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SHORT COMMUNICATION

Neonatal outcome following prolonged umbilical cord prolapse in preterm premature rupture of membranes

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We assessed the outcome of thirteen neonates (five singletons and eight first twins) born after umbilical cord prolapse (UCP) following preterm premature rupture of membranes (PPROM) between 24 and 34 weeks of gestation. The median gestational age at PPROM was 29 weeks + 2 days. The median interval from the diagnosis of UCP to delivery was 60 and 150 minutes in singleton and twin pregnancies, respectively. The median umbilical artery pH was 7.29 [0.06]. Apgar scores ranged between four and 10 at 5 minutes after birth. All infants had a normal neurodevelopmental outcome at two years follow up.

INTRODUCTION

Umbilical cord prolapse (UCP) is a rare event complicating less than 0.5% of all deliveries.[1–6] Independent risk factors for UCP are malpresentation (OR = 5.1; 95% CI 4.1–6.3), hydramnios (OR = 3.0; 95% CI 2.3–3.9), true knot of the umbilical cord (OR = 3.0; 95% CI 1.8–5.1), preterm delivery (OR = 2.1; 95% CI 1.6–2.8), induction of labour (OR = 2.2; 95% CI 1.7–2.8), grandmultiparity (>5 deliveries, OR = 1.9; 95% CI 1.5–2.3) and lack of prenatal care (OR = 1.4; 95% CI 1.02–1.8).[1]

Due to the large proportion of elective caesarean sections for non-cephalic presentations and multiple pregnancies, the incidence of UCP has diminished over the past 50 years.[7] Nevertheless, mortality rate and risk of poor perinatal outcome are still high.[1,3–6]

UCP occurs more frequently in pregnancies with ruptured membranes before labour because the presenting fetal part is less likely to occupy the pelvis. In preterm premature rupture of membranes (PPROM), the combination of prematurity and frequently associated malpresentations further increases the likelihood of UCP occurrence.[8]

Several studies have emphasised the risks of a prolonged prolapse-to-delivery interval.[8,9] The outcome was reported to be favourable if the fetus is delivered within 30 minutes after diagnosis.[3,10] In expectantly managed patients with PPROM, the diagnosis of UCP is only evident when the cord protrudes through the introitus. In some cases however, the umbilical cord may 'silently' prolapse into the vagina. Patients at risk for UCP can be detected by transvaginal colour Doppler sonography,[11,12] presumed that this is performed at regular intervals in women with PPROM. Nevertheless, the diagnosis of 'occult' UCP may frequently be delayed.

The purpose of the study was to investigate the neonatal outcome of a series of cases of either occult or overt UCP following PPROM before 34 gestational weeks.

METHODS

The computerised database of the Perinatology Department was used to identify all cases with UCP following PPROM between January 1994 and December 2002. The database, recorded by trained residents, includes details of all deliveries in the hospital.

UCP was defined when the umbilical cord was visualised within the vagina, appearing at the introitus or outside the vulva. Only cases following PPROM between 24 and 34 weeks without significant uterine activity were included into the study. Gestational age had been determined by the last menstrual period and confirmed by ultrasound examination. The degree of cervical dilatation at diagnosis and the fetal presentation were recorded. The intervals from PPROM to UCP and from diagnosis of UCP to delivery were calculated. The only intervention to relieve cord compression was to place the patient in the Trendelenburg position. No maneuvers such as bladder instillation with saline or manual replacement of the cord were attempted. When UCP occurred after hospital admission and fetal heart rate (FHR) monitoring was maintained for at least 20 minutes after diagnosis, the recordings were retrieved and analysed. In cases with a prolonged diagnosis-to-delivery

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Table 1. Perinatal characteristics of the study population.

	Parity	G.A. at PPROM (weeks + days)	Interval PPROM-UCP (days)	Interval UCP-delivery (minutes)	Location at diagnosis	Cervical dilatation (cm)	Type of UCP	FHR after diagnosis	FHR before delivery[§]	Fetal presentation	Mode of delivery
Singleton pregnancies											
1	3	28 + 3	1	30	Hospital	5	Vagina	S	–	Vertex	CS
2	2	31 + 4	7	120	Hospital	2	Vagina	N	N	Breech	CS
3	2	27 + 3	5	60	Hospital	3	Introitus	N	N	Breech	CS
4	1	34 + 0	0	240	Home	4	Vagina	–	S	Vertex	CS
5	3	25 + 5	6	15	Hospital	10	Introitus	S	–	Breech	VD
Twin pregnancies*											
6 (DC)	0	29 + 6	4	180	Hospital	5	Vagina	N	S	Breech	CS
7 (DC)	0	24 + 0	0	720	Hospital	7	Vagina	P	P	Vertex	VD
8 (DC)	0	27 + 5	15	120	Hospital	10	Introitus	N	N	Breech	CS
9 (MC)	0	33 + 5	0	30	Hospital	5	Vagina	N	–	Breech	CS
10 (DC)	0	29 + 5	3	360	Hospital	10	Outside the vulva	–	N	Vertex	CS
11 (DC)	0	28 + 3	10	10	Hospital	10	Outside the vulva	P	–	Vertex	VD
12 (MC)	0	29 + 2	1	96	Hospital	5	Introitus	N	N	Breech	CS
13 (DC)	0	30 + 2	0	240	Home	8	Vagina	–	S	Breech	CS

N = normal; S = suspicious; P = pathological; CS = caesarean section; VD = vaginal delivery; DC = dichorionic; MC = monochorionic.
* Only the characteristics of the affected twin have been reported.
§ FHR pattern of the last 20 minutes before delivery.

interval, FHR patterns of the last 20 minutes before delivery were separately reviewed. Fetal cardiotocographic recordings (CTG) were classified as normal, suspicious or pathological using the criteria of the Royal College of Obstetricians and Gynaecologists on the use of electronic fetal monitoring.[13]

Values of the APGAR score <7 after 5 minutes and of the umbilical arterial pH <7.20 were considered as markers of potential neonatal asphyxia. In addition, the frequency of admission to the neonatal intensive care unit (NICU), the incidence and severity of intraventricular haemorrhage (IVH), respiratory distress syndrome (RDS), periventricular leucomalacia (PVL) and the results of fetal blood culture were evaluated. In twin pregnancies, only the outcome of the twin presenting with UCP was considered.

For the infants born between 25 and 30 weeks of gestational age, neurodevelopmental assessment of all infants was carried out at the corrected age of two years. The

Table 2. Neonatal outcome of the study population.

	G.A. at delivery (weeks + days)	Birthweight (g)	Umbilical artery pH	1 minute Apgar score	5 minute Apgar score	Ventilation (days)	RDS (0–IV)	IVH (0–IV)	PVL	NICU admission (days)	Neonatal blood culture	18 months outcome
Singleton pregnancies												
1	28 + 4	1120	7.29	7	9	3	I	0	0	11	Negative	Normal
2	32 + 4	1760	7.30	7	8	1	0	0	0	3	Negative	Normal
3	28 + 1	1100	7.29	7	9	0	0	0	0	14	Negative	Normal
4	34	1940	7.13	6	10	0	0	0	0	13	Negative	Normal
5	26 + 4	775	7.23	1	4	9	I	0	I[§]	49	S. epidermidis	Normal
Twin pregnancies*												
6 (DC)	30 + 3	1440	7.23	9	10	2	0	0	0	7	Negative	Normal
7 (DC)	24 + 0	795	–	–	–	–	–	–	–	–	Negative	Normal
8 (DC)	29 + 6	1240	7.29	2	7	23	II	0	I[§]	32	Citrobacter	Normal
9 (MC)	33 + 5	1870	7.29	9	10	0	0	0	0	1	Negative	Normal
10 (DC)	30 + 1	1200	7.30	6	8	2	II	0	I[§]	8	Negative	Normal
11 (DC)	29 + 6	1240	7.33	10	9	1	I	0	0	19	Negative	Normal
12 (MC)	29 + 3	1230	7.27	8	8	0	0	0	0	4	Candida	Normal
13 (DC)	30 + 2	1585	7.17	6	8	0	0	0	0	5	Negative	Normal

RDS = respiratory distress syndrome; IVH = intraventricular haemorrhage; PVL = periventricular leucomalacia; NICU = neonatal intensive care unit. DC = dichorionic, MC = monochorionic.
* Only the outcome of the affected twin has been reported.
§ Flaring.

Bayley Mental Developmental Index, the Non-Verbal Developmental Index and the Psychomotor Developmental Index were determined according to the Dutch norms for the Bayley Scales.[14] From these investigations a developmental age (in months) was determined. For the infants born between 30 and 34 weeks, the follow up was performed by the referring physician during regular follow up visits and expressed as normal or abnormal.

Statistical analysis was performed with Graph Pad Prism version 3.00 for Windows (Graph Pad Software, San Diego CA).

RESULTS

During the study period, obstetric and neonatal outcomes of 22 493 singleton and 878 multiple pregnancies were recorded in the database. Thirty-nine cases with UCP were identified (0.17%). Out of these, 13 cases (five singletons and eight first twins) fulfilled the inclusion criteria. The incidence of UCP following PPROM was one in 1797 pregnancies (0.05%) and one in 16 pregnancies with PPROM before 34 weeks (7.0%). The characteristics of the study population are displayed in Table 1.

Among the five singleton pregnancies, the median gestational age at PPROM was 28 weeks + 3 days (range 25 + 5–34 weeks). The median interval between PPROM and UCP was 5 days, ranging from 0 to 7 days; the median interval between UCP and delivery was 60 minutes (range: 15–240). Caesarean section was performed in 4/5 singleton pregnancies (80%) and breech extraction was performed in one case due to the cervix already being fully dilated and an eminent delivery (case 5).

Among the eight twin pregnancies, the median gestational age at PPROM was 29 weeks + 4 days (range 24–33 + 5 weeks). The median interval between PPROM and UCP was 2 days, with a range of 0–15 days; the interval between UCP diagnosis and delivery ranged from 10 to 720 minutes, with a median of 150 minutes. In 6/8 pregnancies (75%), a caesarean section was performed. The remaining two patients had a vaginal delivery because the first twin was fully engaged at the time of diagnosis (cases 7 and 11). In one of these cases, the delivery was intentiously delayed for the second twin (case 7).

The reasons for a delay of >30 minutes between UCP and delivery were reviewed. In two cases, the UCP occurred at home and the interval between UCP and hospital admission was long (cases 4 and 13). In other cases (2, 3, 6, 8 and 12) the physician delayed the caesarean section due to an acceptable FHR pattern. In one twin pregnancy (case 10) the delay was the consequence of a wrong diagnosis of intrauterine death due to the absence of cord pulsation and inaudible heart beat of the engaged first twin. Diagnosis of a still viable fetus was confirmed by color ultrasound only 6 hours later. In case 7, expectant management was carried out due to extreme prematurity.

The neonatal outcome of the study population is shown in Table 2. One fetus was not resuscitated due to extreme prematurity and prolonged bradycardia and died immediately after birth (case 7). The median umbilical pH of all surviving newborns was 7.29 (range: 7.13–7.30) in singleton and 7.29 (range: 7.17–7.33) in twin pregnancies. The 5-minute Apgar score was <7 in 1 of 12 surviving neonates (8.3%). Umbilical artery blood pH was <7.20 in 2/12 newborns (16.6%).

When the analysis was restricted to cases with a UCP-to-delivery interval >30 minutes ($n = 9$), none of the neonates had a 5-minute Apgar score <7 and umbilical artery blood pH was <7.20 in only one out of those nine cases (11.1%).

Overall, there was no neonate with IVH > grade II, RDS > grade II or PVL other than flaring. Three neonates were characterised by positive blood cultures (cases 5, 8 and 12); however, there were no severe clinical symptoms of sepsis in those infants.

The developmental outcome of all infants at two years of age was normal. The developmental age for the infants born between 25 and 30 weeks ranged between 22 and 26 months with a mean gestational age of 23.5 months. All infants born between 30 and 34 weeks developed normally.

DISCUSSION

Prolonged UCP at early gestational age (<34 weeks) without active labour does not seem to be associated with severe asphyxia or impaired neonatal outcome in our series.

Previous studies suggest that the time from UCP diagnosis to delivery is a critical determinant of neonatal outcome. Most of these investigations did not address the issue of UCP following PPROM without uterine activity but included data deriving from UCP during both preterm and term labour. In most cases described in our study, expectant management was not a standard procedure, or even worse, part of mismanagement. Usually, these cases are underreported in the literature.

Our findings are in agreement with some case reports and observational studies.[4,15] In two previous case reports, a conservative management of UCP was described in three very preterm pregnancies (23 + 2, 23 + 4 and 25 + 4 weeks, respectively), with the longest interval from diagnosis to delivery of up to 3 days.[15,16] None of these newborns developed severe asphyxia. Murphy and MacKenzie[3] conclude in their retrospective study on 132 cases with UCP that the neonatal condition was not influenced by the diagnosis-to-delivery interval, provided that women were already admitted to a perinatal centre. Neonatal mortality was mainly attributable to congenital anomalies and prematurity rather than to asphyxia. Similarly, Prabulos and Philipson[17] analysed a mixed group of either 'frank' or 'occult' UCP and could not find a correlation between the diagnosis-to-delivery interval and the degree of asphyxia.

However, all five cases with severe asphyxia, who had a short diagnosis-to-delivery interval (mean 11 minutes), had a gestational age >36 weeks and 'frank' UCP.

In our series with pregnancies <34 weeks without active labour, the immediate and long term outcome of a pregnancy with UCP outside the vulva up to 6 hours was normal. In most of the cases with prolonged UCP, the FHR pattern remained normal although no specific maneuvers were performed to reduce cord compression other than a Trendelenburg position. In patients with PPROM and 'occult' UCP, the time of diagnosis is not necessarily the time of occurrence and thus the diagnosis-to-delivery interval could even be under-estimated.

One possible explanation of the low incidence of mortality and morbidity in our series might be that UCP without active labour is not necessarily associated with umbilical cord compression and severe fetal haemodynamic changes. Umbilical cord in preterm pregnancies might be less susceptible to compressive insults, compared with term gestation. The physical properties of the cord influencing the vulnerability to vascular occlusion include the vascular coiling and the cord hyaluronan content. Interestingly, Raio *et al.*[18,19] showed that the hyaluronan content and the degree of vascular coiling of umbilical cord both decrease with advancing gestational age. Hyaluronan is a major component of Wharton jelly, which, due to its biophysical and hydrophilic properties, influences tissue biomechanics. The lack of uterine contractions, combined with these features of premature umbilical cord, might have contributed to the favourable outcomes in our study group.

The restricted number of cases and the heterogeneity of clinical characteristics of the study population do not yet allow firm conclusions with regard to clinical management or outcome.

To our opinion, in cases with UCP and gestational age of >25 weeks, an active management is still mandatory.

However, our results can be of use for pregnancies at early gestational age and either PPROM or intact membranes and a high risk of UCP. In these patients, the option to prolong pregnancy might be considered, provided that intense surveillance can be achieved. Enhancing lung maturation and avoiding complications of early preterm birth might outweigh the potential risks of birth asphyxia following PPROM and UCP.

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