The Positive Effect of Water Immersion on Labor Progress Assessed by Intrapartum Ultrasound Examination

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ABSTRACT

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Objective: The study aimed to assess the effect of water immersion on labor progress using the parameters measured by the intrapartum ultrasound method.
Methods: A total of 200 women with uncomplicated singleton term delivery in the active first stage of labor were enrolled in the study and randomized to two equally sized groups. The study group was offered 30 minutes of water immersion, and the control group included women who did not use water immersion during labor. We performed the ultrasound assessment of the angle of progression (AoP) and progression distance (PD) twice in each patient: when criteria for water immersion were met and after 30 minutes.
Results: Both study and control groups did not differ in terms of initial cervical dilation, angle of progression, and progression distance at the first ultrasound examination. After the procedure, we found significant differences between the study and control groups in angle of progression ($p<0.001$) and progression distance ($p < 0.001$). The duration of the active first stage of labor was shorter in the parturients who used the water immersion procedure (86.93 min ± 51.61 min vs. 184.13 min ± 72.73 min, $p < 0.001$).
Conclusion: The use of water immersion during labor is associated with a faster descent of the fetal head in the pelvis confirmed by ultrasound examination.

Keywords: *intrapartum ultrasound, labor progress, water immersion, angle of progression, progression distance*

STRESZCZENIE

Pozytywny wpływ zastosowania immersji wodnej na postęp porodu oceniany metodą ultrasonografii śródporodowej

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Cele pracy: Ocena wpływu zastosowania immersji wodnej na postęp porodu przy użyciu wybranych parametrów ultrasonograficznych
Metody: Do badania zakwalifikowano łącznie 200 ciężarnych, z niepowikłaną ciążą pojedynczą będących w aktywnej fazie pierwszego okresu porodu. Pacjentki rozdzielono losowo do dwóch równolicznych, stuosobowych grup. Grupę badaną stanowiły kobiety rodzące z wykorzystaniem immersji wodnej, zaś grupę kontrolną rodzące, u których nie zastosowano podczas porodu immersji wodnej. W grupie badanej pomiary kąta progresji główki płodu (AoP) oraz odległości punktu prowadzącego od linii podłonowej (PD) zostały wykonane bezpośrednio przed zastosowaniem 30 minutowej immersji wodnej oraz bezpośrednio po jej zakończeniu. W grupie kontrolnej pomiary zostały wykonane w momencie spełnienia warunków do rozpoczęcia immersji wodnej oraz po 30 minutach bez zastosowania dodatkowych interwencji medycznych.
Wyniki: Nie wykazano istotnych statystycznie różnic pomiędzy grupą badaną a kontrolną dotyczących rozwarcia szyjki macicy, kąta progresji główki płodu oraz odległości punktu prowadzącego od linii podłonowej w momencie włączenia pacjentek do badania. Analizując wpływ zastosowania immersji wodnej w I okresie porodu stwierdzono istotne statystyczne różnice pomiędzy grupą badaną i kontrolną w zakresie: kąta progresji główki płodu ($p < 0.001$) oraz odległości punktu prowadzącego do linii podłonowej ($p < 0.001$). Długość aktywnej fazy I okresu porodu była krótsza w grupie badanej (86.93 min ± 51.61 min vs. 184.13 min ± 72.73 min, $p < 0.001$).
Wnioski: Zastosowanie immersji wodnej podczas porodu jest związane z szybszym zstępowaniem główki płodu w kanele rodnym które potwierdzono badaniem ultrasonograficznym.

Słowa kluczowe: *ultrasonografia śródporodowa, postęp porodu, immersja wodna, kąt progresji główki płodu, odległość punktu prowadzącego od linii podłonowej*

Introduction

The management of laboring women is based on clinical assessment with the leading role of digital vaginal examination. Labor is a dynamic process with progress assessed through cervical dilatation/effacement, station and position of the presenting part, and strength of contractions. Friedmann first introduced the graphical analysis of labor in the year 1954 [1,2]. His observations led to defining two phases of labor: latent with slow progression of cervical dilation and active characterized by an acceleration of cervical dilation and resulted in the development of Friedman's curve used as the gold standard for assessment of cervical dilation and fetal head descent during active labor for the past 60 years.

Water immersion

Water immersion during labor or delivery has been used for decades. In 2022 Burns et al. published a meta-analysis of data from 157546 deliveries, showing that use of water immersion during labor has clear benefits for healthy women and their newborns [3]. Authors reported significantly reduced use of epidural (odds ratio (OR) 0.17 95% (Confidence interval) CI 0.05 to 0.56), episiotomy (OR 0.16; 95% CI 0.10 to 0.27), maternal pain (OR 0.24 95% CI 0.12 to 0.51) and postpartum haemorrhage (OR 0.69 95% CI 0.51 to 0.95). Authors also reported no differences in any identified neonatal outcomes. In 2010, Benefield et al. observed lower levels of anxiety, and lower concentrations of vasopressin, and oxytocin, with a decrease in the level of cortisol in the subgroup with a high baseline level of pain, in parturients using water immersion [4]. Henderson et al. analyzed 2505 deliveries with water immersion and observed a lower incidence of medical interventions required by women using it [5]. It is also reported that parturients require less pharmacological analgesia during labor and have higher satisfaction levels with the birth experience afterwards [6]. The effect of water immersion during the 1st stage of labor on the labor duration was the subject of a few studies. In 2018 Cluett et al. published a meta-analysis of data from 1561 deliveries, showing that water immersion shortened the duration of the first stage of labor by 42.21 min (95% CI, −80.93 to −3.49) [7].

Labor progression assessment

A vaginal examination is a cornerstone of labor progression assessment. Unfortunately, it is a subjective method with poor intra-observer and inter-observer reproducibility. A study by Dupuis et al. in the year 2005 showed that the failure to correctly assess the head station on a birth simulator happens in 30–34% of residents and experienced doctors [8]. Similar results showing the unreliability of digital vaginal examination were reproduced in other studies [9,10].

Taking that into account, we planned a study to assess the effect of water immersion on descent of the fetal head in the pelvis, using the objective method of intrapartum ultrasound. Currently, based on a review of the available literature there are no data on the ultrasound assessment of fetal head descent during water immersion.

In 2018, the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) issued a statement summarizing the evidence regarding the use of ultrasound during labor [11]. The parameters that are considered most beneficial for the direct determining of the head station, such as the angle of progression and progression distance, may be obtained in transperineal ultrasound in the midsaggital plane, and they are both easily measured and reproducible [12,13].

Materials and methods

The study enrolled 200 laboring women with uncomplicated singleton term pregnancy with spontaneous onset of delivery between 37 and 41 weeks of gestation in the first stage of labor with occiput anterior fetal presentation, hospitalized at the Labour Ward in years 2018–2019, meeting the criteria for starting water immersion according to local protocol. The inclusion and exclusion criteria for water immersion are presented in Table 1. The parturients were randomized to two equally sized groups using a computer program. The study group consisted of women in labor who were offered water immersion, and the control group included women who did not use water immersion during labor. In the study group, measurements and internal examinations were performed immediately before the beginning of the 30-minute water immersion procedure and immediately after that. In the control group, measurements and internal examination were performed once the conditions for starting water immersion were met and 30 minutes later, without any additional medical interventions in between. Intrapartum ultrasound examination was performed using mobile ultrasound Philips Lumify (Philips, 2017) with the Convex probe (2–5 MHz) in a single-use sterile cover. The transperineal imaging in the midsagittal plane was performed in between contractions with the following digital vaginal examination. Frozen images were used to measure parameters such as the angle of progression and progression distance. We also used table developed by Tutschek et al. in 2010 [12], to assess individual head station in the birth canal in corelation with the AoP (Table 2). Patients and caregivers were not informed about the examination results, so it would not influence decision-making regarding further labor management. The labor man-

agement was performed according to local protocols per the current Guidelines of the Polish Society of Obstetricians and Gynecologists [14]. Both study and control groups did not differ in terms of initial cervical dilation, angle of progression, and progression distance at the time of the first ultrasound examination. The initial cervical dilation was between 3 and 4 cm (3.32 ± 0.47 cm *vs* 3.22 ± 0.42 cm, p=0.22). The AoP was between 115° and 120° (117.95± 5.9° *vs.* 119.14° ± 3.98°, p=0.172). The PD was between 24 and 34 mm (27.96 ± 6.8 *vs* 29.39 ± 5.2, p=0,163). The median time interval between the first and second ultrasound examinations was 30 minutes in both groups.

Ethical considerations

This study was approved by the research ethics committee of the Faculty of Medicine, Medical University of Warsaw (Approval number: KB/186/2016). All procedures performed in presented study were in accordance to the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All the patients were thoroughly informed about the aim of the study and signed an informed consent form.

Statistical methods

Statistical analysis was performed using StatSoft Statistica 10.0. Both parametric and non-parametric tests were used to analyze the variables. The mean, standard deviation, minimum, and maximum were calculated for interval variables meeting the conditions of normal distribution. The median and the first and third quartiles were calculated for ordinal variables and those interval variables that did not meet the conditions of normal distribution. The differences in the average level of a numerical feature in two populations were assessed through the Student's t-test for independent variables or Mann-Whitney non-parametric U test. The correlation of two variables of normal distribution was determined using Pearson's linear correlation coefficient, and Spearman's rank correlation coefficient was calculated for variables that did not meet the criterion of normal distribution. The study also used the method of multifactorial and simple regression analysis. Symmetrical measures based on the chi-square test were used to evaluate the strength of relationships between selected variables in cross tables. The statistical significance level was set at p<0.05.

Results

The study involved 200 women in labor. There were no statistically significant differences between the study and control groups concerning maternal characteristics, obstetrics history, and neonatal birth weight (p>0.05; Table 3). In the presented cohort, most women (184 patients) had spontaneous vaginal delivery; there were no statistically significant differences between the study and control group (96.0% *vs.* 88%, p=1.000). Cesarean section was performed in 15 women (4% *vs.* 11%, p=0.159), and one subject underwent vaginal delivery using a vacuum extractor. In the presented study, no statistically significant differences were found between the study group and the control group in terms of overall perineal trauma (perineal incision and tear) (p>0.05). The amount of lost blood was comparable between the study and control groups, with a trend towards more extensive blood loss in the controls (due to the higher rate of Caesarean sections). No statistically significant differences were demonstrated in the condition of the newborns, assessed per Apgar score, between the study and control groups (p=0.808). None of the patients in the study group received epidural anesthesia. In the control group after the end of the follow-up ultrasound examination, 20 patients received epidural anesthesia to provide pain relief (p<0.001).

When analyzing the effect of water immersion during the first stage of labor, significant differences were found between both groups in cervical dilation, angle of progression of the fetal head, and progression distance. After 30 minutes of the procedure, there was an increase in the angle of progression (133.44° ± 9.86° *vs.* 121.84° ± 5.03°, p<0.001) and progression distance (42.93 mm ± 9.17 mm *vs.* 31.91 mm ± 5.78 mm, p<0.001). We also compared the duration of the active first stage of labor, which was shorter in the study group (86.93 min ± 51.61 min *vs.* 184.13 min ± 72.73 min, p<0.001). Figure 1 showed sample AoP and PD measurement before and after water immersion.

Discussion

Water immersion is known in obstetrics mainly as a method of alleviating labor pain. Currently, many women choose to labor in water and this practice is becoming increasingly popular [15]. The presented study showed that water immersion during the 1st stage of labor leads to a statistically significant shorter duration of the first stage of labor. The results were the most similar to those of Chaichian et al. [16] and Torkamani et al. [17]. It should be emphasized that in the presented study, the women in labor stayed in water immersion for 30 minutes. After the procedure patients were nor using it again until the end of the labor. Due to the lack of a clear consensus on the clinical use of intrapartum ultrasound [11], two parameters were evaluated in the presented study: the angle of progression

and the progression distance. These parameters directly describe the position of the fetal head in the birth canal. They are characterized by high repeatability and ease of performing reliable measurements [18]. At the same time, the angle of progression of the fetal head is currently the most frequently evaluated ultrasound parameter by the authors in publications on the course of labor. In 2010, Tutschek et al. [12] in a group of 50 laboring women performed an ultrasound assessment of the AoP and PD at different stages of labor progression. Authors showed a strong correlations between the obtained AoP and PD values and the head station ($p<0.001$). Based on conducted of the analysis, authors determined AoP values for individual of head station in the birth canal. In 2018, ISUOG reviewed the published studies on the techniques of intrapartum ultrasound examination and its practical application [11]. The authors suggest that intrapartum ultrasound can be used as a complementary tool to conventional vaginal examination. It was shown by Torkildsen et al. in 2011 [19] and Eggebo et al. in 2014 [20] that the assessment of AoP is more sensitive compared to vaginal examination in predicting vaginal delivery in the prolonged 1st stage of labor. In the most extensive multicentre study, Eggebo et al. evaluated AoP in a group of 150 women in labor with a prolonged 1st stage of labor to predict abnormal labor progress. If AoP was above 110°, the risk of Caesarean section was 12%, whereas, in the case of AoP below 100°, the risk of Caesarean section increased to 62% [21].

In the presented study, no statistically significant differences in AoP and PD values between the two groups of women in labor were observed at the start of the active phase of labor. AoP and PD values evaluated at 30 minutes significantly differed between the two groups ($p<0.001$). It is also worth noting that among 11 patients who underwent Caesarean section due to lack of progress in labor in the 1st stage, in 9 patients, the AoP change at 30 minutes was 0 to 2°, and in 8 patients, the PD change at 30 minutes was 0 to 2 mm. The mean change in PD at 30 minutes among all patients in the study group was 14.95 ± 8.5 mm. The mean change in all patients in the control group was much lower, 2.57 mm ± 2.03 mm ($p<0.001$). The mean AoP change at 30 minutes among all patients in the study group was 15.58° ± 10.21°. The mean change in all patients in the control group was much lower, 2.59° ± 3.01° ($p<0.001$).

The main limitation of the study is the fact that it was conducted in a selected group of women with uncomplicated pregnancies in the active phase of labor. It will be difficult (promising) results transfer to the entire population. This applies in particular to induced deliveries, which have different dynamics. The advantage of the study is the fact that the results of the measurements were not known patients and other caregivers. Therefore, they couldn't have an impact on decisions regarding further proceedings.

Conclusions

Water immersion is an attractive alternative to alleviate labor pain and optimize labor progress, consequently allowing for successful vaginal delivery. Its use during labor is associated with a statistically significant reduction in the duration of labor, especially in the active part of the 1st phase. The objective ultrasound parameters confirmed a faster descent of the fetal head in the pelvis. Despite the increased labor speed, it remains safe for both the mother and the newborn.

Patient consent

All patients provided signed informed consent before enrolment.

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Tables

Table 1. Criteria for water immersion during the study according to local protocol

Inclusion criteria	Exclusion criteria
Uncomplicated singleton, term pregnancy with fetus in cephalic presentation	Uterine scar
Regular uterine contractions (spontaneous or stimulated)	Non-reassuring CTG tracing
Cervical dilation at least 3 cm	Vaginal bleeding
No wish for epidural analgesia	Skin lesions, skin infections, genital herpes
Good general condition of the parturient	Temperature >37.5C
Good cooperation with a caregiver with urgent removal from the tub in case of emergency	Viral infections such as HIV, HBV, HCV

Table 2. Comparision of head station and angle of progression (Tutschek et al. 2010)

Head station (cm)	Angle of progression (°)
-3	84
-2	95
-1	106
0	116
1	127
2	138
3	148
4	159
5	170

Table 3. Comparison of the groups

Variables	Groups[a]		p[b]
	Study (n=100)	Control (n=100)	
Age, years	30,09 ± 5,08	29,44 ± 4,91	0,397
Height, cm	166,65 ± 5,33	165,8 ± 5,07	0,138
Weight, kg	77,89 ± 12,13	78,12 ± 13,17	0,814
Gestational age, weeks	39,28 ± 0,87	39,06 ± 1,14	0,299
Parity, nulliparous / parous (≥1)	43 / 57	49 / 51	0,395
Neonate's birth weight, g	3511,5 ± 366,52	3423 ± 458,56	0,133
Cesarean section, %	4	11	0,159
Amount of lost blood, ml	371,35 ± 42,76	381,82 ± 62,71	0,135
Active first stage of labor, min	86,93 ± 51,61	184,13 ± 72,73	<0.001
AoP after 30 min,°	133,44 ± 9,86	121.84 ± 5.03	<0.001
PD after 30 min, mm	42,93 ± 9,17	31,91 ± 5,78	<0.001

[a]Data are presented as mean±SD, [b]Results of *t*-test.

Figures

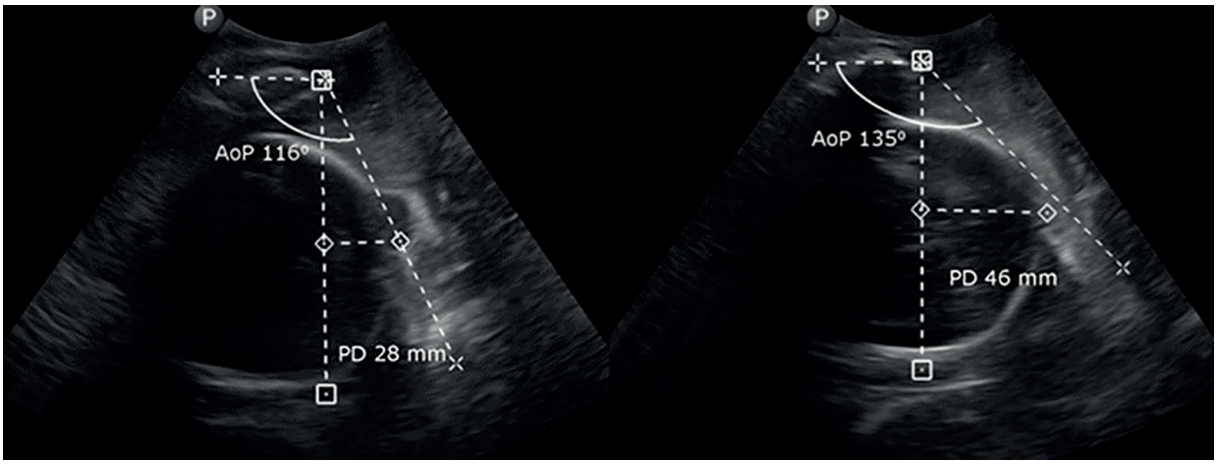

Figure 1. AoP and PD before and after water immersion

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