DIAGNOSTIC VALUE OF ANTENATAL TRANSABDOMINAL ULTRASOUND IN DETECTION OF AMNIOTIC FLUID-STAINED MECONIUM AND PREGNANCY OUTCOMES

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Abstract

Background: Disagreement exists regarding the proper management of gestation known to involve meconium-stained amniotic fluid, and additional fetal, obstetrical, and ultrasonic assessments may be indicated.
Patients and method: A Prospective cohort study was conducted at Al-Elwiya Maternity Teaching Hospital (2022 – 2023). One hundred sixty-eight pregnant women at term with decreased fetal movement were recruited. All were subjected to abdominal ultrasonography to determine the echogenic pattern throughout the amniotic cavity. According to meconium-stained AF (MSAF) observed at the moment of membrane rupture, participants were classified into two groups: Group 1 (positive), 88 women, and Group 2 (negative), 80 women. The sensitivity, specificity, and accuracy of ultrasound in the detection of echogenic AF were calculated. Furthermore, the potential impact of MSAF on the fetal outcomes and emergency cesarean section (C/S) was assessed.
Results: Out of 168 women who were enrolled, 105 (62.5%) had MSAF observed at membrane rupture. The sensitivity and specificity of US in detecting echogenic AF were 65.71% and 84.13% respectively. The positive and negative predictive values were 87.34% and 59.55%, respectively. The accuracy of the US in detecting echogenic AF was 72.62%. Each of emergency cesarean section (OR= 10.73, 95%CI= 4.65-24.83, p<0.001), neonatal intensive care unit admission (OR= 5.67, 95%CI= 2.54-12.65, p<0.001), and <7 Apgar score (OR= 2.47, 95%CI= 1.25- 4.91, p= 0.010) was significantly associated with the positivity to MSAF.
Conclusion: Ultrasound showed a good predictive value in anticipating MSAF with 65.71% sensitivity and 84.13% specificity. A positive MSAF is significantly associated with emergency CS, neonatal admission to ICU, and low Apgar score.
Keywords: Meconium-stained amniotic fluid, ultrasound, echogenic amniotic fluid.

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Introduction

Ultrasound amniotic fluid (AF) examination has become a crucial part of contemporary clinical obstetrical practices in order to evaluate AF volume problems and offer AF physiology. However, compared to the direct dye dilution procedure, some published results suggest that sonographic evaluation of amniotic fluid may not be a precise tool. Although ultrasound is a quick, safe, and non-invasive bedside procedure with comparable clinical results (1).
Amniotic fluid can be evaluated ultrasonographically in a semi-quantitative or qualitative manner. The maximum vertical pocket (MVP) and the four-quadrant amniotic fluid index (AFI) are semi-quantitative methods with established reference ranges that are frequently employed in clinical practice (2).
The liquid that surrounds a growing fetus in the amniotic sac is called amniotic fluid (AF). It is typically clear to pale yellow in color and is regarded as a reliable tool that medical professionals can use to assess pregnancy progress and predict neonatal outcomes (3).
The clinical relevance of echogenicity and composition of AF is not well established and it is vary with gestational

age. The size, quantity, and distribution of AF particles are indirectly represented by the echogenicity of AF, which in turn indicates the turbidity of AF (4).
About 4% of ultrasound images in the first and second trimesters show echogenic AF. The incidence increases to 80% by the third trimester in the majority of cases due to the presence of vernix caseosa, and in a small percentage of cases because of meconium, blood, and inflammatory material linked to intraamniotic inflammation or infection, or to desquamated skin cells in the case of congenital ichthyosis (4).
The word "meconium" comes from the Greek word mekoni, which mean "opium-like" or "poppy juice." This expression refers to the idea—often credited to Aristotle—that if a pregnant woman is exposed to meconium, her unborn child would become drowsy or depressed. It is what causes the newborn's initial bowel activity and is the first substance the developing fetus possesses in its intestines. Meconium can be yellow, brown, or green in color. Healthy term newborns clear the meconium 24 to 48 hours after delivery. Premature babies usually have delayed passage (5).
When meconium passes by a fetus during the prenatal or labor stage, it is referred to as meconium-stained AF. Bile salts, mucus, gastric secretions, lanugo, vernix, blood, pancreatic enzymes, squamous cells, and free fatty acids make up the remaining 15% of meconium, which is composed of water in 95% of cases. MSAF is associated with several adverse outcomes for both the mother and the newborn, in contrast to clear AF. Conversely, women who are in spontaneous labor at term frequently experience post-term meconium passage, which has been connected to gastrointestinal maturation. It is more common in underdeveloped countries and has a prevalence rate of 12% to 20% (6, 7, 8). However, up to 0.05% (or 1 in 4) of neonatal deaths can be attributed to meconium aspiration syndrome (MAS) (9).
Based on the aforementioned considerations, we are conducting this study to ascertain the antenatal transabdominal ultrasound's accuracy, sensitivity, and specificity in detecting echogenic amniotic fluid in term singleton pregnancies. Additionally, we are evaluating the prevalence of MSAF and its perinatal outcomes in comparison to clear fluid at our institute, which is a tertiary teaching center serving the east part of Baghdad city. Additionally, there are few studies conducted in our community on this subject.

Patients and Methods

The Elwiya Maternity Teaching Hospital in Baghdad, Iraq, hosted an prospective cohort study from July 1, 2022, until July 30, 2023. The local ethical committee gave its approval to the study protocol. A total of 2350 pregnant women visited the prenatal clinic during the study period. 208 of these individuals had decreased fetal movement at presentation.
The following are the study's inclusion criteria: A gestational age between 37 and 42 weeks, as established by the previous menstrual period or an early ultrasound performed 24 hours before to study participation, was taken into consideration for all singleton pregnancies with a cephalic presentation and an intact fetal membrane. Exclusion criteria include fetuses with congenital abnormalities, patients with complete rupture of the amniotic sac, pregnancies with twins, and pregnancies that are at risk of premature delivery.

After applying inclusion and exclusion criteria, out of 208 pregnant ladies presented with decrease fetal movement, 168 patients were eligible for the study.

After obtaining verbal consent from participants, all pregnant women who reported reduced fetal movement were evaluated through a comprehensive assessment that included obtaining a detailed medical and obstetrical history, conducting a thorough physical examination, and ordering hematological and biochemical tests. Additionally, a real-time gray-scale abdominal ultrasound examination was performed to evaluate the viability of the fetus, determine the gestational age, assess fetal well-being, detect any congenital anomalies, determine the location of the placenta, measure the AF index (AFI), and evaluate the clarity of the AF. The ultrasound procedure was performed by two radiologists using a convex probe 3.5 MHz of Canon-CUS-X200 G ultrasound machine. The following are the ultrasonography criteria used to identify AFSM: 1. Layering in the more dependent parts, 2. a distinct contrast between the AF and the umbilical veins , 3. a diffuse echogenic pattern across the amniotic cavity, 4. MSAF with a 2* magnification in a 2*2 cm AF region. This appearance, however, is not exclusive to meconium; it can also be observed when vernix or even blood is present. If no particles were seen, the fluid was categorized as clear; if more than ten uniformly distributed particles were present, it was categorized as homogeneous echogenic (10,11).

Kick counts, biophysical profile (BPP) calculations, and non-stress tests (NSTs) were used to assess the fetal health of each patient. Kick counts, weekly serial ultrasound measurements of AFI, and twice-weekly BPP and NST were used to monitor the woman's fetal health in the event

that the NST was reactive. These findings helped us decide when to end the pregnancy. If the NST was non-reactive, the expectant mother was given exogenous oxytocin intravenously as part of the contraction stress test (CST).

An efficient uterine contraction (at least three within ten minutes) was the aim, and the fetal heart rate and variability were continuously monitored using cardiotocography. Consequently, the Bishop score and fetal status were utilized to determine the delivery method. Either induction or acceleration of labor was started, by doing amniotomy in present of authors, and continue with oxytocin (10 units/ 500 ml glucose water). Maternal (cervical changes, uterine contractions and mode of delivery) and fetal (fetal heart rates and fetal descent) conditions were closely monitored during progress of labor.

Maternal age, parity, gestational weeks, antepartum and intrapartum characteristics, mode of birth, Apgar score, and hospitalization to the newborn intensive care unit were among the variables evaluated in our study.

Statistical analysis : An electronic database structure was created from the data. The statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS) version 25.0 (IBM, Corp, Armonk, NY). The numerical variables, expressed as mean ± standard deviation (SD), were evaluated using the independent t-test. Categorical variables, represented as numbers and frequencies, were analyzed using cross-tabulation. The statistical significance of these associations was evaluated using the Chi-square (χ^2) test. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and test accuracy of the US in identifying echogenic AF were assessed using cross-tabulation. Binary logistic regression was used to assess the potential impact of MSAF on pregnancy outcomes. This test determines the odds ratio (OR) and the associated 95% confidence level. A statistical estimate was deemed to be statistically significant if its P value was below a significance threshold (α) of 0.05.

Results

Meconium -stained amniotic fluid:

During the study period, a total of 168 pregnant women with decrease fetal movement were included in the study. Out of those women, 105 (62.5%) had MSAF observed at membrane rupture which considered as case group (positive group), while AF in 63 women (37.5%) was stain-free (control-negative group) (Figure 1).

Relationship between meconium-stained amniotic fluid and demographic traits

Positive women's mean age was 31.46±7.12 years, which was extremely similar to negative women's mean age of 29.37±6.78 years, with no discernible difference (P value - 0.674) . In a similar vein, there was no significant difference (p value 0.784) between the two groups' gestational ages. Multigravida was more common in women with MSAF than in those without (72.38% vs. 61.9%), but the difference was not statistically significant (Table 1).

Association of clinical characteristics with meconium -stained amniotic fluid :

There was a substantial difference in the prevalence of pre-eclampsia between women with MSAF and those without (20.95% vs. 7.94%). Nonetheless, there was no discernible difference in the prevalence of maternal hypertension between the two groups. While not statistically significant, other maternal risk factors were present in 8.75% of women with MSAF compared to 1.59% of women without MSAF (Table 2).

Predictive value of ultrasound

Recruit pregnant women were grouped as positive and negative echogenic AF in US compared with the type of AF actually observed during rupture of membranes and classified into clear (normal), meconium or bloody stained.

69 of the 105 women who tested positive for MSAF also experienced echogenic AF. However, it was also shown that 53 of the 63 women who tested negative for MSAF also had echo-free AF. As a result, US had a sensitivity of 65.71% and a specificity of 84.13% in predicting MSAF. 87.34% and 59.55%, respectively, were the positive and negative predictive values. US had a 72.62% detection accuracy for echogenic AF (Table 3&4).

The potential impact of meconium -stained amniotic fluid on pregnancy outcomes:

For women who tested positive and negative for MSAF, emergency C/S was conducted to 60.95% and 12.7%, respectively; the difference was highly significant (OR= 10.73, 95%CI= 4.65-24.83, p<0.001). Similarly, a highly significant difference (OR= 5.67, 95%CI= 2.54-12.65, p<0.001) was seen between the neonates from MSAF positive mothers who needed NICU hospitalization (48.57%) and those from MSAF negative women (14.29%). Neonatals from MSAF-positive mothers had a greater morality rate than those from negative women (8.57% vs. 1.59%), but the difference was not statistically significant. Lastly, it was shown that 45.71% of neonates from mothers with AFSM had an Apgar score of less than

7, compared to 25.4% of those from women with AFSM-negative. This difference was very significant (OR= 2.47, 95%CI= 1.25-4.91, p= 0.010) (table 5).

OR (odds ratio) is a measure of association between an exposure and an outcome in another word OR tell us how much more (or less) likely an outcome is to happen in one group compared to another.

Discussion

It is recognized that the appearance of AF change from transparent to cloudy as pregnancy advances towards full term and published literatures has shown that presence of echogenic AF is an uncommon finding and its clinical significance still a controversial issue as the primary differential diagnosis for echogenic amniotic fluid (AF) close to term consists of vernix in the majority of cases, and infrequently due to blood or meconium. On the other hand, amniotic fluid containing sonographic

particulate matter elevates the possibility of MSAF(12).

The results of this study demonstrated that the transabdominal U/S ordered prior or within 24 hours of delivery had sensitivity , specificity and accuracy of 65.71% , 84.13%% and 72.62% respectively in detecting MSAF in women with and without echogenic AF with positive predictive value (PPV) of 87.34%. and negative predictive value of 59.55%(NPV) . Therefore, ultrasound has a diagnostic value to identify this condition.

In contrast to Medan et al., who reported sensitivity and PPV of 13.79% and 44.44%, respectively, and came to the conclusion that U/S had limited diagnostic value in detecting echogenic AF, Helewa et al. reported sensitivity, specificity, and accuracy of 100%, 25%, and 70%, respectively, with PPV and NPV of 53% and 100%. The fact that different researchers have different definitions of echogenic AF reflects this variation. The precise incidence and description of echogenic amniotic fluid at term gestation seem to require more investigation with bigger study groups (13,14).

According to the incidence, between 5% and 20% of term deliveries result in MSAF. While the incidence of MSAF in published studies from Iran, Ethiopia, India, and Nigeria was 12.2%, 24.6%, 8.3%, and 20.4%, respectively, the incidence of MSAF in pregnant women with decreased fetal movement was 62.5% in this study, which is greater than what has been reported worldwide. Population differences and study design may be to blame for this. To understand the dispute, more research is needed (15,7,16,17).

According to Iranian multivariate analysis, there was a substantial correlation between MSAFand maternal age, gestational age, and parity (7). However, the majority of published research did not identify a relationship between MSAF and maternal age, which is in line with our findings because the two study groups did not differ significantly (15,18).

Published studies have shown that in up to 52% of post-term pregnancies and 25% of term pregnancy births, gestational age at delivery was independently linked to MSAF. The study group's gestational age ranged from 37 to 41 weeks, with an average of 39.28 +/- 1.3 weeks.Fetal bowel peristalsis rises as gestational age increases, which leads to the passage of meconium. This phenomenon may be explained by the fetus's increased motilin secretion and the maturation of the gastrointestinal system (15,19,20).

Primiparous women are three times more likely to have MSAF, suggesting that parity may be a protective factor against the condition. However , our findings are consistent with other research that revealed no correlation between parity and MSAF. This might be the result of population differences and study design, and more research is necessary to get a deeper understanding of this problem (7,15,18).

Prolonged labor, post-term pregnancy, preeclampsia, maternal hypertension, diabetes mellitus, and hypothyroidism are risk factors for MSAF. These conditions can also be linked to adverse obstetrical and neonatal outcomes, and numerous studies have connected a number of maternal comorbidities to an increased risk of MSAF (15). As far as we are aware, there aren't many research that compare the risk factors of MSAF versus non-MSAF at delivery. According to findings in Table 2, the PET was statistically substantial greater in the AFSM group than in the non-AFSM group (P<0.026). Because uteroplacental insufficiency, which results in fetal hypoxia and meconium passage, has been connected to PET and meconium passage. Compared to controls, cases had higher rates of maternal hypertension, diabetes mellitus, and hypothyroidism , but statistically there was no difference with cohort groups . However, Shekari et al. did not discover any connection between MSAF and these maternal comorbidities. The reason for this disparity is that the majority of maternal comorbidities in their context suggest that an early gestational age termination of pregnancy is necessary. Consequently, post-term pregnancies are uncommon among mothers with comorbidities (15,21,7).

Pregnancy outcomes with MSAF have not been thoroughly investigated. Gluck et al. examined the effects of MSAF on labor by examining 317 deliveries. The rates of cesarean deliveries, instrumental deliveries, and labor induction were higher than those of deliveries with clear amniotic fluid (22) .

The published research has revealed a contentious relationship between MSAF and emergency C/S as MSAF by itself does not indicate the need for a cesarean section; rather, it necessitates careful observation during labor in order to improve perinatal outcomes (23) .

According to the current study, emergency C/S was performed to 60.95% and 12.7% for MSAF positive and negative women respectively, with a highly significant difference (OR= 10.73, 95%CI= 4.65-24.83, p<0.001) in agreement with results of published data that reported the cases of MSAF increase the chances of C/S delivery reflecting the obstetricians' difficulty in managing such labor, also these higher rates partially reflect the abnormal foetal heart rate patterns linked to MSAF . At this point, health caregiver become more worry about unborn baby, and any minor deviations from typical labor patterns result in caesarean delivery. However, E. Mungen found that the incidence of C-section did not differ statistically significantly between women with echogenic AF (31.9%) and those with echo-free U/S (33.7%). (21, 24).

When medical professionals find MSAF during labor, they usually become concerned and anxious because it may indicate fetal hypoxia, which can cause intestinal peristalsis to increase and the anal sphincters to relax. This can result in meconium passing through the uterus and neonatal problems like meconium aspiration syndrome (MAS), acute respiratory distress (ADRS), and hypoxic-ischemic encephalopathy (HIE) (25, 26).

Nonetheless, some contend that gastrointestinal development may also be responsible for the meconium found in amniotic fluid. Furthermore, if there were no abnormalities in the fetal heart rate, the presence of meconium did not suggest fetal compromise or necessitate medical intervention (11).

Our findings are in line with published research that indicates a correlation between the outcomes of infants born via MSAF and higher rates of newborn morbidity, including neonatal acidosis, NICU hospitalization, low 5-min Apgar score, and neonatal death (22, 27).

As, 48.57% of neonates from MSAF positive women required NICU admission compared with only 14.29% of neonates from AFSM negative women a highly significant difference (OR= 5.67, 95%CI= 2.54-12.65, *P* less than 0.001). Although mortality was higher rate in neonates from AFSM positive than those from negative women (8.57% vs. 1.59%), the difference was not significant.

Finally, <7 Apgar score was reported in 45.71% of neonates from MSAF-positive women compared with 25.4% of those from MSAF-negative women a highly significant difference (OR= 2.47, 95%CI= 1.25- 4.91, *P* equal to 0.010) . Additionally, depending on how pregnancies, labors, and neonates are managed, these AFSM-related newborn morbidities vary throughout birth centers and neonatal intensive care units (NICU) (26) .

Limitation of study: Our study has various limitations as it was a single- center observational study, so its findings may not be generalizable to our community. Small sample size, lack of grading of MSAF severity and absence of long- term neonatal follow up represent additional limitations.

Conclusion

The abdominal ultrasound performed at term pregnancy with decrease fetal movement is a useful tool in predicting MSAF in women with and without echogenic AF. Regarding pregnancy outcomes and risk factors for MSAF, higher rates of emergency C/S, neonatal ICU admission, neonatal deaths and pre-eclampsia among MSAF group in comparison to no MSAF group.

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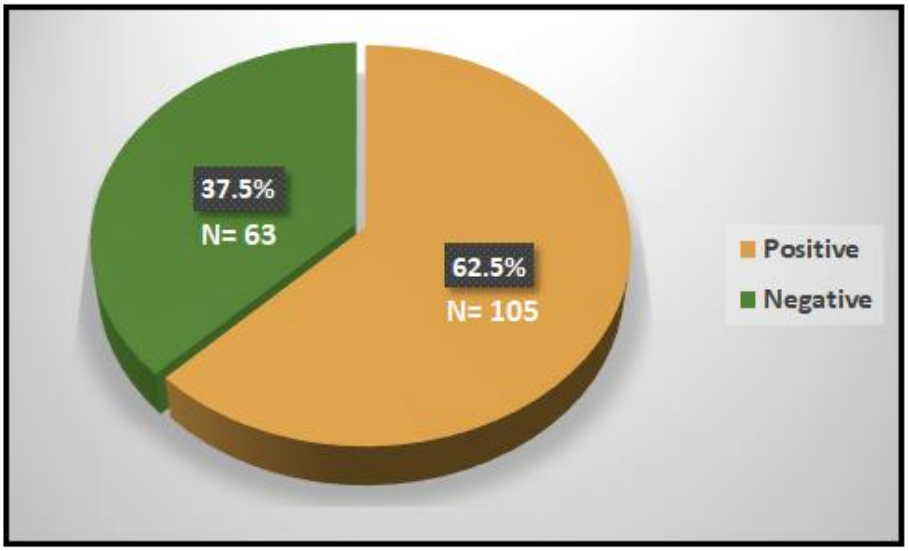

Figure 1: Women's distribution according to amniotic fluid stained with meconium

Table 1: Association of demographic characteristics with meconium-stained amniotic fluid

Variables	MSAF		P-value
	Study GP (n.105)	Control GP (n.63)	
Age, years Mean±SD	31.46±7.12	29.37±6.78	0.674
Gestational age, wks Mean±SD	39.28±1.3	39.74±1.35	0.784
Gravidity Primi-gravida	29(27.62%)	24(38.1%)	0.157
Multigravida	76(72.38%)	39(61.9%)	

Table 2: Association of clinical characteristics with amniotic fluid stained with meconium

Variables	MSAF		P-value
	Study GP(n.105)	Control GP (n.63)	
Pre-eclampsia			
No	83(79.05%)	58(92.06%)	**0.026**
Yes	22(20.95%)	5(7.94%)	
Maternal hypertension			
No	87(82.86%)	54(85.71%)	0.625
yes	18(17.14%)	9(14.29%)	
Other maternal risk factors			
No	96(91.43%)	62(98.41%)	0.092
Yes	9(8.57%)	1(1.59%)	

Table 3: Validity of US detected echogenic liquor in predicting liquor stained with meconium observed at membrane rupture .

		MSAF at membrane rupture		Total
		Positive(study grou	Negative(control grou	
Echogenic liquor by US	**Positive**	69	10	79
	Negative	36	53	89
	Total	105	63	168

Table 4: Overall validity of abdominal U/S echogenic AF in predicting MSAF

Echogenic liquor by U/S	Sensitivity	Specificity	Accuracy	PPV	NPV
MSAF	65.71%	84.13%	72.62%	87.43%	59.55%

Table 5: The potential impact of meconium-stained amniotic fluid on pregnancy outcomes

Variables	**MSAF**		**P-value**	**Odds ratio(95%CI)**
	Study GP (n.105)	**Control GP (n.63)**		
Emergency C/S				
No	41(39.05%)	55(87.3%)	**<0.001**	**1.0**
Yes	64(60.95%)	8(12.7%)		**10.73(4.65-24.83)**
NICU admission				
No	54(51.43%)	54(85.71%)	**<0.001**	**1.0**
yes	51(48.57%)	9(14.29%)		**5.67(2.54-12.65)**
Neonatal death				
No	96(91.43%)	62(98.41%)	0.092	1.0
Yes	9(8.57%)	1(1.59%)		5.81(0.72-47.02)
Apgar score at 5 min				
≥7	57(54.29%)	47(74.6%)	**0.010**	**1.0**
<7	48(45.71%)	16(25.4%)		**2.47(1.25-4.91)**