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Ghosh, Gisela; Marsal, Karel; Gudmundsson, Saemundur

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ORIGINAL ARTICLE

Amniotic fluid index in low-risk pregnancy as an admission test to the labor ward

GISELA GHOSH, KAREL MARSÁL AND SAEMUNDUR GUDMUNDSSON

From the Department of Obstetrics and Gynecology, University Hospital MAS, Malmö, Sweden

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Background. Oligohydramnios has been shown to be a predictor of intrapartal fetal distress. In a selected group of low-risk pregnancies, however, it has not yet been established that oligohydramnios contributes to intrapartal fetal distress.
Methods. Ultrasonically estimated four-quadrant amniotic fluid index as a test for admission to the labor ward was evaluated as a predictive factor for fetal distress during labor in a prospective 'blind' study comprising 600 low-risk pregnancies. Oligohydramnios was defined as an amniotic fluid index ≤50 mm. The parturients were divided into two groups according to the status of the fetal membranes. The amniotic fluid index results were correlated to fetal outcome: Apgar score at 1 and 5 min, pH of blood in umbilical artery and vein, operative delivery because of fetal distress, cesarean delivery because of fetal distress, and number of babies referred to the neonatal intensive care unit.
Results. Two-hundred and sixty-seven women had ruptured membranes. Among these a significant increase in operative delivery because of fetal distress was seen in cases of oligohydramnios compared with the normal amount of amniotic fluid (odds ratio 3.86, confidence interval = 1.25–11.9). No significant differences were seen regarding other variables of perinatal outcome. The group with intact membranes comprised 333 parturients. Among these, no significant differences in perinatal outcome could be seen in relationship to the amniotic fluid index, although a 50% increase in emergency operations for fetal distress was seen in women with oligohydramnios. A significant correlation might have been evident even in that group if a larger sample had been studied.
Conclusion. The results indicate that measurement of the amniotic fluid index in low-risk pregnant women admitted for labor might identify parturients with an increased risk of intrapartal fetal distress.

Key words: amniotic fluid index, distress, labor, low-risk pregnancy, oligohydramnios

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Amniotic fluid index (AFI), a semiquantitative ultrasound measure used to denote the volume of amniotic fluid, was first described in 1987 by Phelan *et al.* (1). Many studies have shown an increased risk of intrapartal fetal distress in parturient women with oligohydramnios (OH), as identified by ultrasound examination (2–5). The exact pathophysiologic mechanism of OH has not been defined, but one likely explanation is an increased risk of umbilical cord compression during uterine contractions.

Most studies on OH have been conducted on high-risk pregnancies (6–8). To our knowledge, no study using AFI in labor has been made exclusively on low-risk pregnancies to predict perinatal outcome.

The purpose of the present study was to evaluate AFI as an admission test to the labor ward for

predicting intrapartal fetal distress in women with a low-risk pregnancy.

Materials and methods

The study population consisted of low-risk pregnant women admitted to the labor ward at the University Hospital in Malmö with either contractions, rupture of the fetal membranes, or for induction of labor. All pregnancies were dated by ultrasound before 20 gestational weeks. Parturients were selected according to the following criteria: (1) previously normal singleton pregnancy, (2) term pregnancy (37 + 0–41 + 6 gestational weeks), and (3) cephalic presentation. Those excluded fulfilled any of the following criteria: (1) AFI measured earlier during pregnancy, (2) known fetal malformation, (3) or, in cases of ruptured membranes, more than 24 h between measurement of AFI and delivery. The managing obstetrician or the midwife was not informed of the AFI results.

The AFI was obtained with a Hitachi EUB 400 ultrasound scanner (Hitachi Medical Corporation, Tarrytown, NY, USA) with an 3.5-MHz linear transducer. With the patient lying supine, the transducer was placed along the longitudinal axis perpendicular to the floor, as described by Phelan *et al*. (1), and the pocket of amniotic fluid with the deepest vertical dimension was identified and measured in millimeters. This procedure was repeated in each of the uterine quadrants, and the values were summed to determine the AFI. Pockets containing both umbilical cord and amniotic fluid were excluded. Oligohydramnios was defined as an

Table I. Maternal variables according to the status of the fetal membranes and amniotic fluid index

	Ruptured membranes		Intact membranes	
	AFI ≤ 50 mm	AFI > 50 mm	AFI ≤ 50 mm	AFI > 50 mm
Number of parturients	66	201	49	284
Gestational Age (days)				
Mean	278	277	283	280
SD	9	8	7	14
Weight deviation				
Mean	− 1.5	0.73	− 2.9	0.68
% SD	12	12	10	12
Nulliparas (*n*)	41	124	26	134
Multiparas (*n*)	25	77	23	150
Preeclampsia	2	5	1	9
Diabetes	1	2	0	3
Bleeding during pregnancy	0	7	0	2
IUGR	0	1	0	2

Weight deviation = difference between birthweight and expected gestational age related weight as a percentage; diabetes = diabetes mellitus and gestational diabetes; IUGR = intra-uterine growth retardation; AFI = amniotic fluid index; SD, standard deviation.

Table II. Perinatal outcome according to the amniotic fluid index in parturients with ruptured membranes

	AFI ≤ 50 mm *n* (%)	AFI > 50 mm *n* (%)	Significance of difference
Number of parturients	66	201	
ODFD	7 (10.6)	6 (3.0)	$p = 0.02$
CS for fetal distress	2 (3.0)	1 (0.5)	NS
Apgar score at 1 min < 7	4 (6.1)	6 (3.0)	NS
Apgar score at 5 min < 7	1 (1.5)	3 (1.5)	NS
pH umbilical artery < 7.10	4 (11.4)	4 (3.4)	NS
pH umbilical vein < 7.20	9 (14.3) of 63 patients	14 (7.4) of 118 patients	NS
Admission to NICU	3 (4.5)	4 (2.0)	NS
NICU (day)			
Median	0	0	NS
Range	0–5	0–16	

ODFD = operative delivery for fetal distress; CS = cesarean section; NICU = neonatal intensive care unit; AFI = amniotic fluid index; SD, standard deviation.

AFI of 50 mm or less. All measurements were made by the same examiner (G.G.), who did not participate in work at the labor ward at that time. At the time of measurement, the status of the fetal membranes and the dilation of the cervix were noted. Informed consent was obtained from all women before they were included in the study.

The AFI was correlated to perinatal outcome based on the Apgar score, umbilical cord blood pH (obtained in 566), birthweight, frequency of cesarean section for fetal distress, operative delivery for fetal distress (ODFD) including both cesarean section, vaginal forceps, and ventous extractions, and referral to the neonatal intensive care unit (NICU). Fisher's exact test was used for statistical evaluation. $P < 0.05$ was considered statistically significant. The computer program 'nQuary Advisor Release 3' (Statistical Solutions Ltd, Cork, Ireland) was used to calculate the sample size needed in order to obtain significance levels at $p < 0.05$ and 0.01 with 90% confidence intervals (CI).

Results

During a 12-month period, 600 women were included in the study. They were divided into two subgroups according to the status of the fetal membranes. The membranes were found to be ruptured at the time of the examination in 267 (44.5%) women; 66 (24.7%) had OH. The membranes were intact in 333 (55.5%); 49 (14.7%) had OH. Table I shows the maternal variables of the two groups.

The median interval between the ultrasound examination and delivery was 6 h (range 0–24 h) in the group with ruptured membranes and 6 h (range 0–70 h) in those with intact membranes.

In the group with ruptured membranes there was a significant difference in the frequency of ODFD between the parturients with OH and those with a normal volume of amniotic fluid [10.6% and 3.0%, respectively, $p < 0.02$, OR 3.86 (range 1.34–1.11)]. No significant differences were found regarding the other variables of perinatal outcome (Table II).

In the group with intact membranes, there was a 50% increased risk of ODFD (OR 1.5), though nonsignificant (CI 0.48–4.63) (Table III).

Discussion

The results of the present study suggest that oligohydramnios after rupture of the membranes in low-risk pregnancies is associated with a nearly four-fold increased risk of ODFD. An ultrasound examination of AFI could thus identify those who may need intensified fetal surveillance during labor.

In the present study there was a 50% increased risk of ODFD in parturients with oligohydramnios and intact membranes. No comparable study was available in the literature when the study was designed. Teoh *et al.* (9) studied 120 pregnancies as an admission study in early labor with intact membranes. The frequency of OH (AFI < 5 cm) in their study was 22%, and ODFD frequency among these was 27%. Based on these data, a sample size of 100 would be sufficient. We chose, however, three times that size, as the low-risk status of their population was uncertain. The results in the present study were, however, different. The sample size needed to obtain a significance of $p < 0.05$ with 90% CI was calculated to be 1600, and 2500 pregnancies for $p < 0.01$. The difference in results might be explained by the relative high frequency of OH in the present study in the cases with intact membranes. The low-risk status of our study group might also have reduced the need for ODFD. With a larger sample

Table III. Perinatal outcome according to the amniotic fluid index (AFI) in parturients with intact membranes

	AFI ≤ 50 mm *n* (%)	AFI > 50 mm *n* (%)	Significance of difference
Number of parturients	49	284	
ODFD	4 (8.2)	16 (15.6)	NS
CS for fetal distress	1 (2.0)	4 (1.4)	NS
Apgar score at 1 min < 7	2 (4.1)	6 (2.1)	NS
Apgar score at 5 min < 7	1 (0.0)	2 (0.7)	NS
pH umbilical artery < 7.10	3 (12.0)	9 (5.5)	NS
pH umbilical vein < 7.20	3 (6.8) of 44 patients	27 (10.0) of 271 patients	NS
Admission to NICU	0 (0.0)	4 (1.4)	NS
NICU (day)			
Median	0	0	
Range	0–0	0–15	

ODFD = operative delivery for fetal distress; CS = cesarean section; NICU = neonatal intensive care unit; AFI = amniotic fluid index.

size, our method might thus prove valuable even in low-risk pregnancies and intact membranes.

The present study was performed on a selected group of women with low-risk pregnancy. As AFI is one of the parameters checked in high-risk pregnancies at our hospital, these parturients were excluded in order to make the study 'blind'. By adding high-risk pregnancies, a much smaller sample size would be needed. The frequency of OH in cases with intact membranes was unexpectedly high: 15% instead of 5% in the controls. Although our pregnancies were low-risk, a few showed signs of pregnancy complications on admission to the labor ward (Table I), which might explain the higher frequency of OH in this group. Although there was a significant correlation between ODFD and OH in cases of ruptured membrane (Table II), sensitivity was low (11%), and false-positive and negative rates were 46% and 23%, respectively. Thus the knowledge of OH in these low-risk pregnancies did not cause any immediate action, only more intense surveillance during labor.

The pathophysiology of OH before membrane rupture is unclear. One theory is that a reduced perfusion of the placenta causes hypovolemia in the fetus, and/or an automatic redistribution of fetal blood volume to vital organs with a resultant reduced blood supply to the kidneys. This in turn could lead to reduced production of urine, and thus reduce the volume of amniotic fluid. Bar-Hava *et al*. (10) studied signs of redistribution, renal blood flow, and signs of OH, but could find no correlation. There was no change in the renal artery pulsatility index.

Oligohydramnios in labor after the rupture of membranes in a low-risk pregnancy is probably not caused by a reduced perfusion of the placenta, but is more probably caused by the loss of large amounts of amniotic fluid at the time of the rupture. One explanation for the significantly increased risk of ODFD in the group with ruptured membranes might be that there is an increased risk of the umbilical cord becoming trapped in an adverse position, at the time of the rupture, if a large amount of amniotic fluid is lost. Amnioinfusion (11) may be a way to treat such cases in order to restore the volume of amniotic fluid and reduce the risk of compression of the umbilical cord, thus averting the need for ODFD.

The conclusion drawn from our study is that an ultrasound examination, including measurement of AFI as an admission test for women presenting at the labor ward with ruptured membranes after an uneventful pregnancy, could help identify those with an increased risk of intrapartal fetal distress, namely those with OH. Measuring AFI in low-risk pregnancies on admission to the labor ward might detect cases needing special surveillance.

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Address for correspondence:
Gisela Ghosh
Department of Obstetrics and Gynecology
Malmö University Hospital
SE-205 02 Malmö
Sweden
e-mail: Gisela.Ghosh@telia.com