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ScienceDirect
European Journal of Obstetrics & Gynecology and Reproductive Biology 134 (2007) 37–43
ejog European Journal of Obstetrics & Gynecology and Reproductive Biology
www.elsevier.com/locate/ejogrb

Maternal and neonatal infections and obstetrical outcome in water birth

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Received 28 June 2006; received in revised form 28 August 2006; accepted 25 September 2006

Abstract

Objectives: The goal of our study was to assess the effect of water birth on obstetrical outcome, the maternal and neonatal infection rate in a selected low risk collective.

Study design: In this prospective observational study (1998–2002) 513 women, wished to have a water birth. The study was approved by the local ethical committee, informed consent was obtained. According to the course of delivery, we compared three groups: woman who had a water birth, a normal vaginal delivery after immersion and a normal vaginal delivery without immersion. Outcome measurements were maternal and fetal infection rate, obstetrical outcome parameters and relevant laboratory parameters.

Results: The groups were comparable in terms of demographic and obstetric data. The maternal and neonatal infection rate and laboratory parameters showed no significant difference among the groups. There was no maternal infection related to water birth. There were five water born neonates and three neonates after normal vaginal delivery preceded by immersion with conjunctivitis. Significant differences were observed in obstetrical outcome parameters: less use of analgesia, shorter duration of first and second stage of labor, smaller episiotomy rate in water birth. In contrast no differences were seen in all observed fetal outcome parameters: APGAR score, arterial and venous pH, admission rate to neonatal intensive care unit.

Conclusions: Water birth is a valuable alternative to traditional delivery. The maternal and fetal infection rate was comparable to traditional deliveries.

A careful selection of a low risk collective is essential to minimize potential risks.

Keywords: Water birth; Immersion; Infection

1. Introduction

The perceived advantages of labor and birth in water include relaxation, diminished sensation of pain, decreased discomfort and possibly, a gentler birth experience for the baby. In 1983, Odent [1] published the results of the first hundred water births in *The Lancet* and quoted not having had infectious complications. Studies have shown that there is no increased risk of maternal or neonatal infections due to immersion during labor [2]. However there are ongoing debates and concerns, that using the bath for delivery has an increased risk of maternal and neonatal infections [3–5]. These concerns have to be taken seriously since organisms from the woman's skin, vagina, perineal and anal areas (group B: *Streptococcus*, *Mycoplasma urealyticum*, *Chlamydia trachomatis*, *Staphyloccocus aureus*, *Enterococci*, *Escherichia coli*), and the water system (*Pseudomonsas aeroguinosa*, *Legionella pneumophila*) as well as possibly from previous tub users are potential source of infection. Additionally, the temperature of the water accelerates the reproduction of potentially harmful organisms, which could harm the mother and especially the neonate.

Our objective was to investigate prospectively in a tertiary obstetrical unit and in a selected low risk collective

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0301-2115/$ – see front matter
doi:10.1016/j.ejogrb.2006.09.012

whether there is an increased risk of maternal and neonatal infections after water birth.

2. Material and methods

Between April 1998 and May 2002, we conducted this prospective, observational study at the University Women's Hospital Basel, Switzerland. The local institutional review board approved this study and written informed consent was obtained from all participating patients. All pregnant women at low risk for obstetrical and maternal complications were informed in the late second and third trimester about the availability of underwater births. Every interested woman was given detailed explanations and information about the inclusion and exclusion criteria (Table 1) and about our guidelines [6,7] concerning safety policy of water birth, either by a trained resident, fellow, or midwife. All women agreed to be tested for HIV, hepatitis B and C virus before admission to protect the staff from infections, according to the requirements of the infection control policy. If a woman tested positive or the results were not available until delivery, a water birth could not be performed. All members of the obstetrical unit underwent hepatitis B vaccination prior to conducting water births, and were obligated to wear gloves during labor and delivery.

Inclusion and exclusion criteria were checked at recruiting and once more at admission to the delivery ward. The woman could enter the bathtub whenever she desired.

Table 1
Inclusion and exclusion criteria inclusion and exclusion column need the same design and the same width

Inclusion criteria	Exclusion criteria
Delivery at our center	
Single pregnancy with cephalic presentation at term (≥37 week of gestation)	Fetal macrosomia (>95th percentile)
	Intrauterine growth restriction (<5th percentile)
	Preterm labor (<37 week of gestation)
Current negative results on HIV, hepatitis B and C virus	
Continuous fetal cardiotocogram by telemetry (Hewlett Packard 71034 Boehringer Germany®)	Pathological and suspect CTG according to the FIGO criteria
The woman agrees to leave the bath in case of a suspicious or pathologic CTG, according to the FIGO criteria	Intrauterine fetal resuscitation
Venous access during labor	Epidural anesthesia
	Meconium stained amniotic fluid
	Acute herpes genitalis
	History of shoulder dystocia

Homeopathic and analgesics were used as first line drugs for pain relief. If an epidural blockade was required, further immersion was not allowed. In case of failure of cervical dilatation (<1 cm/h) during first stage of labor, augmentation with oxytocin and/or rupture of the membranes was performed. The women were asked to leave the bathtub in case of events complicating delivery and/or labor (Table 1). The midwife ensured a controlled delivery of the head and the baby was brought gently but within seconds to the surface and placed on the mother's chest.

The postpartum management was identical in all women. The maternal and fetal outcomes were monitored by clinical and laboratory parameters from delivery until demission.

After having drained the water, the bathtub was cleaned by the midwife first with soap and water and subsequently with Kohrsolin FF Concentrate (Bode Chemie, Hamburg, Germany), containing glutaraldehyde, benzalkoniumchloride and didecyldimethylammoniumchloride, according to the infection control policy and allowed to air-dry between each use.

To reduce the risk of an infection with Pseudomonas the water tap was fully opened for several minutes, before filling the tub, as proposed by our infection control policy.

All data were prospectively collected by midwifes or residents and documented on the trial entry form in the patients' hospital records. After the study's completion, the clinical data were filled in an excel sheet by a member of the research team, not responsible for providing patient care.

2.1. Statistical analysis

In order to compare two groups of continuous variables, Student's *t*-test and Welch-test (when variances in groups are unequal) were used to compare approximate normally distributed data. Mann–Whitney *U*-test was used for ordinal data. As a measure of correlation, Spearman rank order correlation was calculated. All variables used were described by mean, median, standard deviation (S.D.), and minimal and maximal value. If variables were categorical, crosstabs were formed and Fisher's exact test was applied. If possible, relative risks with corresponding 95% confidence intervals were calculated. To compare several subgroups of continuous data, one-way ANOVA's were performed. This study has a purely exploratory character; therefore the *p*-values were not adjusted for multiple comparisons. A p-value <0.05 was considered as significant. All analyses were performed using SPSS 11.5.1 (SPSS Inc., Chicago, USA).

3. Results

On initial screening in our antenatal clinic, 521 patients were interested in having a water birth and simultaneously satisfied the inclusion criteria (Fig. 1). The study population represented 7.7% of all deliveries ($n = 6800$) at the Basel

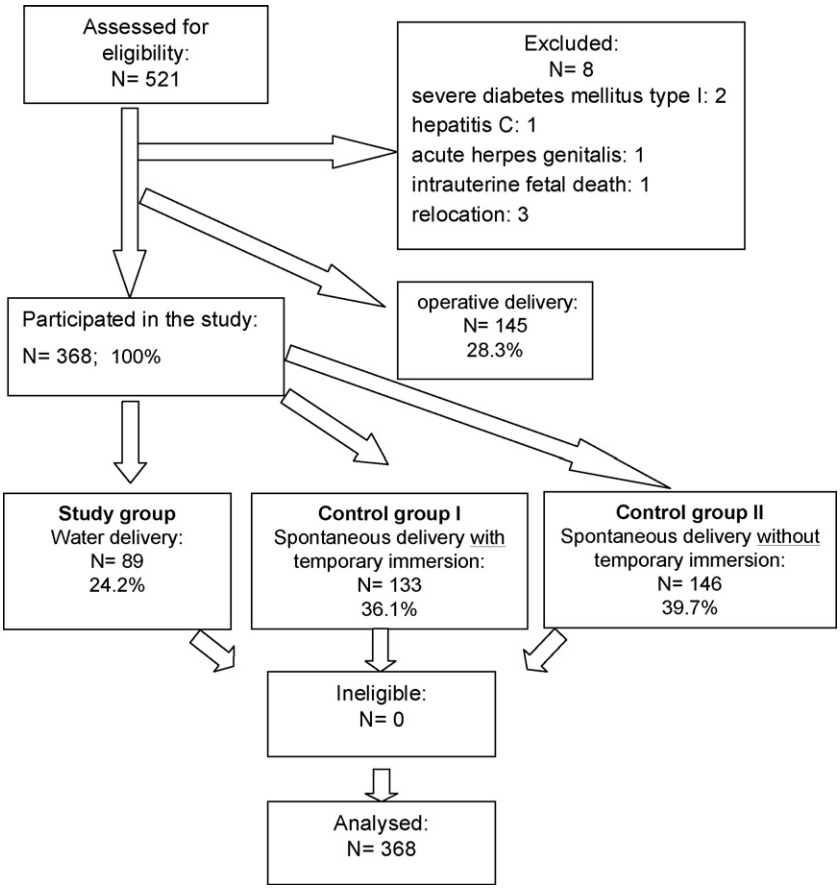

Fig. 1. Assessment for eligibility.

Women's University Hospital between April 1998 and May 2002. Eight of the 521 patients were excluded from participation, either due to medical reasons (two patients with severe diabetes mellitus type I), or exclusion criteria: one women had hepatitis C, one suffered from acute herpes genitalis, and one patient mourned an intrauterine fetal death. Furthermore, three women moved away before birth and therefore could not deliver at our institution. One hundred and forty-five patients (28.3%) had an operative delivery: either a caesarean section ($n = 49$), or a vaginal assisted delivery ($n = 96$). They were excluded from analysis. All the remaining 368 women met the inclusion criteria. According to the course of delivery, three different groups were formed: 89 women (24.2%) delivered in the water and constituted the study group (SG), 133 women (36.1%) had a normal vaginal delivery after temporary immersion and formed the control group I (CG I), 146 women (39.7%) had a normal vaginal delivery but no temporary immersion and established control group II (CG II).

The study group and its control groups were comparable in terms of demographic and obstetric data, such as maternal age, gestational age, maternal occupation and medical insurance, a parameter with regard to the socioeconomic background (Table 2). The ethnical background of the women was recorded according to their origin: local Swiss population, Mediterranean origin and others. CG II was composed of less Swiss women (59.6% versus 77.5%) but more women with Mediterranean roots (36.3% versus 18%) ($p = 0.011$). CG I comprised significant less multiparae than the SG ($p = 0.003$), CG II and the SG were comparable.

Until discharge we looked for clinical signs of maternal postpartum and neonatal infections. The three groups showed no statistical difference concerning maternal or neonatal infection rate (Table 2).

The SG and the two CG were comparable concerning maternal leucocytes or C-reactive protein (CRP) values assessed at admission and 2 days postpartum. Maternal temperature did not show any differences between all groups. We did not observe any maternal infection which could have been related to water deliveries (Table 3).

All three groups were comparable in neonatal admission to the NICU, clinical signs of infections or fever of the infant (Table 2). In the SG 5 neonates, in the CG I 3 neonates and in the CG II no neonate had a conjunctivitis (SG versus CG I p: 0.123; CG I versus CG II p: 0.11; SG versus CG II p: 0.0073) (Table 3).

The need for additional analgesics ($p < 0.001$) and homeopathy ($p = 0.004$) was significantly higher in the CG I compared to the SG. Epidural anesthesia was not allowed in

Table 2
demographic, obstetrical and outcome data

Variable	Study group (SG) Water delivery, $n = 89$ (24.2%)	Control group I (CG I) Spontaneous delivery with temporary immersion, $n = 133$ (36.1%)	Control group II (CG II) Spontaneous delivery with no temporary immersion, $n = 146$ (39.7%)	p
Maternal age	30.1 (4.6)	28.7 (5.5)	29.4 (5.8)	n.s.
Parity				
• Primiparous	46 (51.7%)	96 (72.2%)*	67 (45.9%)**	0.003*
• Multiparous	43 (48.3%)	37 (27.8%)*	79 (54.1%)**	n.s.**
Health insurance				
• Private I	3 (3.4%)	8 (6%)	4 (2.7%)	n.s.
• Private II	14 (15.7%)	13 (9.8%)	13 (8.9%)	
• General	72 (80.9%)	112 (84.2%)	129 (88.4%)	
Place of origin				
• Switzerland	69 (77.5%)	101 (75.9%)*	87 (59.6%)**	% of Swiss women, compared to SG
• Mediteranean countries	16 (18%)	29 (21.8%)	53 (36.3%)	n.s.*
• Others	4 (4.5%)	3 (2.3%)	6 (4.1%)	0.011**
Education				
• Housewife	28 (31.5%)	38 (28.6%)	59 (40.5%)	n.s.
• University degree	18 (20.2%)	13 (9.8%)	14 (9.6%)	
• Vocational school	31 (34.9%), to unskilled worker 10 (11.2%)	67 (50.4%), to unskilled worker 11 (8.2%)	55 (37.7%), to unskilled worker 10 (6.8%)	
• Unskilled worker	to unknown 2 (2.2%)	to unknown 4 (3%)	to unknown 8 (5.4%)	
• Unknown				
Gestational age at delivery	39.93 (1.0)	40.2 (1.2)	39.9 (1.4)	n.s.
Rupture of membranes				
• Spontaneous or artificial	81 (91.0)	103 (77.4)*	129 (88.4)**	0.010*, n.s.**
• PROM	8 (9.0)	30 (22.6)*	17 (11.6)**, 1 (0.7)	
• Unknown				
Use of analgesia	36 (40.4%)	97 (72.9%)*	70 (48%)**	<0.001*, n.s.**
Use of homeopathy	40 (44.9%)	87 (65.4%)*	55 (38%)**	0.004*, n.s.**
Use of peridural anaesthesia	0 (0%)	67 (50.4%)*	55 (38%)**	<0.001*, <0.001**
Duration of the first stage of labor	330.5 (211.6)	438.7 (188.4)*	352.8 (189.3)**	0.003*, n.s.**
Duration of the second stage of labor	35.3 (36.4)	69.7 (64.1)*	49.1 (54.4)**	0.005*, <0.001**
Augmentation with oxytocin	16 (18%)	85 (63.9%)*	65 (44.5%)**	<0.001*, <0.001**
Duration of the third stage of labor	14.2 (14.9)	9.5 (7.1)*	8.6 (8.3)**	0.003*, <0.001**
Retained placenta	1 (1.10%)	3 (2.3%)	3 (2.1%)	n.s.
Birth-injury				
• None	8 (9%)	12 (9%)	30 (20.5%)	<0.001*
• Episiotomy	5 (5.6%)	65 (48.9%)*	54 (37.0%)**	<0.001**
• Perineal laceration I and II	48 (53.9%)	29 (21.8%)	38 (26.0%)	
• Perineal laceration III	0 (0%)	3 (2.3%)	1 (0.7%)	
• Vaginal tears	28 (31.5%)	24 (18%)	23 (15.8%)	
Estimated blood loss	334.8 (119.5)	386 (272.7)	409.9 (268.5)	n.s.
Birthweight (g)	3364 (440)	3489 (448)	3443 (468)	n.s.
APGAR score				
• 1 min	8.7 (0.8)	8.5 (1.13)	8.7 (1.0)	n.s.
• 5 min	9.8 (0.5)	9.8 (0.6)	9.8 (0.5)	n.s.
• 10 min	10 (0.0)	10 (0.2)	10 (0.1)	n.s.
Arterial pH	7.26 (0.06)	7.23 (0.08)	7.25 (0.08)	n.s.
Venous pH	7.38 (0.07)	7.34 (0.07)*	7.35 (0.06)**	0.002*, 0.05**
Admission to NICU	0 (0%)	2 (1.5%)	5 (3.4%)	n.s.
Clinical signs of infection in the fetus	5 (5.6%)	4 (3%)	2 (1.4%)	n.s.
Fever (>38 °C) of the fetus	1 (1.10%)	2 (1.50%)	0 (0%)	n.s.

Table 2 (*Continued*)

Variable	Study group (SG) Water delivery, $n = 89$ (24.2%)	Control group I (CG I) Spontaneous delivery with temporary immersion, $n = 133$ (36.1%)	Control group II (CG II) Spontaneous delivery with no temporary immersion, $n = 146$ (39.7%)	p
Maternal hemoglobin at admission	12.7 (1.3)	12.3 (1.7)	12.2 (1.4)	n.s.
Maternal hemoglobin 2 days after delivery	11.7 (1.6)	11.0 (1.6)*	11.0 (1.6)**	0.036*, 0.045**
Δ maternal hemoglobin (hemoglobin during delivery—hemoglobin 2 days postpartum)	1.2 (1.3)	1.3 (1.5)	1.4 (1.4)	n.s.
Maternal hematocrit at admission	36.4 (3.6)	35.5 (4.8)	35.6 (3.6)	n.s.
Maternal hematocrit 2 days after delivery	34.1 (4.6)	32.2 (4.6)*	32.3 (4.5)**	0.028*, n.s.**
Δ maternal hematocrit (hematocrit during delivery—hematocrit 2 days postpartum)	2.8 (3.8)	3.2 (4.3)	3.8 (4.1)	n.s.
Maternal leucocytes at admission	14.4 (4.5)	14.6 (4.3)	13.2 (4.1)	n.s.
Maternal leucocytes 2 days after delivery	12.4 (3.2)	13.5 (4.0)	13.0 (3.4)	n.s.
Maternal CRP at admission	10.8 (15.6)	13.5 (16.6)	12.1 (15.1)	n.s.
Maternal CRP 2 days after delivery	26.6 (15.3)	49.0 (37.2)	44.9 (35.8)	n.s.
Maternal temperature at admission (°C)	37.3 (0.6)	37.4 (0.5)	37.3 (0.6)	n.s.
Materal temperature 2 days postpartum (°C)	37.2 (0.5)	37.3 (0.5)	37.2 (0.4)	n.s.

Values are mean (S.D.) or n (%).
* p, CG I vs. SG.
** p, CG II vs. SG.

Table 3
Neonatal and maternal outcome

	Water birth study group, $n = 89$		Spontaneous delivery with immersion control group I, $n = 133$		Spontaneous delivery without immersion control group II, $n = 146$	
	n	Diagnosis	n	Diagnosis	n	Diagnosis
Infant						
NICU	0		2		5	
			1	Adaptation problems	1	AO incompatibility
			1	Complex heart vitium	1	Hypoglycemia
					1	Repeated vomiting, hypoglycemia
					1	Hypoglycemia, hypopotassic, hypothermia
					1	Tachypnoic
Fever	1		2		0	
	1	Thirst fever	2	Fever, blood cultures negative		
Infection	5		4		2	
	5	Conjuctivitis	3	Conjuctivitis	1	Meconium aspiration
			1	Staphylodermia	1	Suspected neonatal sepsis
Mother						
Infection	1		1		3	
	1	Infection of the upper airways	1	Infection of the upper airways	2	Urinary tract infection
					1	Subinvolution of the uterus, endomyometritis

the case of water birth because of a potential infection at the puncture site and the epidural space. The prevalence of epidural anesthesia was 50% in CG I and 38% in CG II. CG I featured significantly more often preterm rupture of membranes compared to the SG ($p = 0.010$). Mean values of the duration of first stage of labor were significantly longer in CG I, compared to the water delivery group ($p = 0.003$). The mean values of the duration of the second stage were significantly longer in all control groups ($p = 0.005$ CG I, $p < 0.001$ CG II). In both control groups augmentation with oxytocin was significantly more often necessary ($p < 0.001$ CG I, $p < 0.001$ CG II). Significantly more episiotomies were performed in both control groups ($p < 0.001$ CG I, $p < 0.001$ CG II). This was outweighed by more 1st and 2nd degree perineal lacerations occurring in the water delivery group. No shoulder dystocia occurred in any group. The third stage of labor lasted significantly longer in the water delivery group ($p = 0.003$ CG I, $p < 0.001$ CG II) and 57% of these women delivered the placenta in the tub. This result had no influence on the estimated blood loss. Retained placenta was a rare event in all groups. The SG and the two CG were comparable concerning maternal hemoglobin, hematocrit values assessed at admission. Two days postpartum the hemoglobin was significantly lower in both control groups ($p = 0.036$ CG I, $p = 0.045$ CG II), the hematocrit values were significantly lower in CG I than in SG ($p = 0.028$). By subtracting the values 2 days postpartum from the values at admission, we received a Δ-value, which did not differ among the groups.

In the neonates the mean birth weight, APGAR scores and arterial pH values were similar in all groups (Table 2). Significantly lower venous pH values were observed in all control groups compared to the water delivery group ($p = 0.002$ CG I, $p = 0.05$ CG II).

4. Comment

The goal of our study was to add data to the discussion on the subject of the risk of infection in water birth for the mother and her neonate in a highly selected low risk collective. The literature referring to water births provides some evidence that the overall outcome is similar to that achieved with traditional methods [8–11].

In the literature water birth rates of up to 50% are reported [9–12], whereas in our tertiary unit just 1.3% of the deliveries occurred in water, which is similar to the rate reported from other centers [8,11,13,14]. From all women interested in a water birth only 17.3% ultimately delivered their child in water. Main reasons for leaving the bathtub were a pathologic course of labor, the demand for an epidural anesthesia or the women not feeling comfortable in the warm water.

Clinical reports raised concerns that this mode of delivery may not be safe [15–18], and that there might be an increased risk of maternal and neonatal infections [3,4,19]. This is a legitimate hypothesis, since mother and neonate can spend some time in faecal contaminated water [12].

There have been reports of neonatal infections due to *Legionella pneumomhila* [20,21] and *Pseudomonas aeruginosa* [22–24]. Only sporadic cases of Legionnaires' disease in newborns have been reported whereas *P. aeruginosa* is a well known cause of about 9% of neonatal nosocomial infections. Sinks, taps and respiratory-therapy equipment are commonly described reservoirs [25,26]. We did not diagnose legionella or pseudomonas infections in any neonate born in water.

Thöni et al. [12] was able to show a faecal contamination of the water with *E. coli* in 64% and coliform bacteria in 82% after water delivery. However, the neonates born in water did not have an increased incidence of infection.

Fehervary et al. [14] were able to isolate microorganisms of the normal vaginal flora from the ear and palate of the newborns after water delivery, spontaneous delivery with and without immersion. The neonatal and maternal infection rate and the microbiological colonization of the neonate did not differ between the three groups.

Our data show that infections, fever and referral to the NICU were rare in all groups not showing any significant difference. Similar results are obtained by other groups [8–12,27]. All neonatal infections observed in the study group were mild conjunctivitis, with no need for invasive therapy. We noticed several cases of conjunctivitis: five in the SG, three in the CG I and none in the CG II. Water born neonates had a significant higher incidence for conjunctivitis than neonates whose mother had no immersion. These mild cases of conjunctivitis' might potentially be caused by contaminated bath water, which contains faecal bacteria and maternal skin flora [12,14].

The maternal infection rate and the measured maternal temperature were comparable among the three groups in our study. We diagnosed one case of endomyometritis in the CG II, but none in the study group. Similar results were reported by others [9,11]. All measured laboratory parameters like leucocytes, CRP and maternal temperature did not show any significant difference.

No infections of birth attendants have been reported in the literature so far. At our institution all laboring women have to be tested HIV, hepatitis B and C virus negative and all birth attendants had a hepatitis B vaccination and are urged to wear gloves, according to our safety policy [28–31].

Our data like those of other studies confirm that women who have a water delivery perceive less sensation of pain and therefore need significantly less analgesics [9–12]. Our study results are consistent with those of the Cochrane review [27] showing that there were no significant differences in the incidence of low APGAR scores, higher admission rates to NICU or higher incidence of neonatal infections, in accordance to other series [8–11]. Like others [9,10] we observed higher hemoglobin values postpartum, which were of no clinical significance, whereas the Δ-value (=value at admission minus value 2 days postpartum) did not

differ among the three groups. This indicates that the blood loss in water birth is comparable to a normal spontaneous delivery.

Many authors reported similar results to our study and found no differences in fetal and maternal outcomes [1,8–11,32]. This may be explained by the pre-selection of the study population, the inclusion and exclusion criteria and a rigorous attention to our safety policy.

The weakness of our study is its observational nature. A randomization, however, is difficult to accomplish on this subject as we have seen by others [8]. Our study was done on a highly selected low risk population of our institution, where all women had the intention to have a water birth. The course of labor added an additional selection, since the slightest deviation from an uneventful course of labor resulted in the termination of water birth. The strength of our study is the postpartum measured objective parameters, which leave no room for speculation.

In conclusion, our data indicate that water deliveries performed in a selected low risk collective need less analgesia, have a shorter duration of first and second stage of labor, a lower episiotomy rate and are not associated with an adverse maternal or fetal outcome. We did not observe an increase in neonatal or maternal infection. However, a higher incidence of neonatal conjunctivitis was seen in our study. We do not recommend this way of delivery without a careful selection of pregnant and laboring women. Informed consent, strictly maintained guidelines and continuous intrapartum observation as well as fetal monitoring are mandatory.

Conflict of interest

None.

Acknowledgments

We thank Andy Schoetzau for his help with the statistical analysis, Linda Herberich for proof reading, Agnes Renken and Anne Maertens for helping collecting the data.

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