Meconium Aspiration Syndrome: Incidence, Risk Factors and Neonatal Outcome - A Prospective Study

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Article received: 29th December, 2022
Article accepted: 12th May, 2023

ABSTRACT

Introduction: Meconium aspiration syndrome is a serious condition in which a newborn breathes a mixture of meconium and amniotic fluid into the lungs. These infants are at risk of meconium aspiration pneumonia and must be observed closely for respiratory distress.

Materials and Methods: An observational study was conducted at Pokhara Academy of Health Sciences from 15 January 2022 to 16 November 2022. One hundred and fifty five babies born through the meconium-stained amniotic fluid within the study period were included in the study. Eighty four babies were diagnosed with meconium aspiration syndrome out of these babies. Data were analyzed with bivariate analysis.

Results: The incidence of meconium aspiration syndrome was 11.8 per 1000 live births. 61.3% of babies born through meconium-stained amniotic fluid were post-term. Spontaneous vaginal delivery increased the risk of meconium aspiration syndrome (OR = 3.86; 95% CI: 1.84–8.09). The thick consistency of meconium, Apgar scores less than 7 at 1 and 5 minutes, and need for resuscitation at birth increased the risk. It had a two-fold risk for pre-discharge mortality (odds ratio = 2.06; 95% CI: 1.735–2.44). Factors associated with mortality were small for gestation age, APGAR less than 7 at 1 and 5 minutes, Downe score of ≥ 4, and the need for resuscitation and mechanical ventilation.

Conclusion: Meconium aspiration syndrome has a high risk of neonatal mortality and morbidity. Monitoring during pregnancy and labour is crucial for identifying high-risk conditions. Newborn care plays an important role to reduce neonatal mortality.

Keywords: meconium aspiration syndrome, meconium-stained amniotic fluid, respiratory distress

INTRODUCTION

Meconium aspiration syndrome (MAS) is respiratory distress in newborn born through a meconium-stained amniotic fluid (MSAF) whose symptoms cannot be explained otherwise.[1] Meconium staining of amniotic fluid occurs in 10 to 15% of deliveries.[2] Approximately 3% to 4% of neonates born through MSAF develop MAS in western countries, but in developing countries, a higher incidence of around 11% to 28% is reported.[3] In a recent multicentric study done in Nepal, MAS was found to be 2 per 1000 live births.[4] The clinical presentation can range from mild respiratory distress to life-

threatening respiratory failure. Almost 30 to 50 % of these infants require CPAP (continuous positive airway pressure) or mechanical ventilation and mortality can occur in 4.6%.[5,6] Acute or chronic hypoxia and/or infection are associated with the passage of meconium in utero. MSAF occurs more commonly in term or post-term pregnancies and rarely before 34 weeks of gestation. In a post-term fetus, rising motilin levels, normal gastrointestinal function, and vagal stimulation due to cord or head compression or in-utero fetal stress lead to the passage of meconium. Since MAS is a significant contributor of neonatal mortality and morbidity, this study was done with the aim of determining the incidence, risk factors, and immediate neonatal outcomes of MAS.

MATERIALS AND METHODS

This study was conducted in the Neonatal Intensive Care Unit (NICU) and maternity ward of Pokhara Academy of Health Sciences (PoAHS) from 15 January 2022 to 16 November 2022 after obtaining ethical clearance from the institutional review committeeof PoAHS (reference number 74/078). Newborns born through meconium-stained amniotic fluid, with or without a history of admission into NICU for MAS were included in the study. The neonates were followed till the discharge of the baby from the NICU or discharge of the mother from maternity for babies who were not admitted to the NICU. Babies with incomplete data, stillbirth, absence of meconium in the amniotic fluid, and presence of major congenital anomalies were excluded. The sample size was calculated using the formula $N = z\ (1-\alpha/2)^2 p\ (1-p)/d^2$. The incidence of meconium aspiration syndrome was found to be 2 per 1000 live births in a multicentric study done in Nepal in 2018, so the minimum sample size of MAS required using the formula was 70.[4] One hundred and fifty-five neonates born through MSAF were included in the study where 84 were diagnosed as cases of MAS and rest were diagnosed as cases of MSAF without MAS. A proforma was filled for each case after the delivery of the baby by the attending pediatrician or pediatric resident including the mother and baby`s demographic characteristics and antenatal risk factors. MSAF was diagnosed if there was history of passage of green-coloured amniotic fluid and thick meconium as having a pea soup appearance. The need for resuscitation like orogastric suction, bag and mask ventilation or endotracheal intubation was noted along with Neonatal Intensive Care Unit (NICU) management like oxygenation, bubble Continuous Positive Airway Pressure (CPAP), or mechanical ventilation. MAS was diagnosed by the presence of meconium in the amniotic fluid at the time of birth and the presence of respiratory distress with or without radiological findings suggestive of meconium aspiration and the need for supplemental oxygen with the exclusion of other etiology explaining the distress. The severity of respiratory distress was assessed using Downe score which included parameters like respiratory rate, cyanosis, retractions, air entry, and grunting. Neonates with Downe score ≥4 were diagnosed as having clinical respiratory distress.7 Statistical analysis was done by SPSS version 23. Data were presented as Odd's ratio (OR) and a 95% Confidence Interval (CI). A Chi-square test was done where applicable and a value of <0.05 was considered significant.

RESULT

A total of 7201 deliveries were conducted in the hospital during the study period of 10 months among which 7104 were live births. Among babies born to meconium-stained amniotic fluid, 155 neonates who met the inclusion criteria were included in the study. Out of these, 95 required admission to NICU. Among these ninety five, 84 (54.19%) were diagnosed to have MAS. Nine were diagnosed as perinatal asphyxia without MAS and 2 were diagnosed as sepsis without MAS. MAS's overall incidence was estimated to be 11.8 per 1000 live births. Sixty cases that did not require admission to NICU were diagnosed as healthy babies without complications.

Table 1. Characteristics of Neonates

Characteristics		MSAF with MAS	MSAF without MAS	P value	Chi-square
Cases		84(54.19%)	71(45.81%)		
M:F ratio		1:1	1.02:1	0.93	0.008
Gestation	> 42	2(2.3%)	2(2.8%)	0.16	9.937
	40 to 42	63(75%)	45(63.3%)		
	37 to 40	12(14.2%)	23(32.39%)		
	< 37	7(8.33%)	1(1.4%)		
Postdate		66(78.57%)	48(67%)	0.12	2.378
Small gestational-age babies		27(32.1%)	15(21.1%)	0.12	2.364
Birth weight less than 2500 gm		18(21.4%)	4(5.6%)	0.04	7.882
Mode of delivery	Vaginal delivery(32.9%)	38(45.2%)	13(18.3%)	0.001	13.142
	Vacuum/forceps(4.5%)	4(4.76%)	3(4.2%)		
	Cesarean(62.6%)	42(50%)	55(77.46%)		
APGAR score at 1 minute	< 7	64(76.2%)	29(40.84%)	0.00	20.029
	≥ 7	20(23.8%)	42(59.15%)		
APGAR score at 5 minute	< 7	31(36.90%)	9(12.6%)	0.001	11.797
	≥ 7	53(63.09%)	62(87.32%)		
Thick Meconium		53(63.09%)	22(30.98%)	0.00	15.885
Downe score ≥ 4 at admission		39(46.42%)	8(11.26%)	0.00	22.515
Abnormal chest x-ray		42(50%)	0(0%)	0.00	48.695
Resuscitation at birth		36(42.85%)	6(8.45%)	0.00	23.05
Need for assisted ventilation		77(91.66%)	21(29.57%)	0.00	26.19
Mortality		17(20.02%)	0(0%)	0.00	16.139

Table 1 shows the characteristics of babies born through meconium-stained amniotic fluid with or without MAS. Male to female ratio was 1:1. Maximum MAS (78.57%) cases were delivered at more than 40 weeks of gestational age. Among the MAS cases, 21.4% were low birth weight which was significant ($p<0.05$). 62.6% were delivered via cesarean section, 32.9 % via spontaneous vaginal delivery, and 4.5% were instrumental deliveries. Apgar score was less than 7 in 76.2% and 36.9% at 1 and 5 minutes respectively in MAS. 63.09% of MAS cases were born through thick meconium-stained liquor in comparison to 30.98% in MSAF without MAS which was statistically significant ($p<0.05$). 46.42% had Downe score of ≥4 at the time admission. 50% had an abnormal chest X-ray. 36 (42.86%) required resuscitation at birth and 77(91.66%) required assisted ventilation; 17(21.4% of MAS cases) were kept on nasal CPAP while 18(21.42% of MAS cases) required mechanical ventilation.

Table2. Odds of various factors associated with MAS in Babies with MSAF

Variables	MAS	No MAS	OR (95% CI)	P value
Weight less than 2500 gm	18(21.4%)	4(5.6%)	4.56(1.46-14.21)	0.005
Small for gestational age	27(32.1%)	15(21.1%)	1.76(0.85-3.67)	0.124
Spontaneous Vaginal Delivery	39(46.42%)	13(18.30%)	3.86(1.84-8.09)	0.000
Post date	66(78.57%)	48(67%)	1.75(0.85-3.61)	0.123
1 min APGAR < 7	64(76.2%)	29(40.84%)	4.63(2.32-9.23)	0.000
5 min APGAR <7	31(36.90%)	9(12.6%)	4.02(1.76-9.22)	0.000
Respiratory distress at birth	52(61.90%)	14(19.71%)	6.61(3.18-13.75)	0.000
Abnormal chest Xray	42(50%)	0(0%)	2.69(2.11-3.41)	0.000

Weight less than 2500 gm, spontaneous vaginal delivery, postdatism, Apgar less than 7 at 1 and 5 minutes, presence of respiratory distress at birth, and an abnormal chest X-ray increased the risk of having MAS in neonates delivered through meconium-stained liquor as depicted in table 2.

Table 3. Comparison of various factors associated with neonatal mortality in MSAF

Variables	Died	Survived	OR(95%)	P value
	Total N=17)	Total (N= 138)		
Small for gestational age	9(52.94%)	33(23.91%)	3.58(1.27-10.02)	0.01
Thick meconium	15(88.23%)	60(47.47%)	9.75(2.14-44.82)	0.00
Non-vigorous birth	17(100%)	36(26.08%)	43.67(5.59-341)	0.00
Need for mechanical ventilation	16(94.11%)	3(2.17%)	720(70-7339)	0.00
Hypoxic ischemic encephalopathy (HIE)	16(94.11%)	20(14.49%)	94(11.85-751)	0.00
5 min APGAR(<7)	15(88.23%)	25(18.11%)	33.9(7.28-157.76)	0.00
Downe score ≥4	16(94.11%)	31(22.46%)	55.226(7.04-433.06)	0.00
Chest compression	5(29.41%)	2(1.44%)	28.33(4.9-161.87)	0.00
Bag and mask ventilation at delivery	16(94.11%)	16(11.59%)	122(15.14-982.83)	0.00

Table 3 depicts factors associated with mortality in neonates born through meconium-stained amniotic fluid. Thick meconium increased the odds of mortality by 9.75 times (95 % CI 2.14-44.82) and non vigority at birth increased the odds of mortality by 43.67 times (95 % CI 5.59-341). Need of mechanical ventilation, 5 min APGAR, Downe score ≥ 4 at birth, need of chest compression and bag and mask ventilation at delivery increased the odds of mortality in neonates born through the meconium-stained amniotic fluid; which was statistically significant as well.

Table 4. Final diagnosis of neonates

Final Diagnosis	Frequency (N=155)
Healthy baby without complications	60(38%)
MAS with pneumonia	40(25.80%)
MAS with sepsis	31(20%)
Perinatal asphyxia	16(10.32%)
MAS with meconium gastritis	4(2.58%)
MAS with persistent pulmonary hypertension of the new(PPHN)	1(0.64%)
Sepsis	3(1.93%)

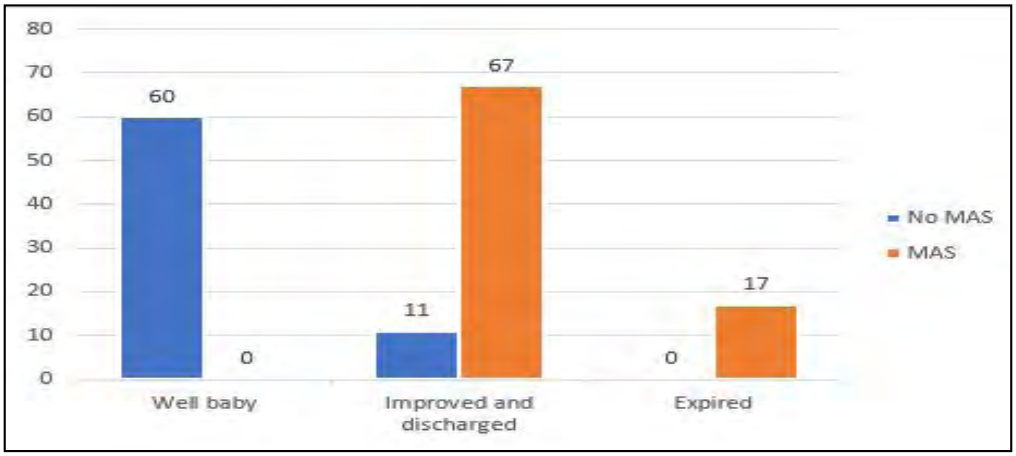

Figure 1. Clinical outcome of neonates born through MSAF

74% of no MAS neonates were well and did not need admission with 13.58% requiring admission. Out of MAS 79.76% improved after admission and were discharged while 20.23% expired. (Figure 1)

Table 5. Maternal demographic and antenatal characters in MSAF

Characteristics		MSAF with MAS(N=84)	MSAF without MAS(N=71)
Maternal age	≤19	2 (2.3%)	3(4.22%)
	20 to 34	72(85.71%)	59(83.09%)
	≥35	10(11.9%)	9(12.67%)
Gravida	Primi	53(63.09%)	45(63.38%)
	Multi	31(36.9%)	26(36.66%)
Interpregnancy interval	< 2 years	3(3.6%)	5(7.04%)
	≥ 2 years	37(44.04%)	31(43.66%)
ANC visits	< 4	3(3.5%)	7(9.85%)
	≥ 4	81(96.4%)	64(90.14%)
Labour induction	Yes	27(32.1%)	24(33.80%)
	No	57(67.8%)	47(66.19%)
MSAF detection	Before onset of labor	17(20.23%)	6(8.45%)
	Latent phase	10(11.90%)	29(40.84%)
	Active phase	24(28.57%)	24(33.80%)
	Second phase	11(13.09%)	2(2.81%)
	Intraoperative	22(26.19%)	10(14.08%)

Table 5 explains the maternal demographic and antenatal characteristics with more than 80% of mothers in each group of 20 to 34 years with around 63% being primiparous. In MSAF without MAS, the majority of MSAF was detected in the latent phase (40.84%) while in MAS the majority was detected in the active phase (28.57%) and intraoperatively (26.19%).

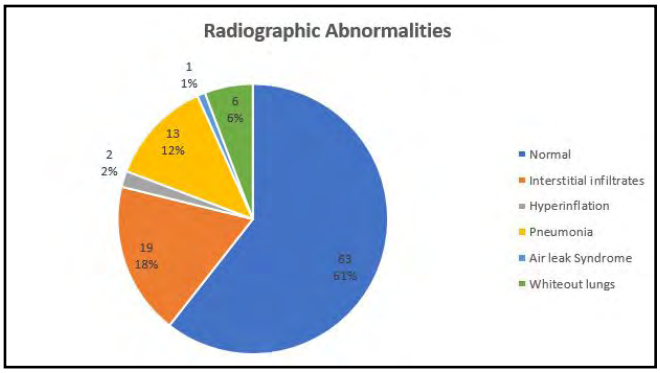

Figure 2. Radiographic abnormalities of neonates born to MSAF

Out of 155 cases of meconium-stained amniotic fluid, a chest x-ray was done in 104 cases due to logistic issues, where 61% had no radiographic abnormalities, 18% had interstitial infiltrates, 6% had whiteout lungs, 2 had hyperinflation and 1 had air leak syndrome as shown in figure 2.

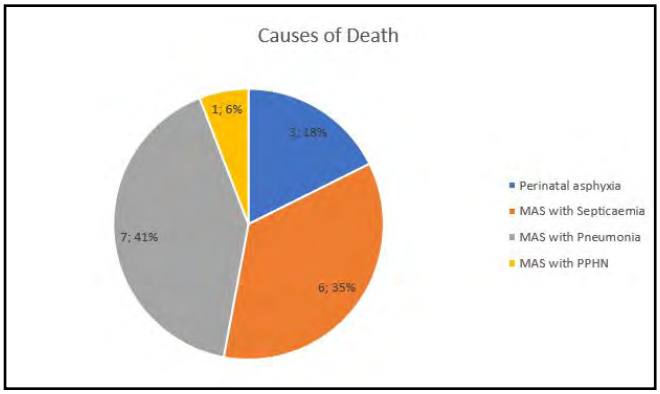

Figure 3. Causes of death in Meconium Aspiration Syndrome

Figure 3 shows the causes of mortality in Meconium Aspiration Syndrome. Maximum number of cases expired due to pneumonia in MAS which was followed by septicemia.

DISCUSSION

In this study, we studied the incidence, risk factors and neonatal outcome of MAS while comparing it with MSAF that did not present with MAS. The incidence of MAS was 11.8 per 1000 live births which is similar to a retrospective study done in West Indies where the incidence was 10 per 1000 live births.[8] However, the incidence was found to be 2 per 1000 live births in a multicentric study conducted by Paudel P et al and 1.3 per 1000 live births in a study done in Australia.[4,9] This may be due to variations in antenatal and intrapartum care as well as in study settings. It was found that 73% of MSAF deliveries and 78.57% of MAS were post-dated, which was comparable with studies reporting higher odds of having MSAF with increasing gestational age.[10] However, in our study, it was not statistically significant (p=0.12, chi-square 2.37). Although 27.09% of deliveries were SGA in MSAF, it was not significantly associated with MAS (p=0.12, chi-square 2.36) which is different from other studies which quoted SGA to be associated with MAS.[6] In contrary, low birth weight was significantly associated with the development of MAS in MSAF (p=0.05, Chi-square 7.882). Spontaneous vaginal delivery was shown to increase the odds of MAS in MSAF (OR 3.86; 95% CI 1.84-8.09) which is consistent with several other studies.[11] Thick meconium was found to be significantly associated with MAS in MSAF which is supported by other studies as well.[12,13] There was a statistically significant difference in APGAR score at 1 and 5 minutes between MSAF with MAS and without MAS ($p < 0.05$).[8] Respiratory distress at birth, Downe score of more than 4 at birth, the requirement of resuscitation at birth, need for assisted ventilation, and abnormal chest x-ray were significantly associated with MAS in MSAF (p=0.00).[10,14] In 51.1% oxygen was required while the requirement of nasal CPAP and Mechanical Ventilator was for 21% each. So 42% of MAS required either CPAP or ventilator which is similar to a study conducted by Wiswell TE et al.[2] Out of 20 babies who required CPAP, 1(5%) expired which was very less in comparison to the death of 16(84.21%) out of 19 neonates who were mechanically ventilated. Out of 84 cases of MAS, death occurred in 17 (20%). In other studies, mortality in MAS ranged from 2.7 to 33%.[2, 9,15] Pneumonia was the main cause of mortality occurring in 7 (41.17%) and 1 case had pneumothorax. The outcome was almost similar in a study in Pakistan by Zahid et al in 2011 with overall mortality being 32%.[16] However, in a study done by Satish et al, birth asphyxia was found to be the commonest cause of mortality in MAS.[17] Small for gestational age, thick consistency of meconium, HIE, and the need for mechanical ventilation were shown to increase the odds of mortality in MAS.

Limitations

Although all MAS cases during the study period were included in the study, the incidence of MSAF could not be assessed due to the inability to include all MSAF cases. Thus MAS could not be calculated

as a percentage of MSAF.

CONCLUSION

Meconium aspiration syndrome is a complication of meconium-stained amniotic fluid which can be prevented by various antenatal and intranatal factors. Several factors like gestational age, postdate, birth weight less than 2500 gms, and consistency of meconium increases the risk of MAS. The presentation at birth can help us predict the risk of mortality. Thus if these issues are addressed, morbidity and mortality associated with MSAF can be curtailed.

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