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Original Article

Maternal and perinatal outcomes among low risk women giving birth in water: a retrospective study in a maternity & infant health hospital over 7 years

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Abstract: Objective: To investigate the effects of giving birth in water on perinatal outcomes. Methods: The clinical data of 50,574 healthy primiparas with singleton pregnancies and cephalic presentation from January 2010 to December 2016 were retrospectively reviewed. A total of 5420 subjects (mean age, 27.57±3.07 y) who received water delivery (water birth group) and a total of 45,154 subjects (mean age, 26.87±2.96 y) who underwent conventional labor and delivery (conventional delivery group) were recruited. The neonatal outcomes including the incidences of neonatal asphyxia and need for transfer to the neonatal intensive care unit (NICU), the maternal outcomes including the visual analogue scale (VAS), duration of labor, postpartum bleeding, perineal laceration, and postpartum urinary retention, were collected and analyzed. In addition, maternal vaginal culture test was preformed to observe the incidence of maternal infection. The clinical data regarding patients who underwent medical interventions including amniotomy, valium and oxytocin have been collected and analyzed as well. Results: The incidence of neonatal asphyxia was significantly lower in the water birth group than that in the conventional delivery group (P=0.025), whereas there were no differences in need for transfer to NICU between the two groups (P=0.455). The VAS pain scores 30 and 60 min after cervical dilation of 3 cm in the conventional delivery group were significantly higher than those of the water birth group (both P<0.001). Meanwhile, the incidences of perineal lacerations (second- and third-degree) and postpartum urinary retention in water birth group were significantly lower than those in the conventional delivery group (all P<0.05). However, the duration of labor and 24 h postpartum bleeding as well as the maternal bacterial culture results were similar between the two groups (all P>0.05). Moreover, there was less patients underwent medical intervention in water birth group compared with the conventional delivery group (almost all P<0.05). Conclusions: Birth in water can reduce maternal pain, II & III degree perineal lacerations, and postpartum urinary retention, and is associated with a lower rate of neonatal asphyxia without the increased risk of maternal infections. In addition, birth in water can reduce the need for the medical intervention.

Keywords: Birth in water, conventional labor and delivery, labor duration, maternal and perinatal outcomes

Introduction

The modern obstetric medicine advocates natural delivery as an advanced concept of healthcare. Birth in water is defined as that the woman labors and delivers in a tub of warm water, which provides a welcome environment and enables a variety of natural and comfortable delivery postures with obvious advantages. For example, not only does the buoyancy of water help in mobility and facilitate an upright position, but also warm water immersion relieves pain and allows women to control their labor and birth experiences [1, 2]. In addition, the previous studies have shown that birth in water has a shorter duration of labor, less dosage of analgesics and less incidences of vaginal and perineal lacerations [3-8]. Meanwhile, birth in water can increase the flexibility of the birth canal and perineal tissues and reduce the pain caused by uterine contractions [3, 9, 10]. However, water immersion in maternity care is not new but continues to face concerns about its safety and potential related risks, such as the risk of neonatal aspiration, possible drowning, umbilical cord avulsion and potential increase in infection rates for mothers and newborns, which may be due to the lack of clinical evidence about its application [11]. In addition, most of previous studies only investigated the effects of water immersion during the first stage of labor.

Table 1. Demographic and clinical characteristics (mean ± SD)

Variables	Water birth (n=5,420)	Conventional delivery (n=45,154)	P
Age (y)	27.57±3.07	26.87±2.96	0.270
Height (cm)	159.55±4.45	160.45±4.40	0.155
Weight (kg)	66.07±7.75	65.77±5.57	0.553
Gestational age (week)	39.45±1.05	39.55±1.00	0.495
Gravidity (times)	1.39±0.55	1.51±0.82	0.289

Therefore, the present study was designed to compare the maternal and neonatal outcomes of birth in water and conventional labor and delivery via retrospectively analyzing the clinical data of 50,574 healthy primipara with singleton pregnancies and cephalic presentation from January 2010 to December 2016 in a maternity & infant health hospital in Shanghai, China. So far as we know, this is the biggest retrospective observational study regarding water immersion labor. Additionally, all the participants had three stages of labor in water and this is the first study investigating the effects of water immersion during all three stages of labor.

Methods

Subjects

A total of 50,547 healthy primipara with singleton pregnancies and cephalic presentation who were admitted at Department of Obstetrics in Shanghai Changning Maternity & Infant Health Hospital, China, for delivery from January 2010 to December 2016 were enrolled in this study. The delivery method including birth in water and conventional labor and delivery was chosen by the subjects voluntarily. The study protocol was reviewed and approved by the Medical Ethics Committee of the hospital and the informed consent was provided by all the recruited subjects.

Inclusion criteria: Gestation age ≥38 weeks; women without contraindications to vaginal delivery; women without risk factors including infectious diseases and pregnancy complications; women without dystocia risk factors. Exclusion criteria: women with pelvic canal stenosis; women with contraindications against vaginal delivery; women had infectious diseases, including hepatitis B, hepatitis C, syphilis and HIV infection; women with untreated vaginal infections.

Data collection

Data collection performed concurrently with the screening process from January 2010 to December 2016. The screening process was conducted by researchers using a self-developed data collection sheet and it involved the use of clinical logs, hospital admission books, labor, delivery, and infant records, and medical records. Potential participants were screened out and only participants who met the inclusion criteria were included in the study. The relevant data on birth outcomes were collected systematically and simultaneously using the data collection sheet.

Birth in water

Before entering the warm water, a vaginal examination was performed to assess cervical dilation and to determine fetal position and presentation. When cervical dilation reached 4-5 cm, the parturient was transferred to the warm water tube (APALETSUNSET, Belgium) with the water temperature maintained at 35-38°C. The parturient was encouraged to drink water to prevent dehydration and leave the tub to rest every 2 hours. The fetal heart rate was measured every 10-15 min until delivery.

Birth was allowed to happen spontaneously with minimal stimulation of the fetal head, including checking for a nuchal cord. Infant's head was brought to the water surface immediately after birth, especially, taking care to prevent cord avulsion. The rest of the infant's body should remain submerged to promote temperature regulation.

Outcome measures

The primary outcome was VAS score during labor which was evaluated 30 and 60 minutes after a cervical dilatation of 3 cm by the same obstetrician. VAS scores range from 0 to 10 points: 0, painless; 1-3, subjects felt a slight pain but can tolerate it; 4-6, subjects felt pain that affects sleep but still can be tolerated; 7-10, subjects felt intense pain that affects sleep and cannot be tolerated any longer.

The secondary outcomes included other maternal outcomes including duration of labor, postpartum bleeding, perineal laceration, postpartum urinary retention, the incidences of ma-

Table 2. The comparison of intra- and postpartum outcomes between the two groups

Variables	Water birth (n=5,420)	Conventional delivery (n=45,154)	P
VAS pain scores			
Cervical dilation of 3 cm	10 (7, 10)	10 (8, 10)	0.777
30 min after cervical dilation of 3 cm	6 (5, 8)	10 (9, 10)	<0.001
60 min after cervical dilation of 3 cm	7 (6, 8)	10 (10, 10)	<0.001
The incidence of perineal laceration			
I	10 (0.18)	15 (0.03)	0.002
II	11 (0.20)	207 (0.46)	0.003
III	3 (0.063)	72 (0.16)	0.001
The incidences of postpartum urinary retention	5 (0.092)	107 (0.24)	0.001
Duration of labor (min)	667.45±299.45	617.32±255.34	0.345
24 h postpartum bleeding (ml)	323.45±125.50	367.55±256.67	0.345

ternal infection and the need for the medical treatment, and the neonatal outcomes including the incidences of neonatal asphyxia and need for transfer to the neonatal intensive care unit (NICU). Patients who received medical interventions including amniotomy, oral valium, or oral oxytocin have been recorded as well.

Maternal vaginal bacteria culture

Samples were collected via sterile swabs without speculum. Swabs were placed in two culture tubes which contained Todd-Hewitt broth (Oxoid, Hampshire, United Kingdom) and supplemented with gentamicin (8 μg/mL) and nalidixic acid (15 μg/mL). After incubating at 33-37°C for 18 to 24 h in a 5% CO_2 atmosphere, the cultures were streaked on 5% sheep blood agar plates and kept incubating with same environment and duration.

Medical interventions

The clinical data from patients who underwent medical interventions including amniotomy, valium and oxytocin have been collected and analyzed. Amniotomy is administrated under these conditions: there is a need of monitoring of internal fetal; combining oxytocin infusion for induction of labor; applying to increase the level plasma prostaglandins for augmentation of labor. Valium was used for the short-term relief of the symptoms of anxiety. Oxytocin injection is performed for induced labor of patients who need medical indication for the initiation of labor; parturient with uterine inertia that need the stimulation or reinforcement of labor.

Statistical analysis

SPSS 17.0 statistics software was adopted to process and analyze data. The measurement data were expressed as mean ± standard deviation and the differences between groups were compared with paired t test; the categorical data were expressed by ratio or percentage and the differences between groups were compared with χ^2 test. $P<0.05$ indicated the statistical significant difference.

Results

Subject characteristics

Among the recruited 50,474 patients, a total of 5,420 patients underwent birth in water and the remaining 45,154 patients underwent conventional delivery. As shown in **Table 1**, there were no differences in baselines including maternal age, maternal height, weight, gestational age, and gravidity between the two groups (all $P>0.05$).

The maternal intra- and postpartum outcomes

The VAS pain scores in the conventional delivery group were significantly higher than those of the water birth group 30 and 60 min after cervical dilation of 3 cm (both $P<0.001$). The incidence of degree I perineal laceration was significantly greater in the water birth group than that in the conventional delivery group ($P=0.002$), however, the incidences of degree II and III perineal lacerations and postpartum urinary retention were significantly lower in the

Table 3. The comparison of neonatal outcomes between the two groups

Variables	Water birth (n=5,420)	Conventional delivery (n=45,154)	*P*
Neonatal asphyxia	17 (0.31%)	715 (1.58%)	0.025
Need for transfer to NICU	550 (10.15%)	7089 (15.70%)	0.455

Table 4. Maternal bacterial culture results

Variables	Water birth (n=5,420)	Conventional delivery (n=45,154)	*P*
Total positive (n, %)	161 (2.97)	1,290 (2.86)	1.000
Gram-positive bacilli (n)	65	553	
Streptococcus agalactiae (n)	32	0	
Escherichia coli/Enterococcus faecalis (n)	32	0	
Fungi (n)	32	369	
Staphylococcus lugdunensis (n)	0	184	
Group B Streptococcus (n)	0	184	

Table 5. Medical interventions between the two groups

Variables	Water birth (n=5,420)	Conventional delivery (n=45,154)	*P*
Amniotomy (n, %)	445 (8.21)	1,937 (4.29)	0.455
Valium + Oxytocin (n, %)	309 (5.71)	4,195 (9.29)	0.002
Amniotomy + Valium + Oxytocin (n, %)	1,723 (31.79)	35,960 (79.64)	0.002
All medical interventions (n, %)	2,477 (45.71)	42,092 (93.22)	0.001
Without medical interventions (n, %)	2,943 (54.29)	3,062 (6.78)	0.001

water birth group than those in the conventional delivery group (P=0.003, P=0.001, P=0.001). Moreover, there was no obviously differences in duration of labor and postpartum bleeding between the two groups (both P=0.345). See **Table 2**.

The neonatal outcomes

The incidence of neonatal asphyxia was significantly lower in the water birth group than that in the conventional delivery group (P=0.025). There was no evidently difference in the need for transfer to NICU between the two groups (P=0.455). See **Table 3**.

The incidences of maternal infection

Maternal vaginal culture results have been shown in **Table 4**, which were positive in 161 patients in the water birth group and 1290 patients in the conventional labor group, without obviously differences between the two groups (P= 1.000).

To be specific, in the water birth group, there are 65, 32, 32, 32, 32 cultures were positive for Gram-positive bacilli, Streptococcus agalactiae, Escherichia coli/Enterococcus faecalis and fungi, respectively; in the conventional labor group, there are 553, 369, 184, 184 cultures were positive for Gram-positive bacilli, fungi, Staphylococcus lugdunensis and Group B Streptococcus, respectively.

The need for medical interventions

The medical intervention results have been shown in **Table 5**. A total of 445 and 1,937 patients underwent amniotomy in the water birth group and the conventional labor group, respectively, which did not show significant difference (P=0.455). There were significantly less patients who had Valium + Oxytocin, and amniotomy + Valium + Oxytocin in the water birth group compared with those in the conventional delivery group (both P=0.002). Besides, the patients with all medical interventions in the water birth group were also significantly less than those in the conventional delivery group (P=0.001). Furthermore, the dystocia incidence in the water birth group was significantly lower than that of the conventional labor group (P<0.005).

Discussion

The buoyancy of water can help parturient to relax and take different delivery postures. In addition, the warm water provides a comfortable environment to eliminate tension and fatigue and decreases stress hormones includ-

ing endorphins and catecholamine during labor and delivery. Besides, it also can increase uterine blood flow and accelerate cervical dilation. With the help of warm water, vagina gradually dilated and anal sphincter relaxed, which can promote the fetus to pass through the birth canal. For example, Lenstrup et al. had reported that the cervical dilation rate of woman who had birth in water was 2.80 cm/h while that of woman who had conventional labor and delivery was apparently lower (1.26 cm/h) [12].

During childbearing in water, the warmth signal can reduce or block the pain signal via the fast fiber transmission by stimulating the skin [13, 14]. In addition, the water wave can gently massage the back muscles to relax the tension of the muscles, which can significantly eliminate the occurrence of cervical resistance, and relieve maternal pain. More importantly, it can reduce catecholamines release to decrease the transmission of pain related substances and maternal anxiety. There are many factors that affect the severity of pain, such as excessive fear and anxiety. Thereby, in our department, the patient can choose to be accompanied by her spouse or others during the water birth process so as to reduce fear and anxiety. Moreover, soothing music and free position in water can also reduce the predisposing factors of pain and improve the pain threshold. The data from our study showed that VAS pain scores were significantly lower in the birth in water group at 30 and 60 min after a cervical dilatation of 3 cm which was in accordant with the findings mentioned above.

In addition, some patients need lateral perineotomy involving bulbocavernosus, musculus transversus perinei superficialis, and musculus transversus perinei profundus, which will cause a lot of blood loss [15]. Sometimes, it will injure pelvic nerve as well. Perineal laceration degree I is defined as perineal skin and mucosa damage without myometrium injury, while perineal laceration degree II causes much smaller and shallower lateral groove on myometrial fascia compared with lateral perineotomy. Due to the warmth of water, perineal tissues become soft and conducive to the perineum and birth canal stretches during delivery. Since the fetus is delivered in the water, the oppression on the perineum by the fetus is significantly reduced because of the water buoyancy. In addition, the parturient woman can take a protective position in water to decrease the risk of perineal laceration [16]. Geissbuhler et al. analyzed more than 7,500 cases of vaginal delivery, of which 2014 cases were birth in water. Among them, the incidences of lateral perineotomy among women had birth in water was 12.8% while it was 35.4% among women had conventional labor and delivery [17]. The data of our study showed that the incidence of degree I perineal laceration was significantly greater in the water birth group than that in the conventional delivery group ($P<0.05$). The incidences of degree II and III perineal lacerations were significantly lower in the water birth group than those in the conventional delivery group (all $P<0.05$), indicating that birth in water has significant protective effects on pelvic floor tissues.

In the meanwhile, birth in water provides a familiar environment to neonate that likes the uterus. In 1999, Gibert et al. retrospectively analyzed the clinical data of 4,032 cases with water delivery and found the perinatal mortality was 1.1% (5 cases) and none of the deaths was associated with water delivery [18]. In the present study, the incidence of neonatal asphyxia was significantly lower in the water birth group than that in the conventional delivery group ($P<0.05$). There were no differences in need for transfer to NICU between the two groups ($P<0.05$).

Nevertheless, the water in the tub cannot be completely sterile, so there are concerns that water immersion may increase the incidence of maternal infections. Bodner et al. found that the incidence of maternal infection in the water birth in water group was significantly lower than that in the conventional group [19]. Zanetti-Daellenbach et al. compared the maternal and neonatal outcomes of women with water immersion birth and with conventional delivery, and found that the maternal infections were similar between the two groups [20]. Additionally, Cluett et al. retrospectively studied 11 randomized controlled clinical trials and concluded that the process of water immersion labor and birth did not increase the incidences of maternal infections [9]. The results of the present study showed that there was no significant difference in the positive rate of postnatal vaginal culture between the two groups, suggesting that the process of water delivery may not increase the risk of maternal infections,

which is consist with the previous conclusions mentioned above. In addition, we also found that there were significantly less patients who need medical interventions in the water birth group compared with those in the conventional delivery group (almost all P<0.005).

However, there were some limitations in this study as well. Firstly, the present study was conducted in a single institution; secondly, we did not conduct follow-up to ensure the short- and long-term maternal and neonatal outcomes, therefore, we should conduct multiple-centered study with long period follow-up time to investigate the long-term effects of water immersion during labor in the future and to verify our findings and conclusions.

In conclusion, birth in water can reduce maternal pain and decrease the incidences of degree II and III perineal lacerations, postpartum urinary retention and neonatal asphyxia, meanwhile, does not increase the rate of maternal infections. Therefore, birth in water is an intrapartum service model that is worthy of promotion and application.

Disclosure of conflict of interest

None.

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