The Relationship between Virtual Reality Technology and Anxiety State of Parturient Women with Labor Pain

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Background: Labor pain is severe physical pain experienced by the parturient. More than 90% of mothers are accompanied by tension-anxiety-pain syndrome during childbirth. Virtual Reality (VR) technology has been widely used in nursing teaching, skill training, and clinical nursing. As a non-pharmacological method, it is rarely used in the management of labor analgesia. This study aims to explore the effect of VR technology on the anxiety state of parturient in labor analgesia. **Methods**: After the ethics committee approved the study, 102 primiparas who received labor analgesia in a tertiary teaching hospital were included in the study from March to October 2020. The included women were randomly divided into epidural Analgesia (E) and epidural analgesia combined with the VR group (EV). The primary outcome was the maternal anxiety score. The score was obtained using a 0-100 digital scoring scale, collected before and 30 minutes after labor analgesia. Statistical analysis used independent or paired t-test, Willson and Mann-Whitney nonparametric test. **Results**: After labor analgesia, the anxiety and pain scores of the two groups (E and EV) were significantly reduced (P = 0.000), and the anxiety and pain of the mothers in the EV group were relieved more significantly (P = 0.000). VR intervention significantly reduced the number of additional analgesics needed by women in the EV group (1.51 ± 0.68 *vs.* 0.32 ± 1.18, P = 0.000) and significantly improved the women's overall satisfaction (9 *vs.* 10, P = 0.000). There were no significant differences in adverse reactions, such as nausea and vomiting between the two groups. **Conclusion**: Our findings indicate that VR can effectively alleviate primipara's anxiety and pain in labor analgesia.

THE pain of childbirth is a severe pain experienced by women undergoing vaginal delivery, and about 90% of them are accompanied by varying degrees of anxiety (1). However, some women still have different degrees of anxiety after giving birth analgesia, which may not only affect the progress of labor but also be a risk factor for postpartum depression

after delivery (2, 3). This anxiety state experience induced by labor pain or birth itself affects the parturient's willingness and decision-making to accept vaginal delivery again.

Epidural labor analgesia is currently the most commonly used, safe, and effective way of labor analgesia (4). However, its technical requirements are high, and nurses are less involved, lack effective psychological care for mothers, and have some side effects. Therefore, the application of non-pharmacological labor analgesia can partly compensate for the lack of psychological care for the parturient, especially when there is a contraindication for intraspinal block analgesia and pharmacological analgesia cannot be used to relieve pain. At present, the commonly used non-drug analgesia mainly includes transcutaneous electrical nerve stimulation (TENS) therapy, water delivery, doula accompaniment, delivery ball, and music therapy (5).

Virtual Reality (VR) technology is also called virtual simulation technology. It is a brand-new practical technology that began to develop in the 1980s. Virtual reality technology includes computers, electronic information, and simulation technology and uses computers to simulate virtual environments to give people a sense of immersion in the environment. The results of the Meta-analysis by Mallari et al. included 20 studies of VR technology used in adults to treat acute and chronic pain from 2007 to 2018. The results suggest that VR technology can effectively relieve acute pain in adults (6). Frey et al.'s study also confirmed that VR could significantly relieve maternal pain and depression in the first stage of labor without medication analgesia (7). This study intends to use VR technology to intervene immediately after epidural analgesia to observe the changes in maternal pain and anxiety scores and to evaluate the anxiety relief effect of VR combined with epidural labor analgesia in labor.

Materials and Methods
Ethics
This study was approved by the ethics committee of Nanjing Maternal and Child Health Hospital affiliated with Nanjing Medical University (Approval #: (2019) KY-071). We collected 102 primiparous women who were planning to undergo physiologic delivery and receiving epidural analgesia during labor in our institution from March to October 2020. All participants signed an informed consent form to participate in the study. According to the computer's random number table, they were randomly assigned to Epidural Analgesia (E) and epidural analgesia combined with VR group (EV).

Inclusion and Exclusion Criteria
Parturients meeting the following criteria were included in this study: (i) Age: 21-34 years. (ii) Gestational age: 37-42 weeks. (iii) Parity: primipara. (iv) The number of births: single birth. (v) Education level: middle school and above.

Exclusion criteria: (i) Mental illness or mental abnormality. (ii) Those who had recently taken antipsychotic drugs or drugs that may cause psychosis. (iii) People who had an abnormal hearing or vision defects and cannot communicate normally. (iv) An abnormality of the fetus or placenta, high-risk pregnancy, or fetal concern was suspected. (v) Delivery was delayed due to the following reasons (for example, body mass index > 40, difficul-

ty breathing, bleeding, deformity), and the risk of emergency delivery was planned. (vi) A history of motion sickness. Those who had one of the above situations were not included in this study.

Intervention
After obtaining the baseline values of anxiety and pain scores, both groups of parturients received L2-L3 intervertebral epidural puncture. After excluding intravascular and subarachnoid catheter placement and confirming the success of epidural catheter placement, the analgesic pump was connected, and epidural delivery analgesics were given. The medicine composition formula of the analgesic pump is 0.08% ropivacaine + 0.4 μg/ml sufentanil, with a total volume of 120 ml; parameter settings: first dose 5 ml, continuous dose 10 ml/h, and extra bolus dose 8 ml per press.

The EV group used VR headsets (HTC VIVE, not in the medical equipment scope), and VR programs purchased from the official website https://store.steampowered.com/ such as Ocean Rift. A soothing and relaxing VR program can meet the mother's preferences to achieve an immersive experience. After 30 minutes of intervention, the two groups of parturients' anxiety and pain scores were re-evaluated.

Primary Outcomes
Anxiety scores are obtained based on the State-Trait Anxiety Inventory (STAI) form. The principal statistical indicator of STAI is the total score of two subscales: the total score of S-AI (the sum of 1-20 items), which reflects the severity of the participants' current anxiety symptoms; the total score of T-AI (out of 21-40 items) reflects the participants' normal or prior anxiety state. Choose the appropriate answer from 4 situations (i.e., grading standards). Double checked whether the filling is complete to prevent omission or repetition. There was no time limit for the assessment, and an assessment took about 10-20 minutes (see **Appendix 1** for details).

The pain was also one of the primary outcome indicators of this study. The score was received through the Numerical Rating Scale (NRS) for pain.

Secondary Outcomes
This study included the following secondary outcomes. (i) Demographic information of the parturient; (ii) Amount of analgesic drugs used: (total amount of drugs, number of self-controlled compressions). (iii) Overall satisfaction; (iv) Adverse reactions: the occurrence of nausea and vomiting, urinary retention, skin itching, and other adverse reactions.

Sample Size and Statistical Analysis
The sample size calculated using PASS version 24.0. According to the preliminary experiment's anxiety scores of 20 primiparas, set $\alpha = 0.05$ and Power = 80%. It is predicted that each group will require at least 46 parturients, and a loss to follow-up rate of 10% (5 cases per group) is set. In the end, each group needs to include 51 parturients, a total of 102 cases.

Data analysis was carried out using SPSS version 24.0. The measurement data of age, height, weight, etc., were described using mean ± standard deviation (SD). Statistical applica-
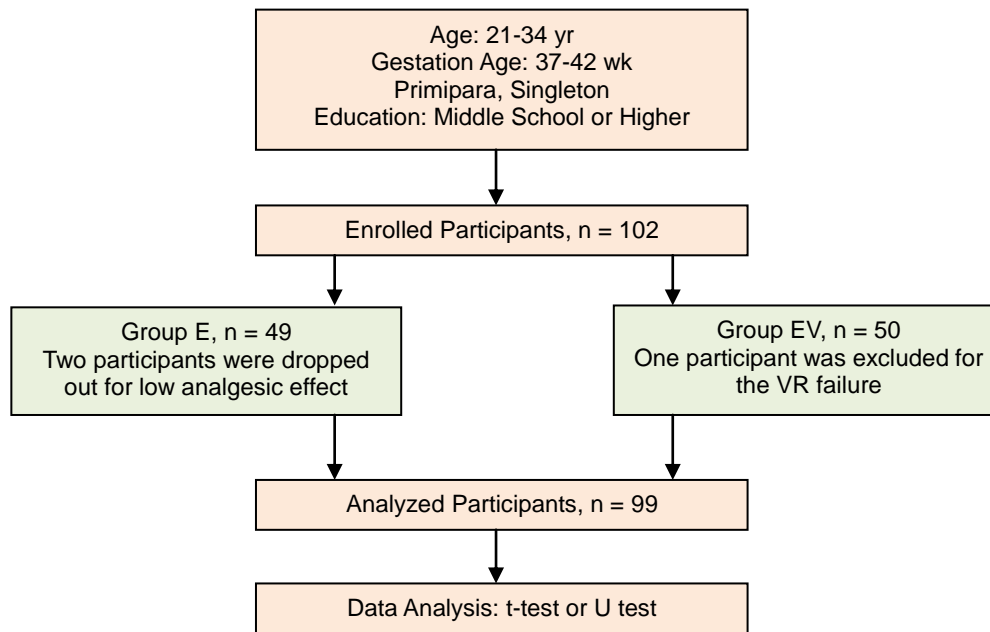
Figure 1. Flowchart of Patient Screening and Analysis.

tion-independent sample t-test or paired *t*-test. Anxiety score, pain score, etc., adopt nonparametric rank-sum test Willson or Mann-Whitney *U* test. P < 0.05 was considered statistically significant.

Results

A total of 102 parturients met the criteria for inclusion in the study, and finally, 99 cases completed the study. Two parturients in group E withdrew from the study because of the low analgesic effect, and one parturient in the group EV was excluded from the study because of VR playback failure (**Figure 1**).

The average age of the lying-in women is 28.4 ± 4.58 years, the height is 162.0 ± 3.84 cm, the average weight is 68.4 ± 5.88 kg, the education level is above the junior college level, and they can receive VR training, and can cooperate with filling out the STAI questionnaire and NRS pain score (Table 1). After the VR intervention, there was no significant effect on maternal delivery, blood loss, and neonatal outcome (**Table 1**).

Before implementing labor analgesia, there was no significant difference in the scores of anxiety characteristics between the two groups (P = 0.371). After delivery of epidural analgesia, the pain and anxiety of the mothers in the two groups were significantly relieved 30 minutes after the implementation of epidural analgesia (P = 0.000); after VR intervention, the pain and anxiety state of the mothers in the EV group were more significant Relief (P = 0.000) (**Tables 2** and **3**). VR intervention significantly reduced the number of additional medications needed by women in the EV group (1.51 ± 0.68 vs. 0.32 ± 1.18, P = 0.000) (Table 1) and improved the overall satisfaction of mothers (9 vs. 10, P = 0.000). There were no significant differences in

adverse reactions, such as nausea and vomiting (**Table 4**).

Discussion

This study mainly used VR technology to intervene for 30 minutes immediately after the implementation of labor analgesia to evaluate the effect of VR on maternal anxiety and pain effects to explore the feasibility of VR combined with epidural analgesia in the management of labor analgesia. The results found that the implementation of VR not only effectively relieves the anxiety of the parturient but also promotes the effect of epidural analgesia, which is consistent with the results of Frey et al. (7).

The idea of VR first appeared in 1956. Its original concept and naming were proposed by Jaron Lanier, the "Father of Virtual Reality" in the 1980s (8). Modern high-tech methods with computer technology as the core are used to generate an interactive and realistic three-dimensional virtual environment that integrates sight, touch, and hearing. Users can interact with objects in the virtual environment through natural movement methods such as head, eye, and body movements with the help of necessary equipment such as data gloves, head-mounted displays, glasses displays, and data suits, to achieve the same feeling and experience as those in the real environment (9). Virtual reality (VR) is almost ubiquitous in clinical applications. Its application in pediatrics has been widespread, including the treatment of oral caries in children. Research suggests that VR is a useful distraction intervention method that can focus on distraction and relieve children's pain and anxiety when undergoing various medical procedures (10, 11). Some studies have shown that VR as an auxiliary or alternative non-drug analgesia is useful in treating a series of acute and chronic pain in adults (6, 12).

Table 1. Demographic Data of the Participants.

	Group E (n = 49)	Group EV (n = 50)	Statistical Value
Age (yr)	28.8 ± 2.89	28.0 ± 5.74	F = 3.316, P = 0.378
Height (cm)	162.4 ± 3.93	161.6 ± 3.76	F = 0.611, P = 0.298
Weight (kg)	69.0 ± 5.93	67.7 ± 5.81	F = 0.092, P = 0.266
Gestation (wk)	39.8 ± 0.74	39.8 ± 0.92	F = 2.406, P = 0.903
Total Duration			
First Duration	466.2 ± 98.4	455.4 ± 119.2	F = 1.856, P = 0.624
Second Duration	25.1 ± 12.9	30.6 ± 19.9	F = 4.365, P = 0.106
Pain Assessment			
NRS 1	9 (9, 9)	8 (8, 9)	None
NRS 2	3 (3, 3)	1 (1, 1)	None
PCA (times)	1.51 ± 0.68	0.32 ± 1.18	F = 0.175, P = 0.000
Blood Loss (ml)	309.8 ± 68.1	299.2 ± 27.8	F = 0.426, P = 0.311
Neonatal Apgar scores	10 (9, 10)	10 (10, 10)	P = 0.892
Satisfied Score	9 (8, 9)	10 (9, 10)	P = 0.000

Table 2. Comparison of Anxiety SAI Score and NRS Pain Score Before and After Epidural Analgesia between the Two Groups.

	Prior Epidural Median (Q1, Q3)	Post Epidural Median (Q1, Q3)	P-Value
Group E			
SAI	59 (57, 61)	51 (49, 53)	0.000
NRS	9 (9, 9)	3 (3, 3)	0.000
Group EV			
SAI	57.5 (56, 59)	42 (39, 44)	0.000
NRS	8 (8, 9)	1 (1, 1)	0.000
Q: Quartile; SAI: State Anxiety Inventory; NRS: Numerical Rating Scale.			

Table 3. Decreased Level of Anxiety and Pain Scores between the Two Groups.

	Rank Sum Test, Mean		P-Value
	Group E (n = 49)	Group EV (n = 50)	
STAI Score	52.59	47.46	0.371
ΔSAI Score	26.28	73.25	0.000
ΔNRS Score	27.82	71.74	0.000

Table 4. Side Effect in the Two Groups.

	Group E (n=49)	Group EV (n=50)	P-Value
Nausea (n, %)	6 (12.2)	5 (10)	0.236
Vomit (n, %)	3 (6.1)	4 (8.0)	0.455
Pruritus (n, %)	0 (0)	1 (2)	0.248

The latest data released by WHO in 2017 showed that more than 300 million people suffer from anxiety or depression worldwide. Among them, the primary cause of disability in women of childbearing age is perinatal depression, and one-fifth of the pregnant women who die by suicide are caused by perinatal depression. Postpartum depression is currently receiving more and more attention. How to effectively relieve the puerpera's anxiety during childbirth is directly related to the parturient's postpartum mental and physical recovery. Therefore, all medical and non-medical methods that can effectively relieve labor pain and reduce maternal anxiety receive attention.

As a new type of non-pharmacological labor analgesia in recent years, VR technology has the effect of reducing pain and anxiety. The theory behind it is related to the limitations of human attention. Therefore, the mother's attention to pain is transferred to a certain extent through VR technology, for example,

through interaction with virtual reality. Therefore, the patient's response to incoming pain is slowed down (13) and achieves a certain analgesia degree. In terms of anti-anxiety, in the absence of nursing staff and doula to comfort or ease, VR can effectively relieve the unhealthy mood of maternal tension and anxiety, pass the delivery process quietly and comfortably, and realize the application of comfort medicine in the perinatal period of delivery women.

We must point out the limitations of this study. The VR intervention in this study was designed immediately after epidural labor analgesia. Although it can reflect the effect of VR combined with analgesia, due to the many factors that affect the analgesic effect during the onset of epidural analgesia, maternal analgesia consistency cannot be determined. Therefore, there may be overlapping effects of VR and epidural analgesia, which cannot be effectively distinguished and evaluated.

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APPENDIX 1.

STATE-TRAIT ANXIETY INVENTORY (STAI)

Instruction: Listed below are some commonly used statements to describe you. Please read each statement and then choose according to your most appropriate feeling at the moment. Do not spend too much time thinking about anyone's statement, but the answer should be the most appropriate feeling for you now.

State Anxiety Inventory (S-AI)

(1)   I have a calm mood.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(2)   I feel safe.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(3)   I am nervous.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(4)   I feel restrained.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(5)   I feel at ease.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(6)   I feel upset.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(7)   I am worrying now, and I feel that this kind of worry exceeds the possible misfortune.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(8)   I am satisfied.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(9)   I feel scared.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(10) I feel comfortable.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(11) I have confidence.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(12) I am oversensitive.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(13) I am incredibly nervous.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(14) I am indecisive.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(15) I am relaxed.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(16) I am satisfied.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(17) I am troubled.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(18) I feel flustered.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(19) I feel calm.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

(20) I feel happy.

1 Not at all

2 Somewhat

3 Moderate

4 Very obvious

Trait Anxiety Questionnaire (T-AI)

(21) I feel happy.

1 Almost not

2 Some

3 Often

4 Almost always

(22) Feel nervous and restless.

1 Almost not

2 Some

3 Often

4 Almost always

(23) I feel self-satisfied.

1 Almost not

2 Some

3 Often

4 Almost always

(24) I hope to be as happy as others.

1 Almost not

2 Some

3 Often

4 Almost always

(25) I feel like I am exhausted.

1 Almost not

2 Some

3 Often

4 Almost always

(26) I feel very peaceful.

1 Almost not

2 Some

3 Often

4 Almost always

(27) I am calm and composed.

1 Almost not

2 Some

3 Often

4 Almost always

(28) I feel that the difficulties are piled up, so I cannot overcome them.

1 Almost not

2 Some

3 Often

4 Almost always

(29) I worry too much about some things, but they are not necessary.

1 Almost not

2 Some

3 Often

4 Almost always

(30) I am happy.

1 Almost not

2 Some

3 Often

4 Almost always

(31) My thoughts are in a state of confusion.

1 Almost not

2 Some

3 Often

4 Almost always

(32) I lack self-confidence.

1 Almost not

2 Some

3 Often

4 Almost always

(33) I feel safe.

1 Almost not

2 Some

3 Often

4 Almost always

(34) I make decisions quickly.

1 Almost not

2 Some

3 Often

4 Almost always

(35) I feel inappropriate.

1 Almost not

2 Some

3 Often

4 Almost always

(36) I am satisfied.

1 Almost not

2 Some

3 Often

4 Almost always

(37) Some unimportant thoughts always haunt me and disturb me.

1 Almost not

2 Some

3 Often

4 Almost always

(38) My frustrations are so intense that I cannot exclude them from my thoughts.

1 Almost not

2 Some

3 Often

4 Almost always

(39) I am a calm person.

1 Almost not

2 Some

3 Often

4 Almost always

(40) When I consider my current affairs and interests, I get into a state of tension.

1 Almost not

2 Some

3 Often

4 Almost always

Topic 1-20 is the State Anxiety Scale, which is mainly used to reflect the immediate or recent experiences or feelings of fear, tension, anxiety, and neuroticism at a specific time and can be used to evaluate the anxiety level under stress. Titles 21-40 are the Trait Anxiety Scale, used to assess people's frequent emotional experiences. The full scale is scored 1-4 (state anxiety: 1-not at all, 2-some, 3-moderate, 4-very obvious. Trait anxiety: 1-almost none, 2-some, 3-often, 4-almost, this is always the case), the subjects choose the most suitable level based on their own experience. Calculate the cumulative scores of the State Anxiety and Trait Anxiety Scales, with a minimum of 20 points and a maximum of 80 points (note: all positive emotion items are scored in reverse order). The higher the score on the scale, the higher the level of anxiety in the subject. Questions 1, 2, 5, 8, 10, 11, 15, 16, 19, 20, 21, 23, 24, 26, 27, 30, 33, 34, 36, 39 are scored in reverse order.