

## Original Article

# Patient-controlled epidural analgesia is superior to nitrous oxide inhalation in controlling childbirth pain

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**Abstract:** Objectives: To compare the effects of different labor analgesia in controlling childbirth pain and seek more effective and reliable pain management strategy during natural childbirth in order to reduce maternal pain and promote natural childbirth. Methods: 400 cases of successful delivery with labor analgesia in our hospital during 2010 and 2014 were enrolled in this study, including 200 cases of nitrous oxide inhalation and 200 cases of patient-controlled epidural analgesia. The effects of the two labor analgesia were compared with pain scaling and patient satisfactory survey. And the results were statistically analyzed with  $\chi^2$  test using SPSS13.0 software. Results: Patient-controlled epidural analgesia showed better analgesic effect than nitrous oxide inhalation, with better pain control (analgesic effect rate of 93% vs 50%, pain relief rate of 98% in patient-controlled epidural analgesia vs 50% in nitrous oxide inhalation group), and better maternal and family satisfaction rate (satisfaction rate of 99% in patient-controlled epidural analgesia vs 50% in nitrous oxide inhalation group). Conclusion: Patient-controlled epidural analgesia is superior to nitrous oxide inhalation in controlling childbirth pain.

**Keywords:** Pain of childbirth, labor analgesia, analgesic effect, patient-controlled epidural analgesia, nitrous oxide inhalation

## Introduction

Pain during labor is caused by contractions of the muscles of the uterus and by pressure on the cervix. This pain can be felt as strong cramping in the abdomen, groin, and back, as well as an achy feeling. The maternal is usually irritable, anxious, groaning and uncooperative. The purpose of labor analgesia is to enhance the safety of both maternal and child, reduce the rate of cesarean section, reduce postpartum hemorrhage, and reduce incidence of fetal hypoxia and newborn asphyxia [1].

Common methods of labor analgesia include psycho-prophylactic painless childbirth such as accompany birth, acupuncture, magnetic stimulation and sterile water injection [2, 3]; pharmaceutical analgesia such as diazepam, meperidine, remifentanyl and tramadol; inhalation anesthesia such as nitrous oxide inhalation anesthesia; paracervical block; pudendal nerve block; intraspinal epidural anesthesia; combined spinal and epidural anesthesia.

The requirements of an ideal labor analgesia are: little impact on newborn and mother; easy administration, fast and reliable analgesic

effect, cover the needs of mothers during the whole labor process; avoid blockage of motor neuron so that maternal have free position; no effect on the labor process; the maternal always remain awake and can actively participate in the delivery process; to meet the needs emergency surgery if necessary.

Patient-controlled epidural analgesia (PCEA) and nitrous oxide inhalation (NO inhal) are two commonly used pain management strategies during delivery. In order to find more effective and reliable pain management strategy during natural childbirth to reduce maternal pain and promote natural childbirth, we compared the analgesic effects of the two pain management strategies.

## Material and methods

### Study population

This is a retrospective data collection study. 400 cases of successful delivery with labor analgesia in our hospital during 2010 and 2014 were enrolled in this study, including 200 cases of nitrous oxide inhalation and 200 cases of

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patient-controlled epidural analgesia. Patient with pregnancy complications or delivery complications were excluded from the study.

## Methods

### *Obstetric analgesia with nitrous oxide inhalation*

50% of nitrous oxide mixed with 50% of oxygen was used in nitrous oxide inhalation analgesia through a self-controlled breathing apparatus. During inspiration, the valve automatically opens so that nitrous oxide was inhaled by inhalation mask; during respiration, the valve automatically closes so that the waste gas will be exhaled out of the body through the exhalation valve. There was a latency of 30-40 seconds before the inhaled nitrous oxide to achieve its analgesic effect. Under the guidance of midwives, when entering the active phase of labor where the cervix is dilated to 2-3 cm, 30-40 seconds before the arrival of uterine contraction, the nose and mouth of the maternal were covered with mask, after three deep inspirations were made, the mask was removed to allow exhalation. Deep breaths were taken continuously for 3-5 times so that the pain accompanying uterus contraction became bearable. The cycles were repeatedly till the cervix was fully dilated. When the maternal has a sense of breath-holding or defecation, inhalation should be stopped [4].

### *Obstetric analgesia with continuous patient-controlled epidural analgesia*

Spinal L2~L3, or L3~L4 was used in the epidural analgesia. 0.1% Ropivacaine (containing 2 ug/ml fentanyl) was used as local anesthetics, when epidural catheter was successfully installed after puncture, test dose anesthetics was first given, then loading dose anesthetics and then pain controlling pump was connected. The maternal was told to lie flat for 15 minutes till after the epidural anesthesia plane was fixed and then free position can be taken. After delivery, the epidural catheter will be removed. The indication for achieving pain control purpose is painless uterus contractions and maternal is quiet and cooperative [5-7].

### *Pudendal nerve block anesthesia*

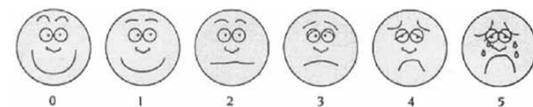
For both nitrous oxide inhalation and patient-controlled epidural analgesia, pudendal nerve

block anesthesia was applied as supplementary pain control strategy. This was done when the fetal head start to be exposed to relax the pelvic floor muscles and ligaments and to reduce maternal vaginal pain sensation. Lithotomy position was taken, the left index finger of the anesthesiologist was inserted in the vagina to touch the ischial spine which was used as a guide, then right hand held asize seven block needle to insert subcutaneously at 0.5 cm to the anal side of the midpoint on the connection of the left or right anus and ischial tuberosity, then the needle was slowly pierced towards the ischial spine. When the tip of the needle reached the front of ischial spine, the needle was withdrawn back a little and turned to a point 1 cm inside of the ischial spine, there was a sense of breakthrough when penetrating the ischial spine ligament, if no bleed after suction, then 10 ml of 0.5% lidocaine was injected into the left and right side [8, 9].

### *Pain scaling*

The pain was assessed according to WHO criteria and clinical manifestations and categorized into four classes. 0: painless, peaceful and cooperative; 1: mild pain, tolerable and cooperative; 2: moderate pain, excruciating, moaning, barely cooperative; 3: severe pain, unbearable, shouting restless, not cooperative [10].

### *Visual analogue scale (VAS)*



The target of the VAS was less than 3 points.

### *Patient and family satisfaction survey towards pain control*

After successful delivery of the baby, patient and family members were surveyed regarding their satisfaction toward pain controlling during delivery. And the satisfaction rate was calculated in each group.

### *Statistical analysis*

The data were statistically analyzed with  $\chi^2$  test using SPSS13.0 software.  $p < 0.05$  was considered as statistically significant.

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**Table 1.** Comparison of analgesic effects of the two anesthesia strategies

Groups	Total cases	Scale 0	Scale 1	Scale 2	Scale 3
NO inhale	200	5	85	60	50
PCEA	200	35	160	5	0

### Results

#### *Demographic data of the study subjects*

Total 400 patients were enrolled in this study and were randomly divided into two groups: 200 cases in nitrous oxide inhalation group and 200 cases in patient-controlled epidural analgesia group. The ages were 21-42 years with mean age  $30 \pm 0.8$  years old, gestational ages were 34-41 weeks with mean gestational age  $37 \pm 3.8$  weeks, body weights were 55-100 kgs with average weight  $77 \pm 3.8$  kg, child birth weights were 2000-4100 g with average weight  $3010 \pm 500$  g. There was no significant difference in age, gestational age, or education level between the two groups.

#### *Comparison of the analgesic effect of the two anesthesia strategies*

Combination of nitrous oxide inhalation and pudendal nerve blockage anesthesia achieved satisfactory analgesic effect in 50% of the cases, and achieved pain relief in 50% of the cases; while combination of patient controlled epidural analgesia (PCEA) with pudendal nerve blockage anesthesia achieve satisfactory analgesic effect in 93% of the cases, and achieved pain relief in 98% of the cases (**Table 1**).

#### *Results of the satisfaction survey for the analgesic effect by maternal and family*

In nitrous oxide group, the satisfaction rate of maternal and their families for the analgesic effect was 50%, and 3 complaints for inadequate analgesic effect were filed; while in PCEA group, the satisfaction rate was 99%, 0 complaints was filed. The difference was hugely significant.

#### *Comparison of maternal reactions after anesthesia administration*

In nitrous oxide group, 30% of the maternal expressed feeling of euphoria, 10% (24 cases)

complain slight dizziness feeling, 10% (20 cases) showed mild drowsiness, Apgar scores for the neonates were all 8-10 points, and there was no other serious adverse reactions. There was some pollution to the surrounding environment.

While in PCEA group, 80% of the maternal expressed feeling of euphoria, 0% (0 cases) complain slight dizziness feeling, 25% (50 cases) showed mild drowsiness, Apgar scores for the neonates were all 8-10 points, and there was no other serious adverse reactions [11].

### Discussion

Labor pain is the pain accompanying the maternal during childbirth. Reduce or eliminate labor pain to have a joyful childbirth is the target of continuous exploration in the medical field in the last hundred years.

Nitrous oxide inhalation analgesia has been widely used in our hospital since 2003. Nitrous oxide is an inhalation anesthetics with strong analgesic effect and weak anesthetic effect. It is absorbed through the respiratory tract, without stimulatory side effect to the respiratory tract and it does not bind to hemoglobin. 25-50% of Nitrous oxide is the analgesic concentration or sub-anesthetic concentration; 50-75% is the anesthetic concentrations. Inhalation of analgesic concentration of nitrous oxide in the maternal does not inhibit the fetus activity or uterus contractions. Nitrous oxide showed effect faster, however its effects disappear also faster [4]. When used in the first stage of labor, inhaled for a short period of time before uterus contraction, nitrous oxide showed no significant side effects for either mother or fetus. Through inhibiting the release of cortical excitatory neurotransmitter and conduction of nerve impulse, nitrous oxide eliminates maternal tension, induces euphoria feeling, promote cervical dilation and fetal head descendance, while the maternal always stays awake. After stopping nitrous oxide inhalation, the accumulated nitrous oxide inside the body, combined perineal nerve block anesthesia, continues to maintain the analgesic effect.

Although the inhalation anesthesia is simple, the maternal will easily master it just after a simple training, it does not need the guidance or management of an anesthesiologist and

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midwives can manage it, however, the maternal must master the correct inhalation method, actively cooperate to ensure proper concentration of inhaled nitrous oxide and safe time frame, in order to achieve good analgesic effect. Because this anesthetic approach achieves the analgesic effect by gas inhalation, and the gas only was only absorbed through upper respiratory tract, if the maternal does not correctly master the inhalation method or too fatigued to use respiratory force correctly, or hyperventilated due to long labor, maternal physical exertion will be increased so that the gas cannot fully enter into the alveoli to reach effective analgesic concentration, the analgesic effect of nitrous oxide inhalation will be compromised.

Patient controlled epidural analgesia (PCEA) in labor has been vigorously promoted in our hospital since 2011. PCEA requires an anesthesiologist to be on duty 24 hours in the delivery room for full management and it has high demands for anesthesia techniques. The indications for PCEA are: feasible vaginal delivery after full assessment by obstetricians, voluntary acceptance of narcotic analgesia, no contraindications for epidural anesthesia. Ropivacaine is a long-acting local anesthetic, and its biggest advantage is its weak blockage to motor nerves and strong blockage to sensory nerve. In addition, the concentration used in PCEA is the lowest possible for effective analgesia, so it has little effect on the labor force of the maternal. During childbirth, the pain originated from the uterus and cervix which was conducted through the sympathetic nerve fibers into the T10-L1 nerve roots combined with pain originated from pelvis and perineal area and was then conducted through pudendal nerve fibers into the spinal cord S2-S4 nerve roots. Epidural anesthesia achieved analgesic effect through blocking the nerve roots in relevant region, and the maternal always stays awake. In cases of maternal fatigue, long labor procedure, PCEA may produce lethargy feeling, the maternal should be encouraged to sleep and rest adequately to facilitate labor progress and transformation of dystocia birth to smooth birth. PCEA also relax visceral smooth muscle and pelvic floor muscles, so it maintains effective uterus contraction while showing best analgesic effect, when necessary, oxytocin can be added [5-7].

In PCEA, before the operation, intravenous access needs to be established, vital signs need to be monitored, cooperation from the maternal is very important. Postoperatively, postoperative reaction and anesthetic complications need to be identified, vital signs of the maternal and labor progress, especially uterus contractions, condition of the fetus (fetal heart rate changes) also need to be closely monitored [12].

Our studies showed that compared with nitrous oxide inhalation analgesia, PCEA was superior since it achieved both better satisfactory analgesic effect and patient/family satisfaction rate. Our results are consistent with recent literatures [13, 14], where the authors systematically reviewed evidence addressing the effectiveness of nitrous oxide for the management of labor pain, and identified a total of 58 publications, representing 59 distinct study populations: 2 studies were of good quality, 11 fair, and 46 poor. Inhalation of nitrous oxide was found to provide less effective pain relief than epidural analgesia. Further study showed that no conclusion can be drawn regarding the risks or benefits of adding a continuous background infusion to PCEA compared with PCEA-only epidural labor analgesia [14].

Evidence-based medicine promotes the development of safe and effective analgesic techniques, as well as a greater emphasis on maternal health care and social psychological problems, and personalized and humane services for the maternal and fetus. Our current study is an example of evidence-based medical science research. Our study shows that patient controlled epidural analgesia combined with pudendal nerve blockage analgesia could achieve satisfactory analgesic effect for labor. It reached the goal of happy childbirth, in the meantime, it improved the safety of both the maternal and fetus by reducing the rate of cesarean section, reducing postpartum hemorrhage, reducing occurrence of birth canal laceration, reducing fetal hypoxia and neonatal asphyxia, supporting maternal and neonatal mental health. PCEA truly facilitates to achieve the goal of modern obstetrics which is maintaining and respecting the autonomy of the maternal, and minimizing labor pain during childbirth.

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## Disclosure of conflict of interest

None.

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