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Intrapartum Sonographic Measurement of Amniotic Fluid Volume for Prediction of Poor Fetal Outcomes in Low Risk Pregnancy

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ABSTRACT

Objective: To determine the diagnostic value of intrapartum amniotic fluid volume, with single deepest pocket (SDP) technique, for prediction of poor fetal outcomes in low risk pregnancy.

Materials and Methods: A cross-sectional study was conducted on 454 low risk singleton term pregnancies who delivered from April 2012–August 2012 at Ramathibodi Hospital. Ultrasonography estimated SDP was performed as an admission test and then continuous intrapartum electronic fetal monitoring (EFM) was done. Oligohydramnios was defined as a SDP ≤ 2.0 cm. The criteria for diagnosis of poor fetal outcomes were Apgar score at 5 minute ≤ 7, meconium stained amniotic fluid, abnormal EFM and neonatal intensive care unit (NICU) admission.

Results: A total 454 low risk singleton pregnancies was enrolled. Thirty eight cases (8.4%) were diagnosed as oligohydramnios by SDP technique and 19 cases of these had poor fetal outcomes. The sensitivity, specificity, negative predictive value (NPV) and positive predictive value (PPV) of SDP ≤ 2.0 cm for prediction of poor fetal outcomes were 20.9%, 94.8%, 82.7%, and 50.0%, respectively. After subgroup analysis, the sensitivity and specificity of oligohydramnios for prediction of meconium stained amniotic fluid was 25.4%, 94.2% and abnormal EFM was 25.0%, 92.9%, respectively. The relative risk of oligohydramnios with meconium stained amniotic fluid and abnormal EFM were 3.7 (95% CI; 2.3, 6.0) and 3.6 (95%CI; 1.7, 7.5), respectively. However, the significance of low Apgar score at 5 minute and NICU admission could not be evaluated due to low incidence.

Conclusion: The intrapartum assessment of oligohydramnios by SDP ≤ 2.0 cm had high specificity for prediction of poor fetal outcomes and also was associated with increased risk of meconium stained amniotic fluid and abnormal EFM.

Keywords: single deepest pocket, amniotic fluid volume measurement, intrapartum, poor fetal outcomes

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Introduction

Assessment of fetal well-being is an important part at antepartum and intrapartum period because these assessment lead to the proper intrapartum care. The evaluation of amniotic fluid volume (AFV) is one of the parameters for surveillance of pregnancy. Decrease of amniotic fluid, in other word oligohydramnios, correlates with increase risk of umbilical cord compression, fetal growth restriction, delivery with meconium stained amniotic fluid, fetal malformation and stillbirth[1]. Amniotic fluid assessment could be measured by many methods for evaluation. The most common techniques are amniotic fluid index (AFI) and single deepest pocket (SDP) technique which is used in biophysical profiles test. In addition, the others are two-pocket technique and subjective assessment, which are less in details and accuracy[2]. These measurements of amniotic fluid volume were used in the part of fetal well-being evaluation[3].

From the previous study, AFI and SDP showed a high correlation for assessment of AFV in high risk pregnancy and oligohydramnios (AFI < 5 cm) had more perinatal morbidity than the normal AFI[4]. Decrease of AFV at antepartum or intrapartum period, which was assessed by AFI technique, was associated with adverse fetal outcomes[5-7]. Magann, et al and Nabhan, et al showed that SDP assessment of AFV in antepartum period seemed to be the better choice than AFI in low risk pregnancy[8,9]. These studies showed AFI increased the detection of oligohydramnios and induction of labor without improvement of fetal outcomes in peripartum period, compared with SDP. Then, intrapartum SDP measurement should be the good predictor for poor fetal outcomes. The purpose of this study was to evaluate intrapartum SDP for predicting poor fetal outcomes in low risk pregnancy.

Materials and Methods

This is a cross sectional study, between April and August, 2012. This study was approved by the Committee on Human Rights Related to Research Involving Human Subjects of Faculty of Medicine Ramathibodi Hospital, Mahidol University. The study population consisted of term singleton, low risk pregnant women who admitted at the labor ward of Ramathibodi Hospital. These pregnant women were followed up regularly at antenatal care unit. Screening ultrasonography at second trimester was done for evaluation of fetal anomaly and confirmation of gestational age. The patients were selected by the following criteria: (1) term singleton pregnancy (GA 37-42 weeks by ultrasonography), (2) in active phase of labor (starting at cervical dilatation 3 cm onward with regular uterine contractions and plan to deliver within 12 hours after admission), (3) intact amniotic membrane (diagnosed by no history of leakage or proved by insertion of speculum showing no vaginal pooling and negative cough test), (4) cephalic presentation, (5) no maternal underlying diseases; such as hypertension or diabetes mellitus, (6) no fetal anomaly (screening by second trimester ultrasonography). The exclusion criteria were prolapsed of umbilical cord, placental abruption, placenta previa and unwilling to participate. Poor fetal outcomes were defined as: (1) Apgar score at 5 minute less than or equal to 7, (2) abnormal EFM in category II or III from NICHD (National Institute of Child Health and Human Development) 2008 guideline for fetal monitoring[10], (3) delivery with meconium stained amniotic fluid, (4) admission at NICU within 24 hours after delivery. The Apgar score was assessed by pediatrician and obstetrician who were calibrated by using Apgar scoring system[11]. On admission, inform consent was obtained from every woman who agreed to participate in this study.

The total sample size was 454 pregnant women, calculated by using estimate single proportion. Probability of error was 0.10 and probability of expected sensitivity was 0.72. The power to detect a clinically significant in poor fetal outcomes was 0.8 from a previous study[12].

The ultrasound machine was Voluson, E8 model (GE®). With the patient lying supine, the ultrasonographic transducer was placed at maternal abdominal wall to identify the deepest pocket of amniotic fluid in vertical

measure in centimeter. The pockets with both umbilical cord and amniotic fluid present were excluded. Oligohydramnios was defined as SDP ≤ 2 cm. The first author (PN) who received training ultrasound technique by maternal fetal medicine staffs performed the measurement. Examiner did not participate at the labor ward during the study. The attending obstetricians or the midwives were not informed of the SDP results. At the labor ward, intrapartum monitoring was applied by using continuous electronic fetal monitoring. Assessments of EFM criteria were evaluated by NICHD 2008 classification[10]. Maternal characteristics, ultrasonographic data, labor and fetal outcomes were documented.

Sensitivity, specificity, negative predictive value (NPV) and positive predictive value (PPV) of the SDP for prediction of poor fetal outcomes were calculated. Subgroup analysis for each poor fetal outcome was also evaluated. The correlation of oligohydramnios (SDP ≤ 2) and poor fetal outcomes was demonstrated by relative risk ratio.

Results

Total of 454 term, low risk, singleton pregnant women in the active phase of labor and intact membranes were enrolled.

Most of the study cases were nulliparous (63%), and below 35 years old (85.5%) as shown in Table 1. By using SDP measurement, 38 cases (8.4%) were oligohydramnios, and 416 cases (91.6%) were normal AFV. Total normal fetal outcomes were 363 cases (80.0%) and poor fetal outcomes were 91 cases (20.0%). The accuracy of oligohydramnios which detected by SDP technique to predict poor fetal outcomes was shown in Table 2. Poor fetal outcomes were categorized in 4 groups for calculating the correlation of oligohydramnios by SDP technique. The poor fetal outcomes (91 cases), one neonate might have more than one poor fetal outcome, composed of delivery with meconium stained amniotic fluid (59 events), abnormal EFM from NIHCD 2008 (33 events), Apgar score ≤ 7 at 5 minute (1 event) and admission to NICU within 24 hours after delivery (3 events). For NICU admission, 1 case was in oligohydramnios group and the other 2 cases were in normal amniotic fluid. The two cases of normal amniotic fluid were diagnosed as a small heart defect and got medical treatment. The case of oligohydramnios who admitted in NICU was term fetus with zero SDP and was delivered by caesarean section due to prolonged deceleration of fetal heart rate. There was no neonate who delivered with low Apgar score in the oligohydramnios group. The normal amniotic fluid (SDP > 2 cm) had 72 events of poor fetal outcomes and oligohydramnios (SDP ≤ 2 cm) had 24 events of poor fetal outcomes. The correlation and relative risk of poor fetal outcomes in details of normal amniotic fluid and oligohydramnios group were shown in Table 3.

Table 1. Maternal and neonatal demographic data

Characteristics		Numbers (%)
Maternal age (yr):	< 35	388 (85.5%)
	≥ 35	66 (14.5%)
Parity:	Nulliparous	286 (63%)
	Multiparous	168 (37%)
Gestational age (weeks): Median (25,75 percentile)		39 (38,41)
Birth weight (g): Mean (±SD)		3,146 (±360.8)

Table 2. Diagnostic accuracy of single deepest pocket to predict poor fetal outcomes

	Poor fetal outcomes (N = 91 cases)	Normal outcome (N = 363 cases)
Oligohydramnios (SDP ≤ 2cm)	19	19
Normal amniotic fluid (SDP > 2 cm)	72	344

Sensitivity: 20.9% (95% confidence interval, 17.3-24.8)

Specificity: 94.8% (95% confidence interval, 92.7-96.8)

Positive predictive value (PPV): 50.0% (95% confidence interval, 45.4-54.6)

Negative predictive value (NPV): 82.7% (95% confidence interval, 79.4-86.3)

Table 3. Correlation of poor fetal outcomes (events) in normal amniotic fluid and oligohydramnios

Poor fetal outcomes*	Normal amniotic fluid SDP > 2 cm (N = 72 events)	Oligohydramnios SDP ≤ 2 cm (N = 24 events)
Meconium stained amniotic fluid	44	15
Abnormal EFM	25	8
NICU admission	2	1
Low Apgar score (Apgar ≤ 7 at 5 minute)	1	0

* 1 case might have more than one poor fetal outcome (events)

EFM = Electronic fetal monitoring

NICU = Neonatal intensive care unit

The relative risk (RR) for delivery with meconium stained amniotic fluid was 3.7 (95% CI; 2.3, 6.0) and abnormal EFM was 3.6 (95% CI; 1.7, 7.5). The RR for NICU admission was not statistical significant due to low event rate. The sensitivity, specificity, NPV and PPV of oligohydramnios (SDP ≤ 2 cm) for prediction of labor with meconium stain were 25.4%, 94.2%, 89.4%, and 39.5%, respectively. For abnormal EFM were 25.0%, 92.9%, 94.2%, and 21.1%, respectively. For NICU admission were 33.3%, 91.8%, 99.5% and 2.6%, respectively. The calculation for low Apgar score could not be done because there was no case in the oligohydramnios group, as shown in Table 4.

Table 4. Predictive values of SDP measurement forpoor fetal outcomes. (events)

Poor fetal outcomes	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
Meconium stained amniotic fluid	94.0% (91.0 – 96.1)	20.3% (11.8 – 31.2)	39.4% (24.0-56.6)	85.8% (82.1-89.0)
Abnormal EFM	92.9% (90.0 – 95.2)	25.0% (11.5 – 43.4)	21.1% (9.6-37.3)	94.2% (91.5-96.2)
NICU admission	91.8% (88.9 – 94.2)	33.3% (5.5- 88.5)	2.6% (0.4-13.9)	99.5% (98.3-99.9)
Apgar score ≤ 7 at 5 minute	91.6% (88.7–94.0)	NE	NE	99.8% (99.3-100)

PPV= Positive predictive value, NPV= Negative predictive value, SDP= Single deepest pocket, EFM= Electronic fetal monitoring, NICU= Neonatal intensive care unit, NE = Not evaluable

Discussion

Amniotic fluid measurement is a test to evaluate fetal well-being. Detection of oligohydramnios (AFI technique) in antepartum period is significantly associated with an abnormal fetal heart rate monitoring and increased the rate of cesarean section for fetal distress[7].

In a previous meta-analysis study compared the use of AFI with SDP measurement in antepartum period for the assessment of fetal well-being showed that SDP was better than AFI[9]. AFI increases the detection of oligohydramnios and the rate of induction of labor without improvement of poor fetal outcomes. Due to the dynamicity of the AFV, intrapartum measurement should represent the actual AFV than antepartum measurement.

This study was done during intrapartum period in active phase of labor which showed the actual AFV and the use of SDP technique to detect oligohydramnios. The result showed the incidence of oligohydramnios detected by SDP measurement was 38 cases (8.4%) and half of them showed poor fetal outcomes. We found that oligohydramnios which was detected by SDP technique had high specificity and negative predictive value to predict poor fetal outcomes. In subgroup analysis, there was a significant correlation of the oligohydramnios and poor fetal outcomes (increase relative risk of delivery with meconium stained amniotic fliud and abnormal EFM). Therefore, intrapartum management of the patient who has SDP ≤ 2cm should be monitored closely to prevent poor fetal outcomes. (How? Give some example. By the way, the RR of SDP < 2 cm was not significant in low Apgar score and NICU admission that were the stronger poor fetal outcomes.) On the other hand, our results could not detect the association between oligohydramnios with NICU admission and low Apgar score. Our data recorded 3 cases admitted in NICU after delivery, 1 case of oligohydramnios and the other 2 cases of normal amniotic fluid. The two cases of normal amniotic fluid were diagnosed as a small heart defect and got medical treatment. The indication for admission in NICU of both of them was for close monitoring the neonatal conditions. The other case of oligohydramios who admitted in NICU was term fetus with zero SDP and was delivered by caesarean section due to prolonged deceleration of fetal heart rate. After delivered, the neonate had to observed respiration at NICU. Finally, all of them could be discharged within 1 week with no serious complication. There was no neonate who delivered with low Apgar score in the oligohydramnios group in our study.

Our study had a few limitations. Firstly, we could not find the correlation between oligohydramnios with

NICU admission and low Apgar score due to the low incidence of both adverse events. A larger sample size is required for further study. Secondly, there were 72 cases of normal amniotic fluid volume with poor fetal outcomes. These showed that the measurement of amniotic fluid volume with SDP technique alone might not be sensitive enough to detect all the poor fetal outcomes. In order to gain more accuracy for prediction of poor fetal outcomes, multiple tests should be applied. Finally, the relative risk of SDP ≤ 2 cm with meconium stained amniotic fluid or abnormal EFM may not be the true relative risk due to each of them are confounders[13].

Conclusion

Intrapartum oligohydramnios defined by SDP measurement ≤ 2 cm in low risk pregnancy showed high specificity and negative predictive value for predictionof poor fetal outcomes and increased risk of delivery fetus with meconium stained amniotic fluid and abnormal fetal monitoring.

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การวัดปริมาณน้ำคร่ำในระยะคลอดเพื่อทำนายผลการคลอดที่ไม่ดีของทารกในสตรีตั้งครรภ์ความเสี่ยงต่ำ

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วัตถุประสงค์ *: เพื่อศึกษาประโยชน์ของการวัดปริมาณน้ำคร่ำโดยวิธี Single deepest pocket (SDP) ในช่วงเข้าสู่การคลอด เพื่อทำนายผลการคลอดที่ไม่ดีของทารกในกลุ่มสตรีตั้งครรภ์ที่มีความเสี่ยงต่ำ*

วัสดุและวิธีการ*: การวิจัยแบบ Cross sectional study โดยทำในสตรีตั้งครรภ์ที่มีความเสี่ยงต่ำ จำนวน 454 คน ที่มาคลอดที่โรงพยาบาลรามาธิบดี ระหว่างเดือนเมษายน 2012 จนถึงเดือนสิงหาคม 2012 เมื่อคนไข้เข้ารับการรักษาภายในห้องคลอดจะมีการตรวจวัดปริมาณน้ำคร่ำด้วยคลื่นเสียงความถี่สูงโดยวิธี SDP หลังจากนั้นจะมีการทดสอบสุขภาพของทารกในครรภ์โดยการวัดอัตราการเต้นหัวใจของทารก และการบีบตัวของมดลูกในระยะรอคลอด ปริมาณน้ำคร่ำน้อยวินิจฉัยจากค่า SDP ≤ 2.0 เซนติเมตร ผลการคลอดที่ไม่ดีคือ การคลอดที่มีขี้เทาปนในน้ำคร่ำ ความผิดปกติของการเต้นของหัวใจทารกในครรภ์ คะแนน Apgar ที่นาทีที่ 5 ≤ 7 หรือการที่ทารกต้องเข้ารับการดูแลที่หออภิบาลทารกแรกเกิดภายใน 24 ชั่วโมงแรกหลังคลอด*

ผลการวิจัย*: สตรีตั้งครรภ์ที่เข้าร่วมการวิจัยทั้งหมด 454 คน ตรวจพบว่ามีปริมาณน้ำคร่ำน้อย โดยวิธี SDP 38 คน (ร้อยละ 8.4) และมี 19 คนที่พบว่ามีผลการคลอดไม่ดี ปริมาณน้ำคร่ำน้อยมี ความไว (sensitivity) ความจำเพาะ (specificity) ค่าพยากรณ์ลบ (negative predictive value) และค่าพยากรณ์บวก (positive predictive value) ในการทำนายผลการคลอดที่ไม่ดีเท่ากับร้อยละ 20.9, 94.8, 82.7 และ 50.0 ตามลำดับ เมื่อคำนวณผลการคลอดที่ไม่ดีในแต่ละกลุ่มพบว่า ความไวและความจำเพาะในการทำนายการคลอดที่มีขี้เทาปนในน้ำคร่ำเท่ากับร้อยละ 25.4 และ 94.2 ตามลำดับ ความผิดปกติของอัตราการเต้นหัวใจของทารกเท่ากับร้อยละ 25 และ 92.9 ตามลำดับ กลุ่มที่มีน้ำคร่ำน้อยเพิ่มความเสี่ยงของการคลอดที่มีขี้เทาปนในน้ำคร่ำและอัตราการเต้นหัวใจของทารกผิดปกติเป็น 3.7 เท่า (95% CI; 2.3, 6.0) และ 3.6 เท่า (95%CI; 1.7, 7.5) ตามลำดับ แต่ไม่พบความเสี่ยงที่สำคัญทางสถิติต่อคะแนน Apgar ที่นาทีที่ 5 มีค่า ≤ 7 และการรับทารกเข้าดูแลที่หออภิบาลทารกแรกเกิดภายใน 24 ชั่วโมงแรกหลังคลอด เนื่องจากมีอุบัติการณ์น้อย*

สรุป*: การประเมินปริมาณน้ำคร่ำน้อยในช่วงเข้าสู่การคลอดโดยวิธี SDP ที่มีค่าน้อยกว่าหรือเท่ากับ 2 เซนติเมตรพบว่ามีความจำเพาะสูงต่อการทำนายผลการคลอดที่ไม่ดีของทารกและเพิ่มความเสี่ยงของการคลอดที่มีขี้เทาปนในน้ำคร่ำและอัตราการเต้นหัวใจของทารกที่ผิดปกติ*