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Maternal and Fetal Factors Associated with Meconium-Stained Amniotic Fluid and Their Impact on Perinatal Outcomes

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ABSTRACT

Background: Meconium-stained amniotic fluid (MSAF) is common at term and is associated with operative delivery and adverse neonatal outcomes, particularly when meconium is thick.
Objective: To describe maternal and fetal factors associated with MSAF and assess mode of delivery and neonatal outcomes according to meconium consistency.
Materials and Methods: This prospective observational study included 260 women with singleton, cephalic pregnancies at ≥37 weeks and MSAF who delivered at Smt Hira Kunwar Ba Mahila Hospital, Jhalawar. Maternal and fetal risk factors, meconium consistency, mode of delivery, Apgar scores, neonatal intensive care unit (NICU) admission, morbidity, and mortality were recorded. Categorical variables were summarized as frequencies and percentages. Associations were assessed using Pearson's chi-square test; Fisher's exact test was specified for sparse cells. Two-sided $p<0.05$ was considered statistically significant.
Results: Thick MSAF was present in 124 (47.7%) cases. Caesarean delivery occurred in 173 (66.5%) cases and was more frequent with thick than thin MSAF (76.6% vs 57.4%; p=0.001). NICU admission was required for 72 (27.7%) neonates and was more frequent with thick MSAF (41.1% vs 15.4%; p<0.001). Neonatal morbidity occurred in 31 (11.9%) cases. Eleven neonates (4.2%) died; mortality was higher with thick than thin MSAF (7.3% vs 1.5%; p=0.021).
Conclusion: Thick MSAF identified a subgroup with higher caesarean-delivery, NICU-admission, and neonatal-mortality rates. Careful intrapartum surveillance and readiness for skilled neonatal resuscitation are warranted.

Keywords: *Meconium-stained amniotic fluid; Meconium aspiration syndrome; Caesarean section; NICU admission; Neonatal outcome.*

INTRODUCTION

Meconium is a viscous, green-black material formed from fetal gastrointestinal secretions, desquamated cells, bile pigments, lanugo, vernix, and swallowed amniotic fluid. Passage before birth becomes more frequent with advancing gestation and increasing duration of labour.[1,2]

Meconium-stained amniotic fluid occurs in approximately 5–20% of labouring patients. It may reflect gastrointestinal maturation, vagal stimulation, or hypoxic stress, and is associated with hypertensive disorders, oligohydramnios, placental insufficiency, and post-term gestation.[2,3]

Clinically, thick or particulate MSAF is more strongly associated with operative delivery, neonatal resuscitation, low Apgar scores, NICU admission, and meconium aspiration syndrome (MAS) than thin staining.[3,4]

Current neonatal guidance does not recommend routine intrapartum suctioning solely because MSAF is present; however, a team capable of complete neonatal resuscitation should be available at delivery.[5]

Intrapartum guidance recommends documenting the character of meconium and escalating surveillance when significant (dark, thick, or particulate) meconium is present.[6] Earlier clinical reviews likewise emphasized that MSAF is a marker requiring contextual interpretation with gestational age, fetal-heart-rate findings, and neonatal condition rather than an isolated diagnosis of fetal asphyxia.[7]

Large cohort studies have linked MSAF with nulliparity, prolonged labour, later gestational age, operative delivery, and neonatal respiratory morbidity, while population studies from low-resource settings have also identified prolonged labour, post-term pregnancy, and hypertensive disorders as associated factors.[8,9]

The present study evaluated maternal and fetal factors observed among term pregnancies complicated by MSAF and examined the association of meconium consistency with delivery mode and neonatal outcomes.

AIM AND OBJECTIVES

Aim: To evaluate maternal and fetal factors associated with meconium-stained amniotic fluid and its impact on perinatal outcomes.

Objectives: To describe gestational age, associated maternal and fetal factors, and meconium consistency; and to assess mode of delivery, Apgar scores, NICU admission, neonatal morbidity, and mortality according to meconium consistency.

MATERIALS AND METHODS

Study design and setting: This prospective observational study was conducted over one year at Smt Hira Kunwar Ba Mahila Hospital, attached to Jhalawar Medical College, Jhalawar, Rajasthan, after institutional ethics approval.

Study population: Pregnant women admitted in labour with meconium-stained amniotic fluid were screened. A total of 260 eligible women were enrolled after written informed consent.

Inclusion criteria: Singleton pregnancy, cephalic presentation, gestational age ≥37 weeks, MSAF detected after spontaneous or artificial rupture of membranes, and consent to participate.

Exclusion criterion: Major congenital fetal anomaly.

Data collection and clinical management: Relevant history, general and obstetric examinations, routine antenatal investigations, and ultrasonography findings were recorded. Liquor was categorized as thin (yellow-green, translucent, non-particulate) or thick (dark green/black, opaque, or particulate). Labour progress and fetal status were monitored. Mode of delivery was determined according to maternal and fetal indications. At birth, one- and five-minute Apgar scores, birth weight, NICU admission, neonatal morbidity, and survival to discharge were recorded.

Statistical analysis: Data were entered in Microsoft Excel and analysed using standard statistical procedures. Categorical variables were summarized as frequencies and percentages. Associations between meconium consistency and categorical outcomes were evaluated using Pearson's chi-square test; Fisher's exact test was planned when expected cell counts were <5. All tests were two-sided, and $p<0.05$ was considered statistically significant. Percentages and reported p-values were independently recalculated from the tabulated counts. Because participant-level data and an Apgar cross-tabulation were unavailable, no inferential comparison was assigned to the marginal Apgar distributions.

Ethical considerations: Institutional ethics approval was obtained before enrolment. Written informed consent was obtained from all participants. Confidentiality was maintained throughout the study.

RESULTS

Among 260 pregnancies complicated by MSAF, 190 (73.1%) occurred at ≥39 weeks and 124 (47.7%) had thick meconium (Tables 1 and 2). No listed risk factor was recorded in 96 (36.9%) cases. Post-dated pregnancy was the most frequent single recorded category (41 [15.8%]); several women had combinations of hypertensive disease, fetal growth restriction, anaemia, premature rupture of membranes, and oligohydramnios (Table 3).

Table 1. Distribution according to gestational age (n=260)

Gestational age (weeks)	n	%
37–38+6	70	26.9
39–40+6	135	51.9
41–41+6	39	15.0
≥42	16	6.2
Total	260	100.0

Table 2. Consistency of meconium (n=260)

Consistency	n	%
Thick	124	47.7
Thin	136	52.3
Total	260	100.0

Table 3. Recorded maternal and fetal risk-factor combinations (n=260)

Risk-factor category	n	%
No recorded risk factor	96	36.9
PIH	9	3.5
PIH + IUGR	6	2.3
PIH + severe anaemia	12	4.6
Anaemia + PIH + IUGR	3	1.2
PIH + PROM	2	0.8
PIH + PROM + IUGR	1	0.4
PIH + PROM + post-dated	1	0.4
PIH + post-dated	4	1.5
PIH + IUGR + post-dated	1	0.4
PIH + post-dated + oligohydramnios	1	0.4
Severe anaemia	9	3.5
Severe anaemia + IUGR	7	2.7
Severe anaemia + post-dated + oligohydramnios	1	0.4
Severe anaemia + IUGR + oligohydramnios	1	0.4
PROM	11	4.2
PROM + IUGR	1	0.4
Non-progress of labour	5	1.9
Non-progress of labour + IUGR	1	0.4
Non-progress of labour + post-dated	1	0.4
Post-dated	41	15.8
Post-dated + oligohydramnios	16	6.2

Risk-factor category	n	%
Post-dated + IUGR	4	1.5
Oligohydramnios	10	3.8
IUGR	16	6.2
Total	260	100.0

PIH: pregnancy-induced hypertension; IUGR: intrauterine growth restriction; PROM: premature rupture of membranes. Categories are mutually exclusive combinations as recorded in the source table.

Caesarean delivery was performed in 173 (66.5%) cases. It was more frequent with thick than thin MSAF (76.6% vs 57.4%; Pearson χ^2=10.806, p=0.001) (Table 4).

Table 4. Mode of delivery according to meconium consistency

Mode of delivery	Thick (n=124)	Thin (n=136)	Total (n=260)
Caesarean delivery	95 (76.6%)	78 (57.4%)	173 (66.5%)
Vaginal delivery	29 (23.4%)	58 (42.6%)	87 (33.5%)
Total	124 (100%)	136 (100%)	260 (100%)

Pearson χ^2=10.806; df=1; p=0.001.

At one minute, 24 (9.2%) neonates had Apgar scores of 0–3; at five minutes, 1 (0.4%) remained in this category (Table 5). These marginal distributions describe improvement over time but do not support a paired significance test without individual-level transition data.

Table 5. Distribution of Apgar scores

Time	Apgar score	n	%
1 minute	0–3	24	9.2
1 minute	4–6	188	72.3
1 minute	7–10	48	18.5
5 minutes	0–3	1	0.4
5 minutes	4–6	66	25.4
5 minutes	7–10	193	74.2

NICU admission was required for 72 (27.7%) neonates and was more frequent after thick than thin MSAF (41.1% vs 15.4%; p<0.001) (Table 6).

Table 6. NICU admission according to meconium consistency

NICU admission	Thick (n=124)	Thin (n=136)	Total (n=260)
Yes	51 (41.1%)	21 (15.4%)	72 (27.7%)
No	73 (58.9%)	115 (84.6%)	188 (72.3%)
Total	124 (100%)	136 (100%)	260 (100%)

Pearson χ^2=21.375; df=1; p<0.001.

Neonatal morbidity was recorded in 31 (11.9%) cases, most commonly birth asphyxia (12 [4.6%]), followed by MAS (8 [3.1%]), pneumonitis (7 [2.7%]), and sepsis (4 [1.5%]) (Table 7).

Table 7. Neonatal morbidity (n=260)

Morbidity	n	%
Birth asphyxia	12	4.6
Meconium aspiration syndrome	8	3.1
Pneumonitis	7	2.7
Sepsis	4	1.5
Total morbidity	31	11.9

Eleven (4.2%) neonates died. Mortality was higher with thick than thin MSAF (7.3% vs 1.5%; Pearson χ^2=5.362, p=0.021) (Table 8). MAS accounted for 5 of 11 deaths (45.5%) (Table 9).

Table 8. Neonatal mortality according to meconium consistency

Outcome	Thick (n=124)	Thin (n=136)	Total (n=260)
Expired	9 (7.3%)	2 (1.5%)	11 (4.2%)
Survived to discharge	115 (92.7%)	134 (98.5%)	249 (95.8%)
Total	124 (100%)	136 (100%)	260 (100%)

Pearson χ^2=5.362; df=1; p=0.021. Fisher's exact test may be preferred because one expected cell count was close to 5.

Table 9. Causes of neonatal death (n=11)

Cause	n	% of deaths
Meconium aspiration syndrome	5	45.5
Pneumonitis	4	36.4
Sepsis	2	18.2
Total	11	100.0

DISCUSSION

In this prospective cohort of 260 term pregnancies complicated by MSAF, nearly half had thick meconium. Thick MSAF was associated with higher rates of caesarean delivery, NICU admission, and neonatal mortality. These results support the clinical importance of documenting meconium consistency rather than treating all MSAF as a homogeneous exposure.

The concentration of cases at later gestational ages is consistent with evidence that the frequency of MSAF rises with advancing gestation and duration of labour.[2] Gavhane et al. reported a high caesarean-delivery rate and greater NICU use with thick meconium, while Sundaram and Murugesan identified post-dated pregnancy and other maternal risk factors in term MSAF.[10,11]

The observed caesarean-delivery difference between thick and thin MSAF (76.6% vs 57.4%) is directionally consistent with prospective and observational studies by Bhat and Rao, Biradar et al., and Qadir et al., in which thick meconium was associated with fetal compromise, operative intervention, or adverse neonatal outcomes.[12–14] However, delivery decisions are affected by fetal-heart-rate patterns, labour progress, and local protocols; the present unadjusted association should not be interpreted as proving that thick meconium itself caused caesarean delivery.

The overall NICU-admission and morbidity patterns are also broadly comparable with Indian hospital studies by Unnisa et al., Priyadharshini and Panicker, and Mundhra and Agarwal.[15–17] Differences between studies may reflect eligibility criteria, grading definitions, referral patterns, and thresholds for NICU admission.

NICU admission occurred in 27.7% overall and was substantially more frequent with thick MSAF. Contemporary studies demonstrate a graded relationship between meconium thickness and adverse neonatal outcomes, whereas thin meconium alone may carry a smaller and more selective increase in risk.[4,18,19]

MAS occurred in 3.1% of the cohort and was the leading recorded cause of neonatal death. Fanaroff described MAS as respiratory distress in an infant born through MSAF when no alternative explanation is present.[1] Only a minority of exposed infants develop MAS, and population data have documented declining MAS frequency alongside changes in obstetric and neonatal practice.[3,4,20]

The one- and five-minute Apgar distributions improved markedly, but the original manuscript reported a significance value based only on marginal totals. A valid paired comparison requires each neonate's one-to-five-minute transition or participant-level data; therefore, that p-value was removed. Similarly, the reported mean Apgar values by meconium consistency were not retained because their underlying participant-level data were not available for verification.

STRENGTHS AND LIMITATIONS

The study included a clinically relevant sample and recorded multiple maternal and neonatal outcomes. Important limitations are its single-centre design, inclusion of only pregnancies already complicated by MSAF, absence of a clear-liquor comparison group, lack of adjusted multivariable analysis, and incomplete reporting of fetal-heart-rate patterns and clinical indications for delivery.

CONCLUSION

Among term pregnancies complicated by MSAF, thick meconium was associated with higher caesarean-delivery, NICU-admission, and neonatal-mortality rates than thin meconium. MSAF—particularly thick or particulate fluid—should prompt close intrapartum surveillance and preparedness for skilled neonatal assessment and resuscitation. Larger multicentre studies with clear-liquor controls and adjusted analyses are needed to identify independent predictors of adverse outcome.

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