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Original Research Article

Non-stress test, amniotic fluid index and color of liquor in term pregnancies in active labour and their association with labour and perinatal outcome

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ABSTRACT

Background: The features of amniotic fluid, such as volume and color, are essential for evaluating fetal health and forecasting postnatal outcomes. Oligohydramnios and meconium-stained amniotic fluid correlate with a heightened risk of unfavorable newborn outcomes, such as diminished APGAR scores, increased NICU hospitalizations and cesarean sections. The non-stress test (NST) is an essential instrument for assessing fetal discomfort during childbirth. This research sought to evaluate the predictive significance of the amniotic fluid index (AFI), wine color and non-stress test (NST) in forecasting newborn outcomes in term pregnancies.

Methods: This comparative prospective cross-sectional research was performed at the Obstetrics and Gynaecology Department of teaching hospitals associated with J.J.M. Medical College, Davangere, from March 2021 to August 2022. A total of 100 term pregnant women in active labor were enrolled. Clinical and ultrasonographic evaluations were conducted to examine Amniotic Fluid Index (AFI), non-stress test (NST) reactivity and liquor properties. Neonatal outcomes, including APGAR scores, birth weight, NICU hospitalizations and delivery method, were documented. Data were evaluated using SPSS v22.0, with statistical significance established at $p<0.05$.

Results: Maternal age had a significant correlation with meconium-stained liquid ($p=0.026$), although other maternal factors, including parity, gestational age and BMI, shown no significant variations. The non-reactivity of NST was markedly elevated in the meconium-stained liquor groups (thin: 50%, thick: 33.33%) in contrast to the clear liquor group (16%) ($p=0.011$). A low amniotic fluid index (AFI) (<8 cm) was more common in the thin meconium-stained liquid group (75%) compared to the clear (54.67%) and thick meconium-stained groups (22.2%). The group with thick meconium staining had markedly lower mean APGAR scores at 1 minute (5.89±0.98) in comparison to the thin (6.47±2.05) and clear liquor groups (6.87±1.21) ($p=0.007$). NST, AFI and liquor color exhibited significant correlations with cesarean delivery, NICU hospitalization and infant morbidity. The predictive sensitivity of liquor volume, liquor hue and NST for neonatal problems was 77.78%, 80% and 81.82%, respectively.

Conclusions: NST, AFI and amniotic fluid color are significant indicators of fetal well-being in term pregnancies. The occurrence of oligohydramnios, abnormal NST and meconium-stained amniotic fluid markedly elevates the probability of negative outcomes, including as surgical delivery and diminished APGAR scores. These results highlight the need of ongoing intrapartum fetal surveillance and prompt management in high-risk pregnancies.

Keywords: Amniotic fluid index, APGAR score, Cesarean delivery, Fetal distress, Meconium-stained liquor, Neonatal

INTRODUCTION

Contemporary obstetrics prioritizes the health and welfare of both the mother and the growing baby. Essential elements of perinatal medicine include the identification of fetuses susceptible to in utero difficulties, evaluation of the severity of these risks, consideration of fetal risks in relation to probable newborn issues arising from

prematurity and the determination of the optimal time and manner for intervention.[1]

The principal aim of intrapartum fetal monitoring is to detect early indicators of fetal distress, facilitating prompt and effective interventions to mitigate perinatal morbidity and mortality, encompassing conditions such as perinatal asphyxia, neonatal hypoxic-ischemic encephalopathy, stillbirth and neonatal demise.[2]

A labor admission test assists in identifying individuals who may require a cesarean section owing to non-reassuring fetal heart rate patterns, thereby averting the delivery of a compromised infant. This test is especially advantageous for identifying high-risk instances that may have been overlooked during antepartum assessments.[3] It also assists in prioritizing patients in high-demand labor and delivery environments with limited resources. Various diagnostic methods have been used for evaluating fetal well-being upon admission, including a 20-minute cardiotocography, reaction to vibroacoustic stimulation, doppler assessments of the umbilical artery and sonographic evaluation of amniotic fluid volume.[4-6] Among them, the evaluation of amniotic fluid is the most frequently used technique. The amount of amniotic fluid is a vital sign of fetal health and its decrease, termed oligohydramnios, correlates with negative postpartum outcomes, especially in high-risk pregnancies.[7] The amniotic fluid index (AFI), a semi-quantitative ultrasound assessment of amniotic fluid volume, was first proposed by Phelan et al, in 1987.[8]

The assessment of the amniotic fluid index (AFI) using ultrasonography Phelan et al, Tom et al is essential for forecasting pregnancy outcomes.[8-10] Simultaneously, electronic fetal monitoring (RCOG Guideline 2001) continues to be the predominant technique for assessing fetal well-being during labor.[11] The integration of AFI measurement with a non-stress test upon admission and the evaluation of amniotic fluid color by Gallo et al.[12] following membrane rupture offers a thorough screening methodology. The combination of these three characteristics functions as a proficient instrument for the early identification of fetal distress (ACOG Practice Bulletin No. 106, 2009), thereby aiding in the reduction of fetal morbidity and death.[13]

Multiple studies have shown an increased probability of intrapartum fetal distress in pregnant women identified with oligohydramnios by ultrasound evaluation. The exact pathophysiological process of oligohydramnios is not fully understood; however, one possible explanation is the heightened risk of umbilical cord compression during uterine contractions.

Decreased amniotic fluid content is linked to negative outcomes including stillbirths, fetal malformations, irregular fetal heart rate (FHR) patterns throughout labor, an increased likelihood of cesarean deliveries owing to fetal distress and a possible risk of fetal acidosis. AFI, NST and liquor coloration together serve as a significant non-invasive approach to detect existing fetal impairment upon admission, enabling obstetricians to enhance vigilance via intermittent or continuous electronic fetal monitoring (EFM). Implementing these three simple tests may reduce the burden of ongoing monitoring in resource-limited environments and enhance fetal outcomes.[14,15]

The objective of this study is to evaluate the efficacy of the NST in combination with the AFI and the color of amniotic fluid in predicting fetal distress during labor. Early detection of fetal distress at the time of admission allows for timely intervention, minimizing unnecessary delays in management. Identifying patients who require continuous fetal monitoring is crucial for optimizing perinatal outcomes. Additionally, this study aims to analyze the mode of delivery and fetal outcomes based on admission test results, AFI and amniotic fluid color in term pregnancies during active labor. Lastly, the sensitivity of each parameter NST, Amniotic Fluid Index and the color of amniotic fluid will be assessed to determine their reliability in detecting fetal compromise.

METHODS

This study was a comparative prospective cross-sectional study conducted in the Department of Obstetrics and Gynaecology at the teaching hospitals attached to J.J.M. Medical College, Davangere. The study was carried out from March 2021 to August 2022 across three hospitals: Bapuji Hospital, Chigateri District General Hospital and Women and Child Hospital, Davangere.

Study population and sampling

A total of 100 term pregnant women in active labor were recruited for the study. Patients who met the inclusion criteria were randomly selected. The inclusion criteria comprised term gestation pregnancies in active labor, whereas the exclusion criteria included multiple gestations, non-cephalic presentations and previous lower segment cesarean section (LSCS).

Data collection procedure

After obtaining ethical clearance, informed written consent was taken from each participant. Patients were informed about the study, including its benefits, cost and voluntary nature, ensuring that their decision did not affect their treatment.

A detailed history was recorded, which included demographic details such as age, educational level, socioeconomic status, marital status, parity, gestational age, serology and comorbidities. General clinical examinations were performed, including pulse rate, blood pressure, temperature, symphysiofundal height measurement, fetal presentation and assessment of amniotic fluid adequacy.

Ultrasonographic and clinical examination

An ultrasound examination was performed using a curvilinear transducer, following the method described by Phelan et al. The uterus was divided into four quadrants using maternal sagittal and transverse reference lines. The transducer was positioned parallel to the maternal sagittal plane and perpendicular to the coronal plane to measure the AFI.

Follow-up and data analysis

Patients were followed throughout labor and delivery and their mode of delivery and fetal condition were recorded. In cases where cesarean sections were performed, the indications for surgery were documented. Neonatal outcomes were assessed based on birth weight, APGAR scores, color of liquor and NICU stay duration.

The collected data were stored in MS Excel and analyzed using SPSS software. Statistical tests were applied to determine the sensitivity of NST, AFI and liquor color in predicting fetal distress.

Categorical data was given in frequency and percentage form and the Chi square test was used to analyze variable associations. The quantitative data were represented using mean and standard deviation. ANOVA and unpaired t-tests were performed to determine correlation ($p<0.05$ was deemed significant). IBM SPSS version 22.0 was used for data analysis.

Sample size estimation

Considering the prevalence of term pregnancies in India (66%) and assuming a 10% margin of error, a minimum of 86 cases was required. However, to enhance the reliability of the study, 100 term pregnant women were recruited.

RESULTS

A total of 100 term pregnant ladies were enrolled in the current study. Participants were further categorized into three groups based on their liquor color which included (clear liquid, thin meconium-stained liquor and thick meconium-stained liquor. Regarding parity, 73% of the participants were multigravida, with no significant difference between groups (p=0.14). Maternal age distribution showed that the majority (78%) were between 21-30 years, with a significant difference among groups (p=0.026), as represented in Table 2. Gestational age analysis revealed that 63% of cases were between 37-40 weeks, with no significant variation among groups (p=0.14). Neonatal gender distribution indicated that 40% of newborns were male, with no significant differences observed between the groups (p=0.568). Birth weight analysis showed that 74% of neonates had a birth weight below 2.5 kg, with no statistically significant difference between groups (p=0.137). Regarding educational levels, most mothers had at least a graduate-level education and no significant difference was found among the groups (p=0.250). Socioeconomic status assessment indicated that the majority of participants belonged to SES III-IV categories, with no significant difference between groups (p=0.271). Additionally, BMI evaluation revealed that 95% of mothers had a BMI above 25 kg/m², with no significant association observed (p=0.436). Overall, apart from maternal age, no other factors showed statistically significant differences among the study groups.

In the clear liquor group, all participants (100%) were non-reactive. Among those in the thin meconium-stained liquor group, 93.75% were non-reactive, while 6.25% were reactive. In the thick meconium-stained liquor group, 77.78% were non-reactive, whereas 22.22% were reactive. The difference between the groups was statistically significant, with a p-value of 0.007 (Table 3). There were no significant changes in IUGR, gestational diabetes or gestational hypertension between the clear, thin and thick meconium-stained liquor groups (p>0.009, 0.964 and 0.164, respectively). The mean GCT and haemoglobin levels were likewise similar across groups (p=0.32 and 0.495). Similarly, there were no significant variations in method of birth, including vaginal, lower segment cesarean and instrumental deliveries (p = 0.344).

NST were substantially greater in the thin (50.00%) and thick (33.34%) meconium-stained liquor groups than in the clear liquor group (16.00%) (p=0.011). A low AFI was found in 45.33% of the clear liquor group, 75.0% of the thin meconium-stained liquor group and 22.2% of the thick meconium-stained liquor group. The thick meconium-stained liquor group had substantially lower APGAR scores at 1 minute (mean 5.89, SD 0.98) than the thin (mean 6.47, SD 2.05) and clear liquor groups (mean 6.87, SD 1.21) (p=0.007) (Table 4). At 5 minutes post-delivery, the average APGAR score was 8.79 (SD±1.21) for the clear liquor group, 8.35 (SD±2.05) for the thin meconium-stained group and 8.22 (SD±0.98) for the thick meconium-stained group. The differences were not statistically significant (p=0.5).

A significant difference was observed between the groups (p=0.08), with 9.33% in the clear liquor group, 31.25% in the thin meconium-stained liquor group and 22.22% in the thick meconium-stained liquor group. A significant association between the AFI and several parameters. Specifically, HIV positivity (p=0.004), antenatal complications (p=0.008), IUGR (p=0.035), mode of delivery (LSCS) (p=0.020), non-reactive NST (p=0.03), NICU stay (p=0.05) and IUGR (p=0.035) were all significantly associated with AFI levels. However, there was no significant relationship between AFI and other parameters such as primipara, multipara, gender, birth weight, GDM, GHTN or liquor status. Similarly, NST demonstrated significant associations with several parameters. A notable association was found between non-reactive NST and low birth weight (p=0.002), with a higher incidence of low birth weight in non-reactive cases. Additionally, non-reactive NST was significantly linked to

IUGR, with a p value of 0.025, indicating that non-reactive NST was more prevalent in cases of IUGR. The mode of delivery also showed a significant relationship with NST, as non-reactive NST was associated with a higher rate of LSCS (p=0.020). Moreover, a significant correlation was observed between non-reactive NST and the need for NICU stay, with a p value of 0.045, highlighting the increased likelihood of NICU admission for non-reactive NST cases.

Diagnostic performance

The diagnostic performance for predicting neonatal complications was evaluated using three parameters. The amount of liquor showed a sensitivity of 77.78% (95% CI: 39.99–97.19%), specificity of 50.00% (95% CI: 6.76–93.24%), positive predictive value (PPV) of 77.78%, negative predictive value (NPV) of 50.00% and an overall accuracy of 69.23%. Similarly, the color of liquor demonstrated a sensitivity of 80.00% (95% CI: 44.39–97.48%) and the same specificity of 50.00%, with a PPV of 80.00%, NPV of 50.00% and a slightly higher accuracy of 71.43%. In contrast, the non-stress test (NST) exhibited the highest sensitivity at 81.82% (95% CI: 48.22–97.72%) but a lower specificity of 33.33% (95% CI: 4.33–77.72%), resulting in an accuracy of 64.71% and a PPV of 69.23% with an NPV of 50.00%. The disease prevalence across these measures ranged from 64.71% to 71.43%.

Table 1: Assessment parameters.

Parameter	Categories
Non-stress test (NST)	Reactive
	Non-reactive
Amniotic fluid index (AFI)	Less than 8 cm
	More than 8 cm
Color of amniotic fluid	Clear liquor
	Thin meconium-stained liquor
	Thick meconium-stained liquor
Mode of delivery	Normal vaginal delivery
	Instrumental delivery
	Cesarean section
APGAR score at 1 minute	Less than 5
	5 or more
APGAR score at 5 minutes	Less than 7
	7 or more
Birth weight	Less than 2.5 kg
	2.5 kg or more
NICU stay duration	Less than 5 days
	5 days or more

Table 2: Maternal age among patients.

Age group (in years)	Clear liquor	Thin meconium-stained liquor	Thick meconium-stained liquor	Total
<20	3	0	0	3
21-30	58	13	7	78
>30	14	3	2	22
Total	75	16	9	100
Mean	27.18	38.94	22.00	29.37
SD	1.35	1.47	1.20	1.34
Df=6, P=0.026 (Significant)				

Table 3: Serology correlation with liquor.

Serology status	Non-reactive	Reactive	Total	Non-reactive (%)	Reactive (%)	Total (%)
Clear liquor	75	0	75	100.00	0.00	100.00
Thin meconium-stained liquor	15	1	16	93.75	6.25	100.00
Thick meconium-stained liquor	7	2	9	77.78	22.22	100.00
Total	97	3	100	97.00	3.00	100.00
P value 0.007 (Significant)						

Table 4: Clinical correlation of NST, AFI and APGAR score (at 1 minute).

Parameter	Category	Clear liquor	Thin meconium-stained liquor	Thick meconium-stained liquor	Total
NST	Reactive	63 (84.00%)	8 (50.00%)	6 (66.67%)	77 (77.00%)
	Non-Reactive	12 (16.00%)	8 (50.00%)	3 (33.33%)	23 (23.00%)
	Total	75 (100.00%)	16 (100.00%)	9 (100.00%)	100 (100.00%)
	P value	**0.011 (Significant)**			
AFI	<8	41 (54.67%)	4 (25.00%)	7 (77.78%)	52 (52.00%)
	≥8	34 (45.33%)	12 (75.00%)	2 (22.22%)	48 (48.00%)
	Total	75 (100.00%)	16 (100.00%)	9 (100.00%)	100 (100.00%)
APGAR score at 1 min	Mean	6.87	6.47	5.89	
	SD	1.21	2.05	0.98	
	P value	0.007 (Significant)			

DISCUSSION

Antepartum oligohydramnios is associated with intrauterine growth limitation, post-term pregnancy and irregular fetal heart rate patterns before delivery. Given that amniotic fluid volume normally decreases with advancing gestational age, evaluating it during the early stages of labor seems to be a rational approach for forecasting fetal morbidity. Moreover, meconium-stained amniotic fluid has been acknowledged as a sign of possible difficulties impacting fetal health during and after childbirth. Historically, the presence of meconium in the amniotic fluid of cephalic presentations posed a considerable worry for midwives and obstetricians alike. The present research concentrated on a low-risk cohort of parturient individuals.

This cross-sectional research examined the relationship between amniotic fluid parameters and diverse maternal and newborn outcomes in 100 term pregnant women in active labor. In general, the majority of maternal variables, such as parity, gestational age, neonatal gender, birth weight, educational attainment, socioeconomic position and BMI, exhibited no significant variations between the groups; nevertheless, maternal age shown a significant difference (p=0.026).

Patel et al reported that 65.71% of the women were primigravida and Jandial et al, found a primigravida rate of 60.0%, which stands in stark contrast to the current study, where only 27% of the participants were primigravida.[14,15]

Significant disparities were seen in the evaluation of fetal well-being. NST were more prevalent in the meconium-stained groups, exhibiting 50.00% non-reactivity in the thin meconium-stained liquor group and 33.33% in the thick meconium-stained liquor group, in contrast to only 16.00% in the clear liquor group (p=0.011). The AFI was substantially correlated with negative perinatal outcomes. In prospective case-control research, Das et al, documented a 38.0% incidence of non-reactive NST, observing that cesarean sections were more prevalent in the presence of oligohydramnios with a non-reactive NST.[16] Hoskins IA noted that 75.0% of instances with a non-reactive NST resulted in a cesarean birth.[17]

A low AFI (<8 cm) was more common in the group with thin meconium staining (75.00%), Maiti et al, reported in their study that the occurrence of meconium-stained liquor in cases where the amniotic fluid index (AFI) was ≤5 was 74.4%.[18] Similarly Rutherford et al, reported AFI≤5 in 54% and Sriya et al, reported 38.88%.[19,20]

This parameter significantly correlated with elevated rates of HIV positivity (p=0.004), antenatal complications (p=0.008), IUGR (p=0.035) and a higher incidence of LSCS (p=0.020). Maiti GD et al, reported that the incidence of cesarean delivery in the severe oligohydramnios group (AFI≤5) was 79%.[18] This rate is notably higher than the findings of Sriya et al, (43.05%), Guin et al, (42.8%) and Casey et al, (51%), but closely aligns with the study by Visvalingam et al, (75.6%).[20-23] The elevated cesarean rate in this study may be attributed to the overall rising trend in operative deliveries and increased patient preference for cesarean sections.

Furthermore, non-reactive NST was substantially associated with low birth weight (p=0.002), IUGR (p=0.025) and heightened NICU hospitalizations (p=0.045), highlighting its predictive value for fetal distress. The APGAR score at 1 minute was much lower in the thick meconium-stained group (mean 5.89, SD 0.98) compared to the other groups (p=0.007), perhaps indicating poor newborn health immediately post-delivery. Maiti GD et al, revealed that the incidence of an Apgar score below 7 at 1 minute and 5 minutes in cases with AFI<5 was 79.1% and 39.5%, respectively. These findings are notably higher compared to other studies including Sriya et al, Umber et al and Chandra et al.[24,25]

The diagnostic performance for predicting neonatal complications was evaluated across three parameters. The amount of liquor demonstrated a sensitivity of 77.78%

(95% CI: 39.99%–97.19%), specificity of 50.00% (95% CI: 6.76%–93.24%), a positive predictive value (PPV) of 77.78%, a negative predictive value (NPV) of 50.00% and an overall accuracy of 69.23%. Similarly, the color of liquor showed a sensitivity of 80.00% (95% CI: 44.39%–97.48%) with the same specificity of 50.00%, PPV of 80.00%, NPV of 50.00% and a slightly higher accuracy of 71.43%. In contrast, the NST exhibited the highest sensitivity at 81.82% (95% CI: 48.22%–97.72%) but a lower specificity of 33.33% (95% CI: 4.33%–77.72%), resulting in a PPV of 69.23%, NPV of 50.00% and an overall accuracy of 64.71%.

Anand et al, reported in their study that in the oligohydramnios group (AFI<5 cm), there was a significant association with pathological NST at admission, meconium-stained liquor during labor, cesarean delivery for fetal distress, low Apgar score (<7) at 1 minute, NICU admission and neonatal mortality, with a highly significant p-value (<0.00001). In addition, the study revealed that NST, AFI and the color of amniotic fluid serve as reliable predictors of fetal well-being in pregnancies between 37 and 41.6 weeks. Their study highlighted that the likelihood of adverse outcomes, including operative delivery and low Apgar scores, increases in cases of oligohydramnios, pathological NST and meconium-stained liquor.[26]

Clinical implications

The findings of this study underscore the clinical importance of detailed antepartum and intrapartum fetal surveillance using NST, AFI measurement and liquor color assessment. The significant associations between non-reactive NST, low AFI and adverse neonatal outcomes such as low birth weight, IUGR and low APGAR scores emphasize the need for close monitoring and timely intervention in pregnancies with abnormal liquor characteristics. This comprehensive evaluation can aid in stratifying risk and guiding decisions regarding the mode of delivery and neonatal care, potentially improving perinatal outcomes in high-risk pregnancies.

While the study provides valuable insights, several limitations should be acknowledged. The sample size, although adequate per the initial calculation, was relatively small and derived from a single geographical area, which may limit the generalizability of the findings. Furthermore, the study design was cross-sectional, precluding any causal inferences. Variability in ultrasound measurements and subjective interpretation of liquor color could also introduce bias. Future studies with larger, multicentric cohorts and standardized assessment protocols are warranted to validate these findings.

CONCLUSION

We determined that while both the color of amniotic fluid and the amniotic fluid index exhibited strong sensitivity in detecting fetal distress, the necessity for NICU admission, interventional deliveries and high-risk pregnancies, the non-reactive non-stress test emerged as a more dependable indicator during labor. It remains a crucial instrument for tracking labor progression and facilitating prompt interventions during active labor.

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