World Health Organization Quality of Life assessment (WHOQOL-100).

Results • Group A exhibited a lower VAS score at 1 hour after analgesia compared to group B ($P < .05$), with no significant differences at other time points ($P > .05$). Group A had lower epidural drug dosages and fewer PCEA compressions than group B ($P < .05$). There were no significant differences in unilateral block incidence and OT use ($P > .05$). PFM recovery levels were similar in both groups ($P > .05$), but the WHOQOL-100 score after nursing was higher in group A compared to group B ($P < .05$).

Conclusions • Administering PIEB with a 60-minute interval after analgesia can enhance the effectiveness and safety of the intervention. (*Altern Ther Health Med.* 2023;29(8):782-787).

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INTRODUCTION

The postpartum period represents a critical phase in a woman's life, marked by physiological and anatomical changes, including those in the pelvic floor region. Among the various factors influencing postpartum recovery and maternal well-being, the management of pain during labor and delivery plays a significant role.[1] Labor pain, often characterized as the most intense form of somatosensory discomfort, not only profoundly impacts the individual's sensory experience but also imposes considerable stress on various aspects of maternal well-being. The impacts of labor pain extend beyond perception alone, affecting maternal cardiovascular, endocrine, organ function, and psychological well-being.[1-2]

Furthermore, the severity of pain experienced during labor can increase the likelihood of patients encountering various adverse events. For instance, it has been associated with a heightened risk of pelvic floor dysfunction (PFD) and postpartum depression after delivery.[2] The relationship between labor pain and these postpartum adverse events highlights the multifaceted impact of pain management during childbirth. Labor pain not only significantly affects the process of childbirth and the recovery of parturients but also has a negative impact on the well-being of both the families of parturients and their newborns.[3]

Relevant studies have highlighted an increased risk of perinatal events, particularly among older parturient women.[4,5] In 2004, the International Association for the Study of Pain (IASP) explicitly recognized that pain relief is a necessity and right for women in labor. Hence, clinical practice is continuously dedicated to advancing research and refining techniques to ensure adequate pain relief during childbirth.

Among various methods of labor pain control, patient-controlled epidural analgesia (PCEA) is the most commonly used extensive analgesic regimen in clinical practice.

However, it has been associated with the undesirable side effect of motor block, which is unsuitable for obstetrics and gynecology cases. In recent years, a new anesthesia and analgesia method called Programmed Intermittent Pulse Injection (PIEB) has emerged. This innovative approach reduces the dosage of analgesic drugs and the occurrence of adverse events (AEs) and enhances maternal comfort during childbirth.[7]

Currently, several studies have demonstrated the impressive application outcomes of PIEB in pain management during delivery, substantially enhancing the standard of healthcare and maternal satisfaction.[8] However, as PIEB operates as an automated program, the crucial factor influencing its effectiveness is the timing of administration.[9] The absence of authoritative clinical guidelines for the exact timing of PIEB administration has led to ongoing debates within the medical community.

This study aims to investigate the impact of varying PIEB administration timings on the pelvic floor function and postpartum rehabilitation of women undergoing analgesic delivery. It aims to enhance the outcomes of analgesic delivery in obstetrics and gynecology to offer a more precise and dependable reference for the future clinical utilization of PIEB.

MATERIALS AND METHODS

Study Design

This study employs a prospective observational design, and we collected data from the Department of Obstetrics and Gynecology at Suzhou Integrated Traditional Chinese and Western Medicine Hospital between January 2021 and October 2021. The research received approval from the ethics committee of our hospital and adhered to pertinent regulations. Informed consent was obtained from all participants in the study.

Inclusion and Exclusion Criteria

We enrolled a total of 85 healthy parturients aged 21 to 35, weighing between 50 and 78 kg, who underwent PIEB analgesia for delivery at our hospital between January 2021 and October 2021. Inclusion criteria included a gestational age of ≥37 weeks, uterine dilation of 2-3 cm or regular contractions at the onset of anesthesia, and uterine contraction intervals of ≥3 minutes. Exclusion criteria included pregnancy complications, a history of mental illness, drug allergies, coagulopathy, or twin pregnancies.

Anesthetic Procedure and PIEB Administration

The parturient was positioned in the left lateral decubitus position, and an epidural puncture was performed at the L_{2-3} interspace. Subsequently, a catheter was inserted proximally (at the head end) to a depth of 3-4 cm. After the confirmation of no cerebrospinal fluid or blood withdrawal, an initial 3 mL of 1% lidocaine was epidurally injected. No signs of spinal anesthesia were observed within 5 minutes. Following this, a solution containing 0.075%-0.1% ropivacaine and an addition of 0.4 μg/mL sufentanil was administered.

The loading dose amounted to 15 mL, followed by a continuous dose of 8 mL/h and a self-controlled dose of 8 mL/time. Among the participants, 39 women received PIEB (pulse dose of 10 mL) 60 minutes after the initial analgesia, constituting group A. Meanwhile, 46 women underwent PIEB (pulse dose of 15 mL) 90 minutes after the initial analgesia, forming group B.

Postpartum Care and Rehabilitation Nursing

Preventing Complications and Promoting Maternal-Infant Bonding. After hospitalization, our nursing staff is dedicated to preventing postpartum complications such as bleeding, infection, and urinary retention. We guide parturients in establishing early contact with their newborns and adopting correct breastfeeding postures. In addition, we provide essential dietary guidance and emphasize the importance of personal hygiene.

Psychological Health Education. As part of targeted postpartum rehabilitation nursing, we prioritize psychological health education. We aimed to facilitate the transition to maternal identity by encouraging open expression of feelings during labor, puerperal care, and infant care. We worked to alleviate maternal distress by offering substantial family support, ensuring mothers feel the warmth of family and societal care. We also assisted parturients in developing effective parenting skills and provided guidance on newborn care.

Rehabilitation Techniques. (1) Rehabilitation Massage: We applied warm towels to the breasts and abdominal area daily, followed by gentle circular massages. We utilized instructional videos on breastfeeding and rehabilitation training in the ward. (2) Rehabilitation Training: Parturients were coached to assume a supine position, legs apart and flexed, while fully contracting the anus. This exercise is performed for 30 minutes each day through slow exhalation and gradual relaxation. The training duration and posture are tailored to each parturient's pelvic floor muscle (PFM) function.

Outcome Measures

Analgesic Effect. Maternal pain relief during childbirth was categorized as follows: (1) markedly effective: essentially no pain; (2) effective: tolerable pain; and (3) ineffective: unbearable pain. The overall response rate was calculated as [(markedly effective + effective) / total number] × 100%.

Visual Analogue Scale (VAS). Maternal pain levels were assessed using the VAS at multiple time points: before analgesia (T0), as well as 1 hour (T1), 2 hours (T2), 3 hours (T3), 4 hours (T4), and 5 hours (T5) after analgesia.

Anesthesia. We recorded the dosage of epidural drugs and the number of PCEA compressions.

Delivery. Adverse events, including maternal unilateral block, oxytocin (OT) use, conversion to cesarean section (CS), nausea, vomiting, and hypotension, were carefully recorded.

Pelvic Floor Muscle (PFM) Recovery. The PFM function of parturients was evaluated using the PFM Strength Grading Scale,[10] with grades ranging from 1 to 5. Recovery was considered good for those achieving grade 3 or higher.

Quality of Life (QOL). The QOL of parturients was assessed using the World Health Organization Quality of Life assessment (WHOQOL-100) both before and after delivery. Each dimension (physical function, mental health, psychological status, social relationships) had a maximum score of 100, with higher scores indicating a better quality of life.

Statistical Analysis

Data were analyzed using SPSS 21.0 software (IBM, Armonk, NY, USA). Categorical data were presented as percentages (%), and statistical analysis was conducted using the Chi-square test. Measurement data were expressed as mean ($\bar{x} \pm s$), and statistical methods included independent samples *t* test, Analysis of Variance (ANOVA), and the Least-Significant Difference (LSD) post-hoc test. Statistical significance was defined as differences with $P < .05$.

RESULTS

Comparison of Maternal Clinical Baseline Data between the Two Groups

We compared age, BMI, gestational week, and body temperature between Group A and Group B. The results indicated that none of these variables exhibited statistically significant differences ($P > .05$), see Table 1. The comparison demonstrated the comparability of the two groups.

Comparison of Analgesic Effects

In Group A, the treatment demonstrated marked effectiveness in 61.54% of parturients, effectiveness in 30.77%, and ineffectiveness in 7.69%, resulting in a total analgesic effectiveness rate of 92.31%. Meanwhile, in Group B, the distribution of treatment outcomes was as follows: markedly effective in 56.52%, effective in 34.78%, and ineffective in 8.70%, resulting in a total analgesic effectiveness rate of 91.30%. The data revealed no significant difference in the total analgesic effectiveness rate between the two groups ($P > .05$), see Table 2.

Comparison of VAS Scores

As illustrated in Figure 1, the VAS score at T0 in Group A was (8.49 ± 0.82), which did not significantly differ from the VAS score in Group B (8.54 ± 1.26) ($P > .05$). However, at T1, the VAS score in Group A was notably lower (2.74 ± 0.59) compared to Group B (3.61 ± 0.93) ($P < .05$).

For subsequent time points (T2, T3, T4, and T5), the VAS scores in Group A (2.79 ± 0.52, 2.79 ± 0.52, 2.74 ± 0.59, and 2.72 ± 0.60) did not significantly differ from those in Group B (2.85 ± 0.47, 2.80 ± 0.50, 2.78 ± 0.51, and 2.76 ± 0.57) ($P > .05$). Interestingly, in Group A, the VAS scores remained consistent among T1-T5, all lower than that at T0 ($P < .05$). Conversely, in Group B, the VAS score was highest at T0, decreased at T1, and further declined at T2-T5 ($P < .05$).

Comparison of Anesthesia

In Group A, the dosage of epidural drugs was measured (57.59 ± 7.93 mL), which was significantly lower than that in Group B (63.11 ± 9.94 mL) ($P < .05$), Refer to Figure 2A.

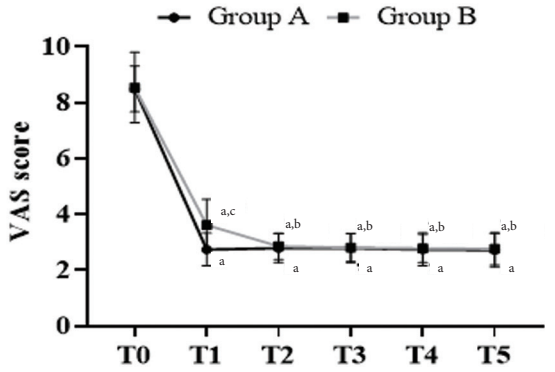
Table 1. Comparison of Clinical Baseline Data ($\bar{x} \pm s$)/[n (%)]

	Group A	Group B	*t* or χ^2	*P* value
Age (years)	26.00 ± 2.38	26.11 ± 2.30	0.216	.829
BMI (kg/cm^2)	23.70 ± 2.08	24.44 ± 1.66	1.824	.072
Cervical Dilatation (cm)	2.50 ± 0.42	2.40 ± 0.28	1.309	.194
Gestational Weeks	39.59 ± 0.82	39.74 ± 0.93	0.782	.437
Pregnant but not in Labor			0.036	.849
Yes	7 (17.95)	9 (19.57)		
None	32 (82.05)	37 (80.43)		
Smoking History			0.350	.554
Yes	16 (41.03)	16 (34.78)		
None	23 (58.97)	30 (65.22)		
Alcohol History			0.011	.915
Yes	14 (35.90)	16 (34.78)		
None	25 (64.10)	30 (65.22)		
Living Environment			0.048	.827
City	28 (71.79)	34 (73.91)		
Rural	11 (28.21)	12 (26.09)		
Nationality			0.541	.462
Han	37 (94.87)	45 (97.83)		
Minorities	2 (5.13)	1 (2.17)		

Table 2. Comparison of Analgesic Effects Between the Two Groups [n (%)]

Group	Markedly Effective	Effective	Ineffective	Overall Response Rate (%)
Group A	24 (61.54)	12 (30.77)	3 (7.69)	92.31
Group B	26 (56.52)	16 (34.78)	4 (8.70)	91.30
χ^2				0.028
P value				0.867

Figure 1. Comparison of Maternal VAS Scores Between the Two Groups



[a]$P < 0.05$ vs. T0
[b]$P < 0.05$ vs. T1
[c]$P < 0.05$ vs. group A

Additionally, the number of PCEA compressions in Group A was (5.72 ± 1.67), also notably lower than that in Group B (7.87 ± 1.48) ($P < .05$); refer to Figure 2B.

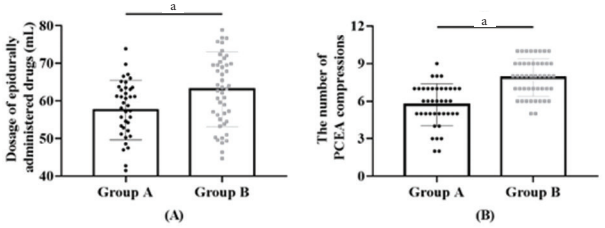
Comparison of Delivery Conditions

In Group A, unilateral block, OT use, and CS incidence were 7.69%, 25.64%, and 10.26%, respectively, resulting in an overall incidence of AEs of 20.51%. Meanwhile, the corresponding values in Group B were 10.87%, 26.09%, 13.04%, and an incidence of AEs of 26.09%. Notably, the incidence of unilateral block, OT use, CS, and AEs did not exhibit significant differences between the two groups ($P > .05$, see Table 3).

Comparison of Pelvic Floor Muscle (PFM) Recovery

In Group A, the assessment of PFM recovery revealed grade 1 in 23.08% of parturients, grade 2 in 30.77%, grade 3

Figure 2. Comparison of Anesthesia Between the Two Groups



[a]indicates a significant difference between the two groups ($P < .05$).

Note: (A) comparison of epidural drug dosage between the two groups; (B) comparison of the number of PCEA compressions between the two groups.

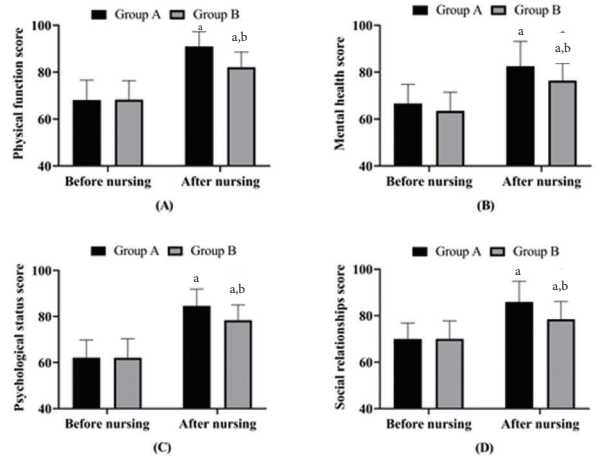
Table 3. Comparison of Delivery Conditions in the Two Groups [n (%)]

Group	Unilateral Block	Use of Oxytocin	Caesarean Section	Adverse Reactions
Group A	3 (7.69)	10 (25.64)	4 (10.26)	8 (20.51)
Group B	5 (10.87)	12 (26.09)	6 (13.04)	12 (26.09)
χ^2	0.250	0.002	0.158	0.365
P value	.617	.963	.691	.546

Table 4. Comparison of PFM Recovery between the Two Groups [n (%)]

Group	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Good Rate (%)
Group A	9 (23.08)	12 (30.77)	16 (41.03)	1 (2.56)	1 (2.56)	94.87
Group B	12 (26.09)	14 (30.43)	15 (32.61)	2 (4.35)	3 (6.52)	89.13
χ^2						0.921
P value						0.337

Figure 3. Comparison of WHOQOL-100 scores Before and After Nursing Between the Two Groups



aindicates a significant difference vs. before nursing
[b]indicates a significant difference vs. group A ($P < .05$).

Note: (A) comparison of physiological function scores before and after nursing; (B) comparison of mental health scores before and after nursing; (C) comparison of psychological status scores before and after nursing; (D) comparison of social relationship scores before and after nursing.

in 41.03%, grade 4 in 2.56%, and grade 5 in 2.56%, resulting in a favorable recovery rate of 94.87%. Conversely, in Group B, the PFM recovery was categorized as grade 1 in 26.09% of parturients, grade 2 in 30.43%, grade 3 in 32.61%, grade 4 in 4.35%, and grade 5 in 6.52%, resulting in a favorable recovery rate of 89.13%. Importantly, no significant difference in the favorable recovery rate was observed between the two groups ($P > .05$) see Table 4.

Comparison of Quality of Life (QOL)

Before nursing, the physiological function score for Group A was (68.08 ± 8.56), which did not significantly differ from Group B (68.30 ± 8.09) ($P > .05$). However, after nursing, the physiological function score for Group A increased to (90.97 ± 6.33), which was higher than Group B (82.13 ± 6.51) ($P < .05$); refer to Figure 3A. Before nursing, the mental health score for Group A was (66.69 ± 8.14), with no significant difference from Group B (63.48 ± 8.00) ($P > .05$). After nursing, the mental health score for Group A rose to (82.54 ± 10.60), which was higher than Group B (76.43 ± 7.34) ($P < .05$); refer to Figure 3B.

Before nursing, the psychological status score for Group A was (62.13 ± 7.67), with no significant difference from Group B (62.09 ± 8.25) ($P > .05$). However, after nursing, the psychological status score for Group A increased to (84.64 ± 7.28), higher than Group B (78.37 ± 6.64) ($P < .05$); refer to Figure 3C. Before nursing, the social relationship score for Group A was (69.95 ± 6.89), which was not significantly different from Group B (70.00 ± 7.78) ($P > .05$). After nursing, the social relationship score for Group A significantly improved to (85.92 ± 8.86), higher than Group B (78.43 ± 7.70) ($P < .05$), refer to Figure 3D. Remarkably, in both groups, all scores after nursing significantly increased compared to their respective scores before nursing ($P < .05$).

DISCUSSION

Analgesic delivery is a crucial aspect of clinical practice, playing a significant role in ensuring the safety of maternal delivery and postpartum rehabilitation.[11] PIEB has emerged as a standard protocol for labor analgesia in several hospitals, attaining widespread recognition for its advantages.[12] Therefore, it is critically important to advance and standardize the PIEB procedure, as it holds significant promise for enhancing maternal delivery health in the future.

There has been a growing focus on delivery care in recent years, both from medical practitioners and patients. Previous studies have affirmed that tailored nursing interventions can effectively reduce the incidence of AEs following delivery in parturients.[13,14] In our study, implementing a comprehensive, targeted postpartum rehabilitation program has yielded significantly improved results. These achievements carry significant implications for clinical practice and serve as a valuable reference.

In this study, we first compared the analgesic effects between groups A and B. Our findings indicated that while there was no disparity in the overall effectiveness of analgesia between the two groups, the VAS score at T1 for parturients in group A was notably lower than that in group B. This observation suggests that administering PIEB 60 minutes after analgesia onset offers swifter pain relief for pregnant women. Furthermore, our investigation revealed that the dosage of

epidural drugs and the number of PCEA compressions administered were lower in group A compared to group B. These outcomes strongly imply that administering PIEB at a 60-minute interval results in a more effective analgesic effect and reduces the required quantity of anesthetic drugs.

It is widely recognized that uterine contraction is regulated by the sympathetic nerves at the T12-L2 level, necessitating the use of epidural block anesthesia to achieve labor analgesia.[15] Different anesthetics can exert varying effects on the delivery process. For instance, ropivacaine has a reduced impact on motor nerve block at lower concentrations, which is advantageous for both the parturient and the fetus. On the other hand, higher concentrations may be more effective in completely blocking uterine contractions [16]. However, this increase in concentration also elevates the risk of uterine contractility loss, significantly raising the chances of dystocia and the potential need for cesarean section during delivery.

We believe the reduction in anesthetic usage with PIEB is in its ability to attain full contact between anesthetics and nerves, resulting in more precise nerve blocking. Furthermore, with higher injection pressures, local anesthetic drugs can be more uniformly dispersed within the epidural space, leading to a quicker onset of action.[17] Hence, within a brief timeframe, PIEB can meet the analgesic requirements of parturients while maintaining a certain level of uterine muscle strength and enhancing the likelihood of a successful delivery. Conversely, when extending the duration of PIEB administration, the efficacy of initially administered anesthetic drugs may diminish. In such instances, a secondary administration with a larger dose and duration becomes necessary, elevating the potential for adverse events.

However, in comparing the final delivery outcomes between the two groups, we observed no distinctions in any of the conditions. This finding suggests that although there might be slight differences in the effectiveness of pain relief between the two administration intervals, these differences are not significant enough to influence the final delivery outcome. It is important to highlight that this finding may be due to statistical uncertainties arising from the small number of studies included in our research. Therefore, we plan to promptly increase the number of participants in our future study to conduct a more comprehensive analysis for confirmation.

The occurrence of postpartum PFD is quite common during analgesic delivery, mainly due to the significant stretching of maternal pelvic tissues.[18] Therefore, tailored delivery nursing and rehabilitation training are often necessary as clinical interventions. Previous research has reported that approximately 10-30% of parturients developed PFD after receiving analgesic delivery.[19,20] However, in our study, the PFM rehabilitation of all parturients was considered satisfactory, likely attributable to the targeted postpartum rehabilitation nursing protocols implemented at our hospital.

In this nursing approach, our study was focused on enhancing the maternal body's excitatory signaling while simultaneously restoring pelvic muscle tension and increasing blood flow. We achieved this through different ways, including knowledge sharing, massage therapy, and physical exercise. These interventions effectively enhanced PFM function and served as a preventive measure against the development of PFD.

Our findings revealed that the nursing process enhanced maternal comfort and improved psychological well-being. This, in turn, elevated nursing satisfaction and maternal rehabilitation, as indicated by the WHOQOL-100 scores of both groups before and after nursing. These outcomes served as a strong reminder of the significant potential for targeted nursing interventions in the field of obstetrics and gynecology, which warrants close clinical attention.

Study Limitations

This study has some limitations to consider. The relatively small sample size may impact the generalizability of the findings. We focused on a specific timeframe, limiting insights into longer-term effects. The observational nature of the study prevents causal conclusions, and confounding variables may influence results. Lastly, the study was conducted at a single institution, which may limit broader applicability. Despite these limitations, this research provides valuable insights into the benefits of targeted nursing interventions for maternal outcomes during analgesic delivery and postpartum rehabilitation. Larger, diverse cohorts and longer-term studies are needed to validate further and expand these findings.

CONCLUSION

This study highlights the effectiveness of PIEB after PCEA in pregnant women. The intervention not only significantly reduces postpartum pain but also contributes to a decreased incidence of PFD. Administering PIEB 60 minutes after PCEA emerges as a favorable approach, offering expedited pain relief while maintaining safety. These findings emphasize the potential of PIEB as a valuable addition to analgesic strategies during labor and delivery, with implications for improving maternal well-being and enhancing the obstetric care landscape. Further research and clinical exploration are warranted to validate and expand upon these promising outcomes.

CONFLICT OF INTEREST

No potential conflict of interest is reported by the authors.

DATA AVAILABILITY

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

AUTHORS' CONTRIBUTION

All authors contributed equally to this work.

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None

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