Value of Middle Cerebral Artery Doppler Study and Amniotic Fluid Index in Prediction of Perinatal Outcome of Prolonged Pregnancies

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Introduction

A prolonged pregnancy is defined as a pregnancy that lasts more than 42 weeks (294 days or more from the first day of the last menstrual period). The International Statistical Classification of Diseases and Related Health Problems (ICD-10) from 2015 uses the term ‘a prolonged pregnancy’, which traverses a post-term gestation. A post-term fetus is determined as a fetus during gestation lasting full 42 weeks or more (294 days or more from the beginning day of the last menstrual period) [1].

The incidence of prolonged pregnancy ranges from 4% to 19% [2]. Mac-Dorman and Kirmeyer reported increased perinatal mortality rate if pregnancy exceeded 41 weeks [2]. Children born after prolonged pregnancies have more developmental abnormalities compared with those born before 42 weeks. The problems of prolonged pregnancy can be decreased by routine antepartum fetal surveillance prior to the onset of spontaneous labor.

Approximately 20% of post-term fetuses have chronic intrauterine growth restriction from uteroplacental insufficiency [3].

A safe limit for continuation of pregnancy beyond the expected date of delivery cannot be established. Doppler sonography provides a unique opportunity to investigate human fetal hemodynamics and to use these findings for fetal surveillance. A large experience with this technique has been reported with respect to the prediction of the fetus at risk of developing IUGR, antepartum and intrapartum fetal asphyxia, and neonatal morbidity [4]. Several studies indicated that Doppler indices may be powerful predictors of adverse perinatal outcome in complicated pregnancies [5].

The middle cerebral artery is the most studied cerebral artery because: It is easy to sample, it provides information on the cerebral blood flow in normal and IUGR fetuses, it can be sampled at an angle of 0° between the ultrasound beam and the direction of...

Abstract

Objective: To assess the role of fetal middle cerebral artery Doppler and amniotic fluid index in uncomplicated prolonged pregnancies for the prediction of perinatal outcome.

Design: Prospective observational study

Setting: Tanta University Hospital and Miniat Elnasr Hospital.

Methods: All cases (50) were prolonged pregnancy, they were subjected to complete history taking, clinical and ultrasound exam to find out the amniotic fluid index (AFI) and middle cerebral artery (MCA) pulsatility index (PI) also and resistance index (RI). The outcomes of the MCA and AFI will be evaluated with respect to outcome of the infants and adverse perinatal outcome defined as: Meconium stained liquor, perinatal death, the need for emergency Cesarean delivery for fetal distress, Admission to the neonatal intensive care unit and Apgar scores at the first moment after birth.

Results: No statistically significant correlation between AFI, RI and PI versus different variables. The best cut off value for the three predictors and the sensitivity and specificity in predicting perinatal outcome. All the 3 markers considered were not valid and RI is considered the best of them. Conclusions: Both, AFI and middle cerebral artery Doppler RI and PI are not useful in predicting perinatal outcomes in normal postdated pregnancies. However, RI was considered the best one of them.

Keywords: Prolonged pregnancy, Postterm, Neonatal outcome
the blood flow. Therefore, for the middle cerebral artery we are able to determine angle-independent indices (the most used is the pulsatility index) and also the real velocity of blood flow [6].

The amniotic fluid volume increases steadily from approximately 200 ml at 16 weeks of gestation to 980 ml at 34 to 35 weeks of gestation, where after it decreases to approximately 800 ml at 40 weeks and 540 ml at 42 weeks [7].

Amniotic fluid index (AFI) is a sum of vertical measurements of the largest amniotic fluid pocket in each of four quadrants, dividing the uterus into upper and lower segments and with the linea nigra indicating the right and left halves. The measured pockets should not contain the umbilical cord. Oligohydramnios is then defined as an AFI less than 5.0 cm at term, and polyhydramnios as an AFI of 20 cm or greater [8].

The aim of this work is to assess the role of fetal middle cerebral artery Doppler and amniotic fluid index in uncomplicated prolonged pregnancies for the prediction of perinatal outcome.

**Patients and Methods**

This prospective observational study was conducted on 50 uncomplicated prolonged, pregnant patients from outpatient clinic and emergency room. Cases were recruited from the Obstetrics and Gynecology Departments of Tanta University Hospital and Mniat Elnasr Hospital. During the period from February 2017 to February 2018.

**The inclusion criteria are**

- Singleton living fetuses with vertex presentation. An accurate estimation of the gestational age (GA) was calculated from the first day of regular last menstrual cycle and confirmed or modified by an early ultrasound examination before 20 weeks gestation.

**The Exclusion criteria are**

- Cases with premature rupture of membranes.
- Antepartum hemorrhage.
- Maternal medical disorders as hypertension, diabetes mellitus, hepatic, cardiac, renal or anemia in pregnancy.
- Patients with a uterine scar will be excluded also.

**Methods**

After taking informed written consent the recruited patients will be subjected to the following: Careful and detailed history, complete clinical examination and ultrasound examination to determine the amniotic fluid index (AFI) and middle cerebral artery (MCA) pulsatility index (PI) also called the impedance index and resistance index (RI) also called the Proucelot ratio.

These patients will be divided into three groups according to Doppler parameters and amniotic fluid index as follows:

- **Group A**: ≤ 10th centile.
- **Group B**: > 10th centile and < 90th centile.
- **Group C**: ≥ 90th centile.

**Follow-up:**

The results of the MCA and AFI will be evaluated with respect to outcome of the infants and adverse perinatal outcome defined as:

- Meconium stained liquor.
- Perinatal death.
- The need for emergency Cesarean delivery for fetal distress.
- Admission to the neonatal intensive care unit.
- Apgar scores at the first minute.

**Statistical Analysis**

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 15 for Windows© (SPSS Inc, Chicago, IL, USA).

**Results**

The mean age of the patients was (26.1 ± 5), BMI was (80.7 ± 14), the average gestational age was 42.3 ± 06 years. The distribution of the studied group as regard parity shows that majority of cases was PG with average parity of P1.

The scattering of the studied group as regard AFI shows that the majority of cases were AFI from 4 to 12 with an average of 7.6 as shown in table 1.

The centile distribution of the middle cerebral artery resistance index (MCA RI) and middle cerebral artery pulsatility index (MCA PI) are summarized in shown tables 2 and 3.

The 10th centile and 90th centile were taken to divide each parameter into three centile groups for comparison.

Cases with AFI (7.6 ± 0.2) (mean ± standard deviation) were not admitted to the NICU while (7.7 ± 0.3) were admitted to the NICU there were no significant difference between both groups with (P ≥0.05), using an unpaired t - test.

Caesarean section deliveries accounted for 28% of all deliveries, while the rest were delivered spontaneously, as shown in table 4.

**Table 1: Distribution of the studied group as regard Amniotic fluid index.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤5 (&lt;10th centile)</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>5-20 (&gt;10th centile &lt; 90th centile)</td>
<td>40</td>
<td>80%</td>
</tr>
<tr>
<td>&gt;20 (&gt;90th centile)</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>Mean±SD</td>
<td>7.6±3</td>
<td>2-17</td>
</tr>
</tbody>
</table>

SD = Standard deviation.

**Table 2: Distribution of the studied group as regard resistance index.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤0.6 (&lt;10th centile)</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>0.6-0.7 (&gt;10th centile &lt; 90th centile)</td>
<td>14</td>
<td>28%</td>
</tr>
<tr>
<td>&gt;0.7 (&gt;90th centile)</td>
<td>30</td>
<td>60%</td>
</tr>
</tbody>
</table>

**Table 3: Distribution of the studied group as regard pulsatility index.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1 (&lt;10th centile)</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>1-1.2 (&gt;10th centile &lt; 90th centile)</td>
<td>27</td>
<td>54%</td>
</tr>
<tr>
<td>&gt;1.2 (&gt;90th centile)</td>
<td>18</td>
<td>36%</td>
</tr>
</tbody>
</table>
Fetal distress occurred in 61.7% & failed induction occurred in 38.2%, the main indication of caesarean sections.

Of the 36 cases who delivered spontaneously 33 cases (84.6%) were not admitted to the NICU while 3 cases (27.3%) were admitted to the NICU. As shown in table 5.

Away of the 14 caesarean deliveries 6 cases (15.4%) were not allowed into the NICU while 8 cases (72.7%) were taken to the NICU, there was a highly important deviation between both groups with (P value <0.001) by using Fisher exact test. The indications for admission were mainly thick meconium stained liquor and low first minute Apgar score.

Patients with RI (0.69 + 0.06), were not allowed into the NICU while patients with RI (0.70 + 0.02) were admitted to the NICU there were no important conflict between both groups with (P>0.05), using an unpaired t - test.

While patients with PI (1.2 + 0.2) were not admitted to the NICU while patients with PI (1.3 + 0.5) were admitted to the NICU there were no significant dispute between both groups with (P>0.05, using an unpaired t - test).

No statistically significant correlation between AFI, RI and PI versus different variables by using correlation co-efficient test as shown in table 6.

The best cut off value for the three predictors and the sensitivity and specificity in predicting perinatal outcome was described in table 7.

Figures 1-6 show the ultrasound and Doppler findings in cases of prolonged pregnancy.

### Table 7: Validity of AFI, PI and RI in prediction of fetal outcome.

<table>
<thead>
<tr>
<th>Variables</th>
<th>AFI</th>
<th>RI</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best cut off</td>
<td>5.50</td>
<td>0.69</td>
<td>1.10</td>
</tr>
<tr>
<td>AUROC (area under the curve)</td>
<td>0.47</td>
<td>0.57</td>
<td>0.41</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>60%</td>
<td>65%</td>
<td>50%</td>
</tr>
<tr>
<td>Specificity</td>
<td>40%</td>
<td>50%</td>
<td>43%</td>
</tr>
<tr>
<td>PPV</td>
<td>55%</td>
<td>60%</td>
<td>56%</td>
</tr>
<tr>
<td>NPV</td>
<td>62%</td>
<td>70%</td>
<td>58%</td>
</tr>
</tbody>
</table>

**AFI= Amniotic fluid index & RI= Resistance index & PI= Pulsatility index.**

Table 7: Shows that all the 3 markers considered were not valid and resistance index (RI) is considered the best of them. Which proved that the best cutoff value for amniotic fluid index (AFI) was (5.5) with an area under the curve (0.47), sensitivity (60%), specificity (40%), positive predictive value (PPV) (55%), negative predictive value (NPV) (62%)

While the best cutoff value for middle cerebral artery resistance index (MCA RI) was (0.69) with an area under the curve (0.57) with sensitivity (65%) and specificity (50%), PPV (60%), NPV (70%)

The best cut off value for middle cerebral artery pulsatility index (MCAPPI) was (1.1) and area under the curve (0.41), sensitivity (50%), specificity (43%), PPV (56%), NPV (58%).

**Discussion**

The aim of this survey was to find out the use of amniotic fluid index (AFI) and middle cerebral artery (MCA) Doppler findings as a predictor of perinatal outcome in uncomplicated prolonged pregnancies.
postdated pregnancies. However, RI was considered the best one of them. The diagnostic accuracy was performed for the parameters of the MCA and the sensitivity was 65% for middle cerebral artery RI and 50% for the specificity while the sensitivity for middle cerebral artery PI was 50%, and the specificity was 43% for detection of adverse outcome of postdated pregnancies.

Lam and associates recruited 120 postdated pregnancies and found that the use of middle cerebral artery PI was statistically significant in predicting perinatal outcome in these pregnancies as regards admission to the NICU and the passage of thick meconium-stained liquor in contrast to our subject area. In this study, they included patients with impaired glucose tolerance, patients with a history of thyroid disease and two patients of antepartum hemorrhage while in our study patients were selected on medically free bases [10].

Kitlinski in his observational study on 229 post-term pregnancies, with the managing obstetricians blinded to the effects of Doppler ultrasound flow velocimetry in the fetal middle cerebral artery, detection of a brain-sparing flow would have experienced little to add in a post-term pregnancy surveillance program already including the nonstress test, umbilical artery Doppler flow velocimetry, and ultrasound for estimation of fetal growth and amniotic fluid volume. They put up no association between brain-sparing flow and an adverse neonatal or childhood outcome of post-term pregnancy. Morbidity data obtained from national registers based on hospital admissions showed no differences in long-term outcome between fetuses with and without BSF, and the death rate in the BSF group was nil. This suggests that there is no requirement to add MCA Doppler flow velocimetry to the current routine management program [11]. El-Sokkary and co-workers in contrast to this study used the middle cerebral artery RI to UA ratio to be the best predictor of perinatal outcome in postdated pregnancies. They applied the ratio with cutoff value 0.85 to be considered the best predictor to detect adverse perinatal outcomes in postdated pregnancies [12].

Gramellini and associates in a study recruited 90 patients used the ratio between the pulsatility index (PI) of both the middle cerebral artery and the UA respectively, and they found that the cerebral-umbilical PI ratio had a 90% diagnostic accuracy compared with 78.7% of the middle cerebral artery and 83.2% of the umbilical artery [13].

Makhseed and co-workers recruited 100 pregnant patients

Oligohydramnios is a threatening condition of fetal health and is linked to increased fetal morbidity. The definition of oligohydramnios is AFI <5 cm. Oligohydramnios is associated with Intrauterine Growth Restriction, small for gestational age, extended labor, cesarean section for fetal distress, meconium stained liquor, Low Apgar score and Neonatal Intensive Care Unit admission. Women with oligohydramnios are associated with higher fetal risk, but can expect a safe delivery and safe effects for which proper fetal surveillance and regular [9].

In the current study, we found that both, AFI and middle cerebral artery Doppler RI and PI were statistically insignificant in predicting perinatal outcomes in normal uncomplicated postdated pregnancies. However, RI was considered the best one of them. The diagnostic accuracy was performed for the parameters of the MCA and the sensitivity was 65% for middle cerebral artery RI and 50% for the specificity while the sensitivity for middle cerebral artery PI was 50%, and the specificity was 43% for detection of adverse outcome of postdated pregnancies.

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Makhseed and co-workers recruited 100 pregnant patients
found that the use of the MCA RI to the UARI a ratio is a useful predictor of the neonatal outcome. Nevertheless, the ratio below 1.05 can be used as a good predictor to detect adverse neonatal outcome[14].

Morris and coworkers found that AFI is considered a nonsignificant predictor in predicting the perinatal outcome of postdated pregnancies. An AFI < 5 cm but not a single deepest pool < 2 cm was significantly linked with fetal birth asphyxia or meconium aspiration. An AFI < 5 cm was also significantly linked with an emergency cesarean section for fetal distress, a cord arterial pH < 7 at delivery and low Apgar scores. Despite there is a statistically significant association with adverse effects, the sensitivity of AFI was low at 28.6 %, 12 % and 11.5 % for the major adverse outcome, fetal distress in labor or admission to the NICU respectively. While in this study showed that the best cutoff value for AFI was (5.5) with an area under the curve (0.47), sensitivity (60%), specificity (40%), Positive predictive value (PPV) (55%), Negative predictive value (NPV) (62%). AFI has a poor sensitivity to adverse pregnancy outcome. Everyday use is likely to lead to increased obstetric intervention without any improvement in perinatal outcome [15].

Locatelli and associates found that AFI is not a sensitive indicator to predict perinatal outcome in uncomplicated postdated pregnancies as regards fetal distress or NICU admissions or in the prediction of meconium aspiration while they found AFI was sensitive to predict low birth weight[16].

Lam and associates studied 118 postdated pregnancies as regards AFI and its connection to the perinatal outcome and its value to detect adverse outcome in uncomplicated postdated pregnancies. They found that there is no statistical significance of the AFI to predict the perinatal outcome [17].

Weiner, et al. (1993) examined one hundred forty-two gravid women at term were followed prospectively by a non-stress test, estimation of amniotic fluid volume and Doppler velocimetry of the umbilical and uterine arteries. The adverse perinatal outcome was detected in 12 women (8.5%). Abnormal antepartum were observed in 26 women (17%). Seven women had an abnormally elevated resistance index (RI) in the umbilical artery, but only two had an unnatural effect. Seven women had an abnormally elevated RI in the uterine artery, but only two had an unnatural effect. Three out of 11 women with oligohydramnios had an abnormal perinatal outcome. Only one out of seven women with an abnormal non-stress test had an abnormal perinatal outcome. In six women, more than one antepartum test was abnormal. The various surveillance methods demonstrated a low sensitivity (the highest was obtained by estimating amniotic fluid volume: 25%) and a low positive predictive value (the highest obtained by measuring the resistance index in either the umbilical or the uterine arteries: 28.6%). By attending at any abnormal test as a positive test result for a given patient, a significant advance in sensitivity (66.7%) and positive predictive value (33.3%) are considered as Doppler velocimetry adds very little in itself to the follow-up of patients with post-term pregnancies [18].

Lastly, we resolve that both, amniotic fluid index and middle cerebral artery Doppler RI and PI are not useful in predicting perinatal outcomes in normal postdated pregnancies. However, RI was considered the best one of them.

Declaration of interests
The authors declare no conflicts of interest in this study.

References