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Risk factors for MSL and its effect on perinatal outcome

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ABSTRACT

Background: Meconium-stained liquor (MSL) is a common obstetric finding associated with increased perinatal morbidity and mortality. The presence of meconium in amniotic fluid may indicate fetal distress and is linked with complications such as birth asphyxia, meconium aspiration syndrome (MAS), respiratory distress, persistent pulmonary hypertension of the newborn (PPHN), neonatal sepsis, and increased neonatal intensive care unit (NICU) admissions. Early identification of maternal and fetal risk factors associated with MSL is essential for improving neonatal outcomes.

Aim: To study the risk factors for meconium-stained liquor during labour and its effect on perinatal outcome.

Objectives:

1. To analyse the maternal and fetal risk factors associated with meconium-stained liquor.
2. To compare the perinatal outcomes of meconium-stained liquor in preterm, term, and post-term pregnancies.
3. To study the correlation between identified risk factors and adverse perinatal outcomes.

Materials and Methods: This hospital-based observational study was conducted in the Department of Pediatrics and Obstetrics & Gynecology at a tertiary care centre. Neonates born through meconium-stained amniotic fluid during the study period were included. Maternal demographic data, antenatal and intrapartum risk factors, gestational age, mode of delivery, fetal heart rate abnormalities, APGAR scores, NICU admissions, and neonatal complications were recorded and analysed. Perinatal outcomes were compared among preterm, term, and post-term pregnancies.

Results: The incidence of meconium-stained liquor was higher among term and post-term pregnancies. Common maternal risk factors identified included post-dated pregnancy, oligohydramnios, pregnancy-induced hypertension, gestational diabetes mellitus, prolonged labour, fetal distress, and intrauterine growth restriction. Thick meconium-stained liquor was associated with a higher incidence of abnormal cardiotocography, lower APGAR scores, increased rate of caesarean section, NICU admission, birth asphyxia, respiratory distress, and meconium aspiration syndrome. Adverse neonatal outcomes were more frequently observed in cases with thick meconium and associated fetal distress.

Conclusion: Meconium-stained liquor remains an important predictor of adverse perinatal outcome, especially in term and post-term pregnancies. Identification of maternal and intrapartum risk factors, continuous fetal monitoring, timely obstetric intervention, and prompt neonatal resuscitation are essential to reduce neonatal morbidity and mortality associated with MSL and MAS.

Keywords: Meconium-stained liquor, Meconium aspiration syndrome, Perinatal outcome, NICU admission, Fetal distress, Pregnancy-induced hypertension, Oligohydramnios, Neonatal morbidity.

INTRODUCTION

Meconium-stained liquor (MSL), also referred to as meconium-stained amniotic fluid (MSAF), is a significant obstetric and neonatal concern associated with increased perinatal morbidity and mortality. Meconium is a thick, viscous, greenish-black sterile material present in the fetal intestine, composed of water, desquamated epithelial cells, lanugo, vernix caseosa, mucus, bile pigments, pancreatic enzymes, and intestinal secretions.[1] Formation of meconium begins around the 10th week of gestation; however, its passage into the amniotic fluid before birth is generally uncommon due to poor fetal intestinal peristalsis and tonic contraction of the anal sphincter.

The passage of meconium into the amniotic fluid is more commonly observed in term and post-term pregnancies and is considered an important indicator of fetal compromise. Meconium passage may occur as a physiological event in mature fetuses or as a pathological response to fetal hypoxia and distress. Hypoxic stress stimulates vagal activity, causing increased intestinal peristalsis and relaxation of the anal sphincter, resulting in the passage of meconium into the amniotic cavity.[2] Conditions such as placental insufficiency, post-dated pregnancy, oligohydramnios, pregnancy-induced hypertension, gestational diabetes mellitus, intrauterine growth restriction (IUGR), prolonged labour, and fetal distress are commonly associated with MSL.

Globally, meconium-stained amniotic fluid complicates approximately 10–22% of all deliveries, with incidence increasing significantly after 37 weeks of gestation. It is observed in nearly 10% of pregnancies at 36 weeks, 30% at 40 weeks, and up to 50% at 42 weeks of gestation.[3] Although not all neonates born through meconium-stained liquor develop complications, the presence of thick meconium is strongly associated with adverse neonatal outcomes.

One of the most serious complications associated with MSL is Meconium Aspiration Syndrome (MAS), which occurs when meconium-contaminated amniotic fluid is aspirated into the fetal or neonatal airway before, during, or immediately after birth. MAS develops in approximately 1–3% of neonates born through meconium-stained liquor and remains an important cause of neonatal respiratory distress and mortality.

Additionally, inflammatory mediators present in meconium initiate a severe inflammatory response within the lungs, resulting in chemical pneumonitis and surfactant dysfunction. These changes impair gaseous exchange and may precipitate pulmonary hypertension and severe neonatal hypoxia.[4]

Clinically, neonates born through meconium-stained liquor may present with respiratory distress, tachypnea, cyanosis, chest retractions, low APGAR scores, birth asphyxia, and need for NICU admission. Thick meconium-stained liquor is associated with increased operative delivery rates, abnormal cardiotocography (CTG), neonatal sepsis, hypoxic ischemic encephalopathy (HIE), prolonged hospital stay, and increased perinatal mortality. [5]

Several studies have demonstrated that increasing grades of meconium staining correlate with worsening neonatal outcomes. The presence of thick meconium, especially when associated with abnormal fetal heart rate patterns, significantly increases the incidence of caesarean section, meconium aspiration syndrome, respiratory complications, and NICU admissions. However, many neonates born through thin meconium-stained liquor remain asymptomatic and require only routine neonatal care. [6]

Early recognition of maternal and fetal risk factors associated with MSL is therefore essential for timely obstetric intervention and neonatal management. Continuous fetal monitoring during labour, prompt identification of fetal distress, preparedness for neonatal resuscitation, and availability of NICU support play a crucial role in reducing neonatal morbidity and mortality associated with meconium-stained liquor.

The present study was undertaken to analyse the various maternal and fetal risk factors associated with meconium-stained liquor during labour and to evaluate its impact on perinatal outcomes in preterm, term, and post-term pregnancies. The findings of this study may help in improving risk stratification, optimizing obstetric and neonatal management protocols, and ultimately improving neonatal survival and long-term outcomes.

Aim & Objectives:

1. To analyse the risk factors related with meconium stained liquor.
2. To compare the perinatal outcome of meconium stained liquor in pre-term, term, and post-term pregnancy.
3. To study the correlation between the risk factors and the perinatal outcomes of meconium stained liquor.

MATERIAL AND METHODS:

The present study entitled "Study of Risk Factors for Meconium Stained Liquor During Labour and its Effect on Perinatal Outcome" was conducted in the Department of Pediatrics, Muzaffarnagar Medical College.

Study Design

Hospital-based observational prospective study.

Study Place

Department of Pediatrics, Muzaffarnagar Medical College.

Study Population

The study population comprised neonates born with meconium-stained amniotic fluid (MSL) and admitted to the outpatient department (OPD) or inpatient department (IPD) of the Department of Pediatrics, Muzaffarnagar Medical College and Hospital, fulfilling the inclusion criteria.

Study Duration

The duration of the study was 18 months, including:

- 12 months of data collection
- 6 months of data compilation and analysis

Sample Size

A total of 100 neonates diagnosed with meconium-stained liquor were included in the study. The sample size was calculated based on the average number of diagnosed MSL cases during the preceding three years at Muzaffarnagar Medical College and Hospital and the feasibility within the study duration.

Sampling Technique

A purposive sampling technique was employed. All neonates fulfilling the inclusion criteria and presenting during the study period were consecutively enrolled until the desired sample size was achieved.

Inclusion Criteria

- All neonates diagnosed with meconium-stained liquor during labour
- Neonates presenting to OPD or admitted in IPD of the Department of Pediatrics
- Neonates whose parents gave consent for participation

Exclusion Criteria

- Neonates with clear amniotic fluid
- Neonates with unknown gestational age
- Intrauterine fetal deaths or fetal death on admission
- Neonates with congenital malformations
- Neonates whose parents did not provide informed consent for participation

Study Procedure

All neonates diagnosed with meconium-stained liquor during labour and delivered at Muzaffarnagar Medical College and Hospital or referred to the pediatric department were included in the study after fulfilling eligibility criteria.

Maternal and Antenatal Data Collection

Maternal details were recorded using a structured proforma, including:

- Maternal age
- Parity and gravidity
- Antenatal care status
- Gestational age at delivery
- Presence of maternal risk factors such as:
    - Gestational hypertension
    - Oligohydramnios
    - Gestational diabetes
    - Anaemia
    - Antepartum hemorrhage
    - Prolonged rupture of membranes
    - History of substance use (tobacco exposure)
    - Post dated pregnancy
    - Thyroid disorders

Intrapartum Data Collection
Details related to labour and delivery were documented, including:

- Gestational age at delivery (preterm, term, post-term)
- Mode of delivery (normal vaginal delivery, instrumental delivery, or cesarean section)
- Duration of labour
- Fetal heart rate monitoring during labour (continuous or intermittent)

Neonatal Assessment
All neonates were assessed immediately after birth and during hospital stay for the following parameters:

- Birth weight
- APGAR score at 1 minute and 5 minutes
- Requirement of neonatal resuscitation
- Need for endotracheal intubation
- Development of meconium aspiration syndrome (MAS)
- Grading of MAS
- Need for NICU admission, including indication and duration of stay
- Occurrence of neonatal infections
- Length of hospital stay
- Perinatal mortality, if any

Neonates were managed according to standard neonatal care protocols of the institution.

Outcome Measures
Primary Outcome

- Identification of maternal, fetal, and intrapartum risk factors associated with meconium-stained liquor

Secondary Outcomes

- Assessment of perinatal outcomes including birth asphyxia, MAS, NICU admission, and neonatal mortality
- Comparison of outcomes among preterm, term, and post-term neonates with MSL
- Correlation between identified risk factors and adverse perinatal outcomes

Data Collection Method
The sample size of 100 was selected based on the three-year average number of neonates with meconium-stained liquor admitted at Muzaffarnagar Medical College and Hospital. Data were recorded using a pre-designed and pre-structured questionnaire and case record form, which included maternal details, intrapartum factors, and neonatal outcomes.

Statistical Analysis and Software
Data entry was performed using Microsoft Excel, and statistical analysis was carried out using SPSS version 30.

- Quantitative variables were expressed as mean ± standard deviation.
- Qualitative variables were expressed as frequencies and percentages.
- Chi-square test or Fisher's exact test was applied for categorical variables.
- A p-value of <0.05 was considered statistically significant, while $p<0.001$ was considered highly statistically significant.

RESULTS
Table 1: **Association between grading of MAS with maternal risk factors**
In Table 1, the association between maternal risk factors and the severity of meconium aspiration syndrome (MAS) was analyzed.

Maternal age did not show a statistically significant association with MAS severity, as most cases across all grades occurred in mothers aged 19–35 years, and the distribution among mild, moderate, and severe MAS was comparable ($p = 0.49$). Similarly, parity had no significant influence on MAS severity, with primigravidae and multigravidae demonstrating similar distributions across MAS grades ($p = 0.74$).

Maternal weight gain during pregnancy was also not significantly associated with MAS severity ($p = 0.42$). Regular antenatal visits likewise did not show a statistically significant association with MAS grading ($p = 0.18$), although severe MAS appeared relatively more frequent among mothers with irregular antenatal care.

In contrast, a statistically significant association was observed between the number of pregnancy scans and MAS severity ($p = 0.04$). Moderate and severe MAS were more common among mothers who had undergone two or more antenatal scans, possibly reflecting increased surveillance in pregnancies identified as high risk.

The mode of delivery did not significantly influence MAS severity (p = 0.20). However, a greater number of moderate and severe MAS cases were observed among neonates delivered by LSCS, likely due to underlying fetal distress necessitating operative delivery rather than the delivery mode itself.

Importantly, fetal monitoring during labour demonstrated a statistically significant association with MAS severity (p = 0.03). A larger proportion of moderate and severe MAS cases occurred in pregnancies where fetal monitoring was performed, suggesting that high-risk labours with suspected fetal compromise were more closely monitored and subsequently diagnosed with more severe MAS.

Overall, this table demonstrates that among the maternal risk factors studied, the number of pregnancy scans and intrapartum fetal monitoring were significantly associated with MAS severity, whereas maternal age, parity, maternal weight gain, antenatal visits, and mode of delivery did not show significant associations.

Table 1: Association between grading of MAS with maternal risk factors:

Maternal risk factors	Mild MAS	Moderate MAS	Severe MAS
Maternal age (in years)			
19-35	04	29	19
>35	00	03	04
p value		0.49	
Parity			
Primigravidae	02	21	16
Multigravidae	02	11	07
p value		0.74	
Weight gain during pregnancy (in kg)			
< 8 kgs	01	05	03
8- 10 kgs	01	21	14
11-12 kgs	02	04	06
>12 kgs	00	02	00
p value		0.42	
Regular visits			
Yes	02	23	11
No	02	09	12
p value		0.18	
Pregnancy scans			
1	02	03	02
2	00	06	10
3	00	12	04
4	02	11	07
p value		**0.04**	
Mode of delivery			
LSCS	03	19	11
Institutional VD	00	09	05
Non- institutional VD	01	04	07
p value		0.20	
Fetal monitoring during labour			
Yes	03	28	16
No	01	04	07
p value		**0.03**	

Table 2: Association between grading of MAS with neonatal risk factors

Table 2 evaluates the association between neonatal risk factors and the severity of meconium aspiration syndrome (MAS). Birth weight did not show a statistically significant association with MAS grading (p = 0.09), although moderate and severe MAS were more commonly observed among neonates weighing less than 2.5 kg, suggesting a possible trend toward poorer outcomes in low-birth-weight infants.

APGAR scores demonstrated a strong and statistically significant relationship with MAS severity. At 1 minute, low APGAR scores (0–5) were increasingly common with worsening MAS severity and were highest in the severe MAS group (p = 0.009). A similar trend was observed at 5 minutes, where persistently low APGAR scores were significantly more frequent in severe MAS (p = 0.02), indicating prolonged neonatal depression and compromised adaptation after birth.

The requirement for neonatal resuscitation was very strongly associated with MAS severity ($p < 0.0001$) Endotracheal intubation showed a highly significant association with severe MAS ($p < 0.0001$), reflecting marked respiratory compromise in these neonates.

All neonates with MAS required NICU admission; therefore, statistical comparison was not applicable. However, the intensity of NICU care was substantially greater among moderate and severe MAS cases.

Neonatal sepsis demonstrated a statistically significant association with MAS severity ($p = 0.004$). Most neonates with moderate and severe MAS developed sepsis, whereas sepsis was relatively uncommon in mild MAS. Although early-onset sepsis appeared more frequent in severe MAS, the difference between early- and late-onset sepsis was not statistically significant ($p = 0.08$).

Blood culture positivity was significantly higher among severe MAS cases ($p < 0.0001$), indicating an increased risk of systemic infection in critically ill neonates. Klebsiella pneumoniae was the most commonly isolated organism in severe MAS, followed by MSSA, E. coli, and Pseudomonas species. However, the distribution of isolated organisms across MAS grades was not statistically significant ($p = 0.18$).

Duration of hospital stay was significantly associated with MAS severity ($p = 0.0004$).
Similarly, oxygen and ventilatory support demonstrated a very strong association with MAS severity ($p < 0.0001$). Mechanical ventilation was required in nearly all severe MAS cases, whereas most moderate MAS cases were managed with high-flow nasal cannula (HHFNC), and mild MAS generally required only minimal oxygen supplementation.

Overall, this table clearly demonstrates that increasing severity of MAS is associated with poorer neonatal condition at birth, greater need for resuscitation and respiratory support, higher rates of neonatal sepsis and blood culture positivity, prolonged hospitalization, and increased intensive care requirements.

Table 2: Association between grading of MAS with neonatal risk factors:

Neonatal risk factors	Mild MAS	Moderate MAS	Severe MAS
Birth weight			
<1 kg	00	00	00
<1.5 kg	00	00	00
<2.5 kg	00	08	10
2.5-4 kgs	04	24	13
p value	0.09		
APGAR Score			
At 1 min			
0-5	03	19	22
6-10	01	11	01
Not known	00	02	00
p value	**0.009**		
At 5 min			
0-5	00	01	03
6-10	04	29	20
Not known	00	02	00
p value	**0.02**		
Need for resuscitation			
Yes	03	10	23
No	01	22	00
p value	**<0.0001**		
Intubation			
Yes	02	01	23
No	02	31	00
p value	**<0.0001**		
NICU admission			
Yes	04	32	23
No	00	00	00
p value	**NA**		
MAS			

Yes	04	32	23
No	00	00	00
p value	**NA**		
Neonatal sepsis			
Yes	02	30	23
No	02	02	00
p value	**0.004**		
Onset of neonatal sepsis			
Early onset	00	11	14
Late onset	02	19	09
p value	0.08		
Blood culture			
Positive	00	06	21
Negative	04	26	02
p value	**<0.0001**		
Organism isolated			
Klebsiella pneumonia	00	02	10
MSSA	00	00	05
MRSA	00	01	01
E. coli	00	02	02
Pseudomonas	00	01	03
p value	0.18		
Hospital stay			
0-10 days	04	14	02
11-20 days	00	18	17
21-30 days	00	00	04
Shifted to postnatal care	00	00	00
p value	**0.0004**		
Oxygen support			
HHFNC	00	31	00
Oxygen via prongs	02	00	00
Mechanical ventilation	02	01	23
p value	**<0.0001**		

Table 3: Comparison of neonatal outcome in preterm, term and post-term groups
Table 3 compares neonatal outcomes among preterm, term, and post-term neonates, highlighting the influence of gestational age on neonatal morbidity and clinical outcomes.

Birth weight showed a strong association with gestational age. All preterm neonates weighed less than 2.5 kg, whereas the majority of term and post-term neonates weighed ≥2.5 kg, reflecting the expected physiological relationship between gestational maturity and fetal growth.

The APGAR score at 1 minute did not differ significantly among the three groups ($p = 0.15$), indicating comparable immediate neonatal status after delivery. However, APGAR scores at 5 minutes demonstrated a statistically significant difference ($p = 0.02$). Low 5-minute APGAR scores (0–5) were more frequent among preterm and post-term neonates compared with term neonates, suggesting delayed recovery and poorer postnatal adaptation in these groups.

The need for neonatal resuscitation was significantly higher among term and post-term neonates (21 cases each) compared to preterm neonates (1 case) ($p = 0.04$), indicating greater intrapartum compromise in mature fetuses exposed to meconium-stained liquor.

Endotracheal intubation was more commonly required among post-term (15 cases) and term neonates (13 cases) than among preterm neonates, although this association did not reach statistical significance ($p = 0.08$).

NICU admission rates were comparable across all gestational age groups ($p = 0.15$), with most neonates requiring NICU care because of the high-risk nature of meconium-associated deliveries.

The occurrence of meconium aspiration syndrome (MAS) differed significantly according to gestational age (p = 0.02). MAS was substantially more common among term (31 cases) and post-term neonates (27 cases) than among preterm neonates (1 case), consistent with the increased incidence of meconium passage in mature and post-mature fetuses.

Neonatal sepsis did not show a significant association with gestational age (p = 0.36), suggesting comparable susceptibility across preterm, term, and post-term groups. Similarly, the onset of sepsis (early versus late onset) (p = 0.39), blood culture positivity (p = 0.59), and the type of organisms isolated (p = 0.71) did not differ significantly according to gestational age. Duration of hospital stay was also comparable among the three groups (p = 0.21)

The type of oxygen support required did not differ significantly across gestational age groups (p = 0.256), although mechanical ventilation was more frequently required in term and post-term neonates, reflecting greater respiratory compromise associated with MAS in these groups.

Overall, gestational age significantly influenced 5-minute APGAR scores, the need for resuscitation, and the occurrence of MAS, with term and post-term neonates showing greater respiratory morbidity. However, neonatal sepsis, blood culture positivity, duration of hospitalization, and oxygen requirements were comparable across preterm, term, and post-term groups, indicating that meconium-related respiratory disease rather than gestational age alone primarily determined neonatal outcomes in this cohort.

Table 3: Comparison of neonatal outcome in Preterm, Term and Post-term Groups:

Neonatal risk factors	Pre term	Term	Post term
Birth weight			
<1 kg	00	00	00
<1.5 kg	00	00	00
<2.5 kg	06	20	07
2.5-5 kgs	00	38	29
p value		**<0.001**	
APGAR Score			
At 1 min			
0-5	03	26	21
6-10	03	32	13
Not known	00	00	02
		0.15	
At 5 min			
0-5	02	00	03
6-10	04	58	31
Not known	00	00	02
p value		**0.02**	
Need for resuscitation			
Yes	01	21	21
No	05	37	15
p value		**0.04**	
Intubation			
Yes	00	13	15
No	06	45	21
p value		0.08	
NICU admission			
Yes	03	41	31
No	03	17	05
p value		0.15	
MAS			
Yes	01	31	27
No	05	27	09
p value		**0.02**	
Neonatal sepsis			

Yes	03	39	26
No	03	19	10
p value	0.36		
Onset of neonatal sepsis			
Early onset	02	20	11
Late onset	01	19	15
p value	0.39		
Blood culture			
Positive	01	16	13
Negative	05	42	23
p value	0.59		
Organism isolated			
Klebsiella pneumonia	00	06	06
MSSA	00	05	03
MRSA	00	01	01
E. coli	01	01	02
Pseudomonas	00	03	01
p value	0.71		
Hospital stay			
0-10 days	01	17	10
11-20 days	01	22	19
21-30 days	01	02	02
Shifted to postnatal care	03	17	05
p value	0.21		
Oxygen support			
HHFNC	03	21	13
Oxygen via prongs	00	06	03
Mechanical ventilation	00	13	15
CPAP	00	01	00
None	03	17	05
p value	0.256		

DISCUSSION

This study evaluated the association of maternal and neonatal risk factors with the severity of MAS and assessed neonatal outcomes across different gestational age groups. The findings demonstrate that while several maternal factors were not significantly associated with MAS severity, important neonatal indicators such as APGAR score, need for resuscitation, intubation, sepsis, and ventilatory support showed strong correlations with worsening grades of MAS.

In the present study, maternal demographic characteristics such as age and parity did not demonstrate a statistically significant association with MAS severity. Most mothers belonged to the 19–35-year age group irrespective of MAS grading. Similar observations have been reported in earlier studies. Ramyasundaram et al. and Pooja et al. documented a higher proportion of primigravidae in pregnancies complicated by meconium-stained amniotic fluid, although extremes of maternal age have occasionally been associated with adverse perinatal outcomes. [7-8]

Maternal weight gain and regular antenatal visits were also not significantly associated with MAS grading. However, severe MAS appeared relatively more common among mothers with irregular antenatal care, indicating that inadequate prenatal surveillance may contribute indirectly to delayed recognition of high-risk pregnancies. Although not statistically significant, this finding is consistent with the findings of other studies by Pooja et al. and Mohammad et al. [8-9]

An important observation in this study was the statistically significant association between the number of antenatal pregnancy scans and MAS severity. Moderate and severe MAS were more common among mothers who underwent multiple scans, likely reflecting increased fetal surveillance in pregnancies already considered high risk. This finding may not indicate causation but rather represent the tendency for complicated pregnancies to receive closer monitoring and is documented in other studies like of Rokade et al. [10]

The mode of delivery did not show a significant relationship with MAS severity, although LSCS was more common among moderate and severe MAS cases. Indian studies by Patil et al. and Chavan et al. observed increased LSCS rates in such pregnancies, largely due to concerns regarding fetal distress and abnormal cardiotocography findings. [11-12]

Fetal monitoring during labour demonstrated a significant association with MAS severity. Continuous fetal monitoring was more commonly performed in moderate and severe MAS cases, indicating that these fetuses likely exhibited signs of intrapartum distress requiring closer surveillance. This finding is reported in earlier studies done by Patra et al. and Patil et al. [11] [13]

The neonatal factors analyzed in this study showed a much stronger relationship with MAS severity than maternal factors. Low APGAR scores at both 1 and 5 minutes were significantly associated with severe MAS. Neonates with severe MAS frequently had APGAR scores between 0–5, reflecting profound perinatal asphyxia and poor cardiopulmonary adaptation. These findings are consistent with previous studies done by Mundhra et al. and Jain et al. demonstrating that low APGAR scores are strong predictors of severe respiratory morbidity, persistent pulmonary hypertension, and adverse neonatal outcomes in MAS. [14-15]

The need for resuscitation and endotracheal intubation showed highly significant associations with severe MAS. Nearly all neonates with severe MAS required aggressive resuscitative measures and ventilatory support, indicating severe respiratory compromise at birth. This observation aligns with the pathophysiology of MAS and is in line with previous studies done by Shaikh et al. [16]

Neonatal sepsis was significantly associated with increasing MAS severity. Severe MAS cases demonstrated higher rates of sepsis and blood culture positivity, suggesting that critically ill neonates are more vulnerable to systemic infection. The most commonly isolated organism in severe MAS was Klebsiella pneumoniae, followed by MSSA and Pseudomonas species. Similar bacteriological profiles have been reported in other studies done by Patil et al and Chavan et al. [12-13]

The duration of hospital stay increased significantly with MAS severity. Neonates with severe MAS frequently required hospitalization beyond 11 days, with some requiring prolonged NICU stay up to 21–30 days. Mechanical ventilation was predominantly required in severe MAS, whereas moderate MAS was largely managed with HHFNC and mild MAS with minimal oxygen supplementation. These findings emphasize the substantial healthcare burden associated with severe MAS and is consistent with findings of earlier studies done by Ramyasundaram et al. and Chavan et al. [7] [13]

Comparison of neonatal outcomes across gestational age groups revealed that MAS was significantly more common among term and post-term neonates than preterm neonates. This finding is well supported by existing literature, described in Matthews et al. and Abramovich et al. as meconium passage is uncommon in preterm fetuses due to relative gastrointestinal immaturity and reduced exposure to intrauterine stress. In contrast, post-term fetuses are more prone to chronic placental insufficiency and fetal hypoxia, predisposing them to meconium passage and aspiration. [17-18]

The 5-minute APGAR score and need for resuscitation were significantly worse among term and post-term neonates, reflecting greater respiratory morbidity in these groups.

Overall, the findings of the present study reinforce that the severity of MAS is primarily determined by the degree of perinatal hypoxia and neonatal respiratory compromise rather than maternal demographic factors alone. Neonates with severe MAS had significantly poorer APGAR scores, greater need for resuscitation and mechanical ventilation, higher incidence of sepsis, prolonged hospitalization, and increased NICU dependency. Early identification of fetal distress, vigilant intrapartum monitoring, timely obstetric intervention, and prompt neonatal resuscitation remain critical in reducing MAS-related morbidity and improving neonatal outcomes.

CONCLUSION:

The present study highlights the significant burden of meconium aspiration syndrome (MAS) and neonatal sepsis among neonates born through meconium-stained liquor, particularly in term and post-term pregnancies. Maternal risk factors such as post-dated pregnancy, oligohydramnios, hypertensive disorders, maternal anaemia, and inadequate antenatal care contributed to fetal compromise and meconium passage.

Inadequate antenatal surveillance and poor intrapartum fetal monitoring were associated with increased severity of MAS. Severe MAS was significantly associated with low APGAR scores, increased need for neonatal resuscitation, intubation, ventilatory support, prolonged NICU stay, and higher incidence of neonatal sepsis and blood culture positivity.

Term and post-term neonates showed greater respiratory morbidity and higher occurrence of MAS compared to preterm neonates. The high incidence of culture-positive sepsis, particularly due to organisms such as Klebsiella pneumoniae and Escherichia coli, further emphasizes the vulnerability of these neonates to secondary infections.

Overall, early identification of high-risk pregnancies, adequate antenatal care, continuous fetal monitoring during labour, timely obstetric intervention, and prompt neonatal resuscitation and intensive care are essential to reduce the severity of MAS, prevent neonatal sepsis, and improve neonatal outcomes.

Limitations of the Study

1. The study was conducted at a single tertiary care centre, limiting the generalizability of the findings.
2. The sample size was relatively small, which may have reduced the statistical strength of some associations.
3. Being a hospital-based observational study, referral bias may have been present due to inclusion of more severe MAS cases.
4. Variations in intrapartum management, neonatal resuscitation, and transport facilities among outborn neonates may have influenced outcomes.
5. Long-term neurodevelopmental and respiratory follow-up was not performed.
6. Some maternal and intrapartum variables could not be uniformly standardized.
7. The study mainly evaluated early neonatal outcomes and not long-term complications.
8. Blood culture positivity may have been underestimated because of prior antibiotic exposure and technical limitations.
9. The observational design limits establishment of definite causal relationships.
10. Advanced investigations and newer modalities for assessment of fetal distress and pulmonary complications were limited due to resource constraints.

Relevance of the Study:

Meconium-stained liquor (MSL) remains an important cause of neonatal morbidity and mortality, especially in developing countries with limited antenatal and intrapartum care. The present study is clinically relevant as it identifies maternal, fetal, and intrapartum risk factors associated with meconium aspiration syndrome (MAS), enabling early recognition of high-risk pregnancies and neonates.

The study highlights the importance of adequate antenatal care, timely detection of obstetric complications, continuous fetal monitoring, and prompt obstetric intervention in reducing the severity of MAS and improving neonatal outcomes. It also emphasizes the strong association of MAS with respiratory distress, neonatal sepsis, prolonged NICU stay, and increased need for ventilatory support.

The findings provide useful clinical and epidemiological data that may help improve neonatal resuscitation preparedness, NICU management, infection control practices, and institutional protocols for pregnancies complicated by meconium-stained liquor.

Overall, the study contributes to better perinatal surveillance, early intervention, and reduction of neonatal morbidity and mortality associated with MAS and neonatal sepsis.

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Dr. Manish Aggarwal

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