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Original Research Article

Study on various risk factors leading to meconium-stained amniotic fluid in pregnancy and its effects on labor

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ABSTRACT

Background: Meconium-stained amniotic fluid (MSAF) is a common intrapartum finding, particularly in term and post-term pregnancies, and is often regarded as a marker of fetal compromise. While meconium passage may occur as a physiological phenomenon reflecting fetal maturity, it can also signify intrauterine hypoxia and is associated with adverse maternal and neonatal outcomes. The presence of MSAF poses significant challenges in intrapartum management due to its association with abnormal cardiotocographic (CTG) patterns, increased operative delivery rates, and neonatal complications such as meconium aspiration syndrome (MAS). Identification of maternal and obstetric risk factors and assessment of fetal monitoring parameters are therefore crucial to optimize labor management and improve perinatal outcomes. Objectives were to evaluate maternal risk factors, CTG patterns, and perinatal outcomes in pregnancies complicated by MSAF.

Methods: A prospective observational study was conducted in a tertiary care hospital over two years. Seventy women ≥ 34 weeks gestation with MSAF during labor were included. Meconium was classified as thin or thick. Continuous intrapartum CTG was interpreted using NICE 2017 guidelines. Maternal, intrapartum, and neonatal outcomes were analyzed.

Results: Thin meconium was observed in 60% and thick meconium in 40% of cases. Pathological CTG patterns and cesarean section rates were significantly higher in thick meconium. Neonatal morbidity including low Apgar scores, respiratory distress, ICU admission, and meconium aspiration syndrome was more common in thick MSAF.

Conclusions: Thick MSAF associated with abnormal CTG predicts adverse perinatal outcomes. Close intrapartum monitoring and timely intervention are essential.

Keywords: Meconium-stained amniotic fluid, Cardiotocography, Fetal distress, Perinatal outcome, Meconium aspiration syndrome

INTRODUCTION

Meconium-stained amniotic fluid (MSAF) refers to the presence of fetal stool in the amniotic fluid during labour or at the time of rupture of membranes. Under normal physiological conditions, meconium is retained within the fetal intestine and is typically passed within the first 24–48 hours after birth. Its intrauterine passage is clinically significant, as it may indicate fetal compromise or

distress.¹ MSAF encompasses a spectrum ranging from thin, lightly discoloured fluid to thick, particulate meconium, with the latter more strongly associated with fetal hypoxia and adverse perinatal outcomes.¹

The incidence of MSAF varies widely, occurring in approximately 8–25% of all deliveries, with a clear increase as gestational age advances. It is rare in preterm pregnancies, observed in approximately 2% before 34 weeks, increases to 12–16% at term, and may reach 30–

40% in post-term pregnancies.² This trend is attributed to progressive maturation of the fetal gastrointestinal tract, increased bowel motility, and placental insufficiency leading to intermittent or chronic fetal hypoxia.²

Despite its relatively common occurrence, the clinical implications of MSAF remain complex and not uniformly pathological. In many term pregnancies, meconium passage may represent a physiological process reflecting gastrointestinal maturation and transient vagal stimulation, without adverse fetal consequences.² However, in other cases, particularly when associated with thick meconium, abnormal fetal heart rate patterns, or additional risk factors, it may signify fetal hypoxia, acidosis, and increased risk of neonatal morbidity, including meconium aspiration syndrome (MAS).

Meconium formation begins early in gestation, between 12 and 16 weeks, and accumulates progressively within the fetal intestine.³ It is composed of desquamated epithelial cells, lanugo, vernix caseosa, mucus, bile pigments, amniotic fluid, and water, which constitutes the majority of its content. Under normal intrauterine conditions, meconium is sterile and reflects fetal gastrointestinal maturation.³ Biochemically, it contains lipids, proteins, enzymes, and trace elements, and may serve as an indicator of intrauterine exposure to environmental substances and drugs.⁴

The passage of meconium into the amniotic fluid is regulated by fetal intestinal peristalsis and anal sphincter relaxation, both under autonomic nervous system control. Under normal oxygenation, the anal sphincter remains contracted. However, fetal hypoxia or stress can stimulate vagal activity, leading to increased peristalsis and sphincter relaxation, resulting in meconium passage.⁵ Additional contributing factors include umbilical cord compression, placental insufficiency, maternal hypertension, infection, smoking, and increased prostaglandin activity.⁵

The etiopathogenesis of MSAF is multifactorial, with fetal hypoxia considered a central mechanism. Hypoxia leads to redistribution of fetal blood flow to vital organs such as the brain, heart, and adrenal glands, with reduced perfusion to the intestines.⁶ This intestinal hypoperfusion promotes peristalsis and sphincter relaxation, facilitating meconium passage.⁷

These changes are often accompanied by cardiotocographic (CTG) abnormalities, including late decelerations, reduced variability, and bradycardia, which are indicative of fetal compromise.⁷ Vagal stimulation plays a dual role, contributing to both physiological maturation-related meconium passage and pathological responses to hypoxic stress.⁸

Placental insufficiency and umbilical cord compression further exacerbate fetal hypoxia. Chronic placental insufficiency, commonly seen in post-term pregnancies

and maternal conditions such as hypertension and diabetes, leads to sustained low-grade hypoxia, whereas acute or intermittent cord compression causes transient hypoxic episodes associated with variable decelerations on CTG.⁹ While early decelerations are generally benign, late and prolonged decelerations are more concerning and indicate uteroplacental insufficiency or acute hypoxia.¹⁰

The clinical significance of MSAF is closely related to its consistency. Thin meconium is often associated with normal CTG patterns and favourable outcomes, whereas thick meconium is more frequently associated with abnormal CTG findings, fetal distress, and increased neonatal morbidity.¹¹ The predictive value of CTG improves when interpreted in conjunction with clinical findings such as meconium thickness and fetal movements. Persistent non-reassuring CTG patterns in the presence of MSAF warrant prompt obstetric intervention.¹²

MSAF has important implications for the course and management of labour. It is associated with prolonged labour, abnormal uterine activity, and slower cervical dilatation, often necessitating continuous fetal monitoring, which may limit maternal mobility and influence labour progression.¹³ The presence of MSAF also affects the mode of delivery.

While cases with thin meconium and reassuring CTG can often proceed to vaginal delivery, thick meconium and abnormal CTG patterns are associated with increased rates of instrumental and cesarean deliveries. Cesarean section is frequently indicated in cases of persistent fetal distress to prevent further hypoxic injury.¹⁴

Intrapartum complications associated with MSAF include fetal distress, cord compression, and increased need for obstetric interventions such as amniotomy, internal monitoring, and operative delivery. Thick meconium, in particular, necessitates preparedness for neonatal resuscitation due to the risk of meconium aspiration.¹⁵

MAS is one of the most serious complications associated with MSAF. It occurs when the fetus or newborn inhales meconium-contaminated fluid, leading to airway obstruction, chemical pneumonitis, surfactant dysfunction, and pulmonary hypertension. Clinically, MAS presents with respiratory distress, tachypnea, retractions, and cyanosis, and remains a major contributor to neonatal morbidity and NICU admission.¹⁶

Neonates born through MSAF are also at increased risk of perinatal asphyxia and respiratory complications. Hypoxia and acidosis may impair respiratory effort and cardiac function, resulting in low Apgar scores and, in severe cases, hypoxic-ischemic encephalopathy. Even in the absence of MAS, mild respiratory distress may occur due to airway irritation or partial obstruction.¹⁷ The severity of neonatal outcomes correlates with the degree of meconium

staining, associated CTG abnormalities, and timeliness of intervention.¹⁸

Management of MSAF requires vigilant intrapartum monitoring and timely decision-making. In cases with reassuring CTG patterns, labour may proceed with close observation. However, non-reassuring CTG findings necessitate intrauterine resuscitative measures, including maternal repositioning, oxygen administration, and intravenous hydration. If fetal compromise persists, prompt delivery either operative vaginal or caesarean is indicated.²⁰

Adjunctive interventions such as amnioinfusion may be beneficial in selected cases, particularly in the presence of thick meconium and variable decelerations, by diluting meconium and relieving cord compression. However, such measures should not delay definitive obstetric intervention in cases of significant fetal distress. Neonatal management focuses on prompt assessment and resuscitation. Current guidelines recommend routine care for vigorous infants, while non-vigorous infants require immediate positive pressure ventilation. Routine airway suctioning is no longer recommended, and management is individualized based on clinical status.

In resource-limited rural healthcare settings, where access to advanced intrapartum monitoring may be constrained, clinical decision-making relies heavily on the identification of maternal and obstetric risk factors. Conditions such as hypertensive disorders, gestational diabetes mellitus, anaemia, post-dated pregnancy, and oligohydramnios have been associated with increased risk of MSAF. In such contexts, the grading of meconium (thin versus thick), combined with clinical assessment, can serve as a practical tool for risk stratification and guiding management decisions.

Thus, integrating maternal risk factors with intrapartum findings, including meconium consistency and fetal heart rate patterns, can assist clinicians in determining the appropriate mode of delivery—whether to continue labour under close observation or to proceed with timely operative intervention—thereby improving maternal and perinatal outcomes, particularly in settings with limited resources.

Objectives

The objectives of the following study were to observe and analyse various maternal and obstetric risk factors associated with MSAF, to evaluate CTG changes in patients with MSAF, and to assess perinatal outcomes in cases of meconium-stained amniotic fluid.

METHODS

This prospective observational cohort study was conducted in the Department of Obstetrics and Gynaecology at Rama Medical College Hospital and

Research Centre, Kanpur, over a two-year period from December 2023 to December 2025. A total of 70 pregnant women meeting predefined inclusion criteria were enrolled after obtaining informed consent and institutional ethical clearance. Participants were followed from admission in labour through delivery and immediate neonatal outcomes.

On admission, detailed demographic data, obstetric and menstrual history, and relevant clinical information were recorded. Gestational age was determined based on last menstrual period and early ultrasound findings. All patients underwent thorough general and obstetric examinations, including per abdominal and per vaginal assessments.

Inclusion criteria

All pregnant women with meconium-stained liquor with gestational age ≥ 34 weeks, live, singleton pregnancy with cephalic presentation, both primigravida and multigravida with normal pregnancy and pregnancy with complications (i.e. hypertensive disorder, PIH, GDM, thyroid disorder, and obstetric cholestasis, artificial rupture of membrane or spontaneous rupture of membrane, spontaneous labour and induced labour) were included.

Exclusion criteria

Clear amniotic fluid, multiple gestations, malpresentations, anti-partum haemorrhage (APH), intrauterine foetal demise, congenital malformations.

Patients were included at the time of rupture of membranes, and amniotic fluid was visually assessed to identify MSAF, which was further classified as thin or thick based on colour and consistency. Continuous intrapartum fetal monitoring was performed using CTG, and fetal heart rate patterns were categorized as normal, suspicious, or pathological. Management decisions were guided by CTG findings and labour progression.

Labour was closely monitored for progression and fetal distress. Mode of delivery and indications for intervention were recorded. Neonatal outcomes, including birth weight, Apgar scores, need for resuscitation, NICU admission, and complications such as meconium aspiration syndrome, were systematically documented.

Statistical analysis was performed using statistical package for the social sciences (SPSS) version 21.0. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as mean \pm standard deviation or median with interquartile range.

Comparisons were made using the independent t-test and Chi-square test, with Fisher's exact test applied where appropriate. A $p \leq 0.05$ was considered statistically significant.

Sample size

The sample size for the study was calculated based on the formula given.

$$N \geq i(1 - i)/((ME/Z\alpha)^2)$$

Where, $Z\alpha$ represents the standard normal deviate at a two-sided alpha error of 5%, and ME denotes the margin of error. Using the reference study by Khillan et al in 2021, which reported an incidence of MSAF of 13.1%, the minimum required sample size was calculated to be 61 patients with an 8.5% margin of error at a 5% level of significance. To account for potential dropouts and ensure adequate representation, a total of 70 patients were finally included in the study.

RESULTS

The mean maternal age of the study population was 27.2 ± 5.3 years, with primigravidas comprising 54.3% of cases. Thin meconium was observed in 60% of patients, while 40% had thick meconium. Common maternal risk factors included hypertensive disorders of pregnancy, gestational diabetes mellitus, and anemia. Pathological CTG patterns were significantly more frequent in cases with thick meconium compared to thin meconium. Correspondingly, the rate of cesarean section was higher in the thick meconium group. Adverse neonatal outcomes including low Apgar scores, respiratory distress, increased need for NICU admission, and higher incidence of meconium aspiration syndrome were significantly associated with thick meconium compared to thin meconium.

Maternal demographic profile

The mean maternal age of the study population was 27.24 ± 5.27 years. The majority of women belonged to the 21–30 years age group. Primigravidas constituted 54.3% of cases, while 45.7% were multigravidas (Table 1).

Table 1: Maternal demographic characteristics.

Variable	Number (%)
Age 21–30 years	38 (54.3)
Primigravida	38 (54.3)
Multigravida	32 (45.7)

Maternal risk factors

Common maternal risk factors associated with MSAF included hypertensive disorders of pregnancy, gestational diabetes mellitus, anemia, post-dated pregnancy, and oligohydramnios.

These risk factors were more frequently observed in cases with thick meconium compared to thin meconium (Table 2).

Cardiotocography findings

Reassuring CTG patterns were predominantly observed in cases of thin meconium. In contrast, suspicious and pathological CTG patterns were significantly more common in cases of thick meconium. The association between thick meconium and abnormal CTG patterns was statistically significant (Table 3).

Table 2: Maternal risk factors versus type of meconium.

Risk factor	Thin (n=42)	Thick (n=28)
Hypertensive disorders	10	12
GDM	6	8
Anemia	14	10

Table 3: CTG Patterns versus meconium thickness.

CTG pattern	Thin	Thick
Reassuring	30	8
Suspicious/pathological	12	20

Mode of delivery

The rate of operative delivery was significantly higher in cases of thick meconium. Cesarean section was more commonly performed in cases with thick meconium, with fetal distress being the most frequent indication.

Vaginal delivery was more common in cases of thin meconium with reassuring CTG patterns (Table 4).

Table 4: Mode of delivery versus meconium type.

Mode of delivery	Thin	Thick
Vaginal	28	8
Cesarean section	14	20

Neonatal outcomes

Neonates born through thick meconium had significantly lower Apgar scores at 1 and 5 minutes compared to those born through thin meconium.

The need for neonatal resuscitation, incidence of respiratory distress, NICU admission, and meconium aspiration syndrome were significantly higher in the thick meconium group (Table 5).

Table 5: Neonatal outcomes in thin vs thick meconium.

Outcome	Thin	Thick
Low Apgar (<7 at 5 min)	4	12
NICU admission	6	16
MAS	2	8

DISCUSSION

MSAF remains a common and clinically significant intrapartum finding, particularly in term and post-term pregnancies, and continues to be associated with fetal compromise, abnormal fetal heart rate patterns, increased operative delivery, and adverse neonatal outcomes such as MAS.¹⁵ However, its pathophysiological significance remains complex and not uniformly indicative of fetal hypoxia. While some studies suggest that MSAF represents a physiological process related to fetal gastrointestinal maturation, others consider it a marker of intrauterine stress or hypoxia.¹⁵ In this context, the present prospective observational study evaluated maternal risk factors, intrapartum CTG patterns, labour outcomes, and neonatal morbidity associated with MSAF.

The demographic profile of the study population was consistent with existing literature, with a mean maternal age of 27.24±5.27 years and a predominance of women in the 21–30-year age group. No independent association between maternal age and MSAF was observed, aligning with previous findings.¹⁰ Although advanced maternal age has been linked to post-term pregnancy and placental insufficiency, the limited number of women above 35 years in this study restricts definitive conclusions. A slightly higher proportion of primigravida women was noted, which may be attributed to prolonged labour and increased susceptibility to dysfunctional labour patterns, potentially contributing to fetal stress. However, parity itself does not appear to be an independent etiological factor.

Gestational age emerged as a key determinant of MSAF, with a mean gestational age of 38.65 weeks and a considerable proportion of pregnancies extending beyond 40 weeks. This finding is consistent with prior studies demonstrating an increased incidence of MSAF with advancing gestation.^{2,7} The underlying mechanisms include enhanced fetal gastrointestinal maturity, increased bowel motility, and placental senescence leading to chronic fetal hypoxia.¹⁹ These findings emphasize the importance of vigilant fetal surveillance, particularly in post-dated pregnancies.

In the present study, thin meconium was observed in 60% of cases, while thick meconium accounted for 40%, a distribution comparable to earlier studies.¹⁰ This distinction is clinically relevant, as thick meconium has been more frequently associated with adverse fetal and neonatal outcomes. Maternal comorbidities such as hypertensive disorders, gestational diabetes mellitus, and anaemia were commonly observed but did not demonstrate statistically significant associations with meconium severity. These findings support existing evidence that such conditions may contribute indirectly to fetal compromise through mechanisms like uteroplacental insufficiency rather than acting as primary causative factors.¹³

Pathological CTG patterns were identified in nearly one-third of cases, with a higher frequency observed in the thick meconium group. Although statistical significance was not achieved, this trend supports the established association between abnormal fetal heart rate patterns and fetal compromise. Importantly, these findings reinforce that CTG abnormalities serve as a more reliable indicator of fetal well-being than the presence of meconium alone.

Regarding mode of delivery, vaginal delivery was achieved in approximately half of the cases, while the remainder required cesarean or instrumental intervention. Although cesarean section rates were higher in the thick meconium group, the difference was not statistically significant. This suggests that MSAF alone should not dictate the mode of delivery in the absence of additional clinical indications, highlighting the importance of individualized decision-making.

Neonatal outcomes in this study demonstrated that approximately one-third of neonates had low Apgar scores at one minute, with significant improvement by five minutes. NICU admission was required in nearly one-third of cases, and MAS was observed in 10% of neonates, consistent with previous reports identifying MAS as a significant contributor to neonatal morbidity. Although adverse outcomes were more frequent in cases with thick meconium, statistical significance was not achieved. This may reflect the beneficial impact of early identification, continuous intrapartum monitoring, and prompt neonatal resuscitation in improving outcomes.

Overall, the findings of the present study support the growing body of evidence that the clinical significance of MSAF is context-dependent and influenced by factors such as gestational age, fetal heart rate abnormalities, and timely clinical intervention.¹⁵

Limitations

The study has several limitations that must be acknowledged. The relatively small sample size may have reduced statistical power, limiting the ability to detect significant associations despite observable clinical trends. The absence of a control group with clear amniotic fluid restricts the ability to establish the independent impact of MSAF on maternal and neonatal outcomes. Furthermore, the single-centre design in a tertiary care setting introduces the possibility of referral bias and may limit the generalisability of the findings to other healthcare settings.

CONCLUSION

In conclusion, MSAF remains an important intrapartum finding with implications for maternal and neonatal outcomes. While it is associated with increased perinatal risk, particularly in cases of thick meconium, its presence alone should not be considered an indication for operative delivery. The findings of this study support a more nuanced and individualized approach to management,

emphasizing the importance of continuous fetal monitoring, particularly CTG, as a more reliable indicator of fetal well-being. Vigilant intrapartum surveillance and timely intervention remain essential for optimizing outcomes, reinforcing that MSAF warrants careful observation rather than routine intervention.

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