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Detrimental Complications of Meconium Aspiration Syndrome; A Cross-Sectional Study at a Tertiary Care Hospital in Pakistan

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Author`s Contribution

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ABSTRACT

Objective: To investigate the detrimental complications associated with Meconium Aspiration Syndrome (MAS) among neonates, focusing on the prevalence of persistent pulmonary hypertension of the newborn (PPHN) and air leak syndrome.

Methodology: This is cross sectional descriptive study conducted at the Pediatrics department of Farooq Hospital in Rawalpindi over six months spanning from July 2023 to December 2023. The study enrolled 167 neonates with a history of meconium-stained amniotic fluid & clinical signs of MAS (tachypnea (respiratory rate >60/min), cyanosis, nasal flaring, grunting and chest retractions). In order to check for air leak and PPHN, diagnostic procedures such as echocardiography and chest X-ray were carried out. Using SPSS 23, statistical analysis was performed on characteristics such age, weight, gender, and complications.

Results: Of the 167 newborns that were enrolled, 17.4% had PPHN, and 11.98% had air leak syndrome. With a mean age of 6.96±6.50 days and a mean weight of 3.081±0.32 kg, male neonates constituted the majority (62.87%). Out of these babies 82% were discharged and 18% babies expired.

Conclusion: The study found that newborns with MAS had a noteworthy frequency of PPHN and air leak.

Key words: Air Leak Syndrome, Meconium, Neonatal mortality, Pneumothorax, Pulmonary Hypertension

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Introduction

Meconium aspiration syndrome (MAS) occurs when a foetus inhales meconium-contaminated amniotic fluid after birth or in utero. This causes chemical inflammation, airway blockage, hypoxemia, acidosis and a range of systemic symptoms.[1] MAS affects roughly 2 to 10% of newborns born through meconium stained amniotic fluid (MSAF).[2] Meconium staining of amniotic fluid is uncommon before 34 weeks of gestation and affects just 2% of newborns with a gestational age <37 aspiration syndrome. Meconium levels increase with gestational age, with neonates born at 42 weeks having a four-fold increased risk of MAS compared to those born at 37 weeks. ([3]) Incidence of MSAF might range from 23% to 52% when the gestational age is more than 42 weeks.([4]) This difference of incidence in gestational age is possibly due to vagal stimulation of gastrointestinal motility and relaxation of anal sphincter during hypoxic stress or umbilical cord compression. Preterm newborns' gastrointestinal tract maturity may limit their ability to expel meconium, while full-term and post-term foetuses have a higher likelihood of doing so.[5]

MAS is a serious health concern that frequently results in morbidity and fatality even in otherwise healthy infants. Neonates with MAS have a mortality rate of up to 13.3%.(1) Although the incidence of MAS in the United States varies from 0.1 to 0.4 percent of births.[6] Its varying severity and possible complications continue to worry obstetricians and neonatologists. The severity of these complications can vary, from milder variants which require minimal care to severe conditions like pneumothorax, hypoxic ischemic encephalopathy (HIE), persistent pulmonary hypertension of the newborn (PPHN), intraventricular haemorrhage and necrotizing

enterocolitis carrying a significant risk of permanent disability and death. [7] In milder cases, these complications may require minimal intervention. According to published research, MAS is the most prevalent cause of PPHN. [8]

Neonatal mortality is very high in countries like Pakistan despite advances in neonatal medicine. One of the important causes responsible for this is meconium aspiration syndrome which is associated with high risk of morbidity & mortality. Although the incidence of MAS has drastically reduced over last few years owing to evolving obstetric practices particularly in developed countries, it is still a major cause of perinatal deaths in nations like Pakistan, where the newborn mortality rate is high at 41/1000 live births.[9] This is evident by few local research studies which reveal the prevalence of MAS from 14% to 32%.[10,11] This incidence is significantly greater not only from developed countries but than the one reported from a low-resource country, which is a matter of concern for us.[12] Despite its impact, complications such as PPHN often go unrecognized, especially in low-income settings where pediatric echocardiography facilities are scarce, leading to increased morbidity and mortality rates. PPHN, if untreated, can result in life-threatening hypoxia and circulatory failure, with mortality rates ranging from 5% to 10%. Additionally, a significant proportion of infants with moderate or severe PPHN may experience neurodevelopmental impairments and sensorineural hearing loss in the long term. [8]

[1]While numerous studies have explored MAS outcomes in developed nations and neighboring countries, data from our country on the two most drastic complications PPHN and air leak syndrome remains scarce. In Pakistan, complications like PPHN often go unrecognized due to limited access to diagnostic tools such as echocardiography. Highlighting these issues with recent data supports the need for our study to address these critical gaps in management and outcome assessment. By understanding the burden of these complications, interventions can be tailored to improve outcomes and prevent long-term disabilities as well as policies can be developed at national level for urgent referral of sick babies from the centres lacking such diagnostic facilities for timely management of the babies hence reducing mortality.

Methodology

This cross-sectional study was conducted at the Pediatrics department of Farooq Hospital in Rawalpindi over a six-month duration spanning from July 2023 to December 2023. Approval for the research protocol was obtained from the Institutional Review Board (IRB) of Akhtar Saeed Medical College, Rawalpindi. Neonates with a history of meconium-stained amniotic fluid were observed for six hours post-birth. The neonates underwent examination for meconium staining, tachypnea (respiratory rate >60/min), cyanosis, grunting, nasal flaring, and subcostal, intercostal and suprasternal recessions. Hypoxemia was defined as oxygen saturation < 89%, determined through pulse oximeter and arterial blood gases. Neonates displaying tachypnea or signs of respiratory distress were included in the study with parental consent obtained beforehand, utilizing a non-probability consecutive sampling method. Any neonates who expired prior to investigations or had sepsis, diaphragmatic hernia, congenital defects of cardiovascular, respiratory, gastrointestinal, neurological and any syndromes were excluded. Sample size of 167 cases calculated with WHO calculator with 95% confidence level, 3.2% margin of error and taking expected percentage of air leak 4.5%.[13]

All of the enrolled babies underwent chest X-ray and echocardiography to assess for air leak syndrome and persistent pulmonary hypertension of the newborn (PPHN). PPHN diagnosis relied on clinical signs of meconium aspiration syndrome (MAS) along with a loud second heart sound confirmed by echocardiography. Any of the following echocardiographic findings were considered positive: abnormal right ventricular dilatation, leftward deviation of the interventricular septum, tricuspid regurgitation, with right-to-left shunting at the level of the patent foramen ovale and patent ductus arteriosus. Likewise, the identification of air leak syndrome relied on the observation of diminished air entry in the chest, either unilaterally or bilaterally, among neonates with meconium aspiration syndrome (MAS). This diagnosis was corroborated by radiographic evidence showing lung collapse and deviation of the trachea along with characteristic findings of MAS (hyperinflated lungs with flattened diaphragm and streaky or diffuse patchy densities). Neonates were monitored in the hospital for complications until discharge or mortality, with data recorded using a pre-designed form. Statistical analysis was performed using SPSS 23, describing quantitative variables such as baby age and

weight in terms of mean and standard deviation, while qualitative variables like gender, air leak syndrome, and pulmonary hypertension were measured in frequencies and percentages. Effect modifiers such as age, weight, and gender were addressed through stratification, and the significance level was set at $p \leq 0.05$ using the chi-square test.

Results

This study enrolled a total of 167 patients, with a mean age of 6.96±6.50 days and a range from 1 to 24 days. Among these participants, 105 (62.87%) were identified as male, whereas 62 (37.13%) were female, resulting in a male-to-female ratio of 1.69:1. The mean weight of the neonates was 3.081±0.32 kg, ranging from 2.50 to 3.69 kg. Pulmonary hypertension was identified in 29 (17.4%) patients, while air leak occurred in 20 (11.98%) patients out of the total cohort. The associations of PPHN and air leak with respect to age and gender is presented in Tables I and II respectively.

Table I: Comparative Analysis of PPHN based on Patient Age and Weight.

		Pulmonary Hypertension		Total	p-value
		yes	no		
Age (days)	≤15	28	116	144	0.133
		19.4%	80.6%	100.0%	
	>15	1	22	23	
		4.3%	95.7%	100.0%	
Weight (kg)	≤ 3	15	60	75	
		20.0%	80.0%	100.0%	
	>3	14	78	92	0.417
		15.2%	84.8%	100.0%	

Table II: Comparative Evaluation of Air Leak Incidence in Relation to Patient Age and Weight.

		Air leak		Total	p-value
		yes	no		
Age(days)	≤15	19	125	144	0.315
		13.2%	86.8%	100.0%	
	>15	1	22	23	
		4.3%	95.7%	100.0%	
Weight (kg)	≤ 3	10	65	75	0.626
		13.3%	86.7%	100.0	
	> 3	10	82	92	
		10.9%	89.1%	100.0%	

Out of 167, 137 (82%) neonates were discharged while 30 (18%) neonates expired.

Discussion

Meconium aspiration syndrome (MAS) remains a significant challenge for neonatologists due to its associated morbidity and mortality. Our study sheds light on several important aspects related to MAS and its complications.

The mean age of neonates in our study was 7 days, indicating that MAS can manifest beyond the immediate postnatal period. A local study results showed mean age of 12.8 days.[14] This finding emphasizes the importance of vigilant monitoring for MAS beyond the immediate neonatal period, particularly in high-risk infants.

We observed a predominance of male neonates in our study population, consistent with previous research suggesting a higher incidence of MAS among male infants. (58-68% male and 32-42% females).[15–19] Similar results are found in another study conducted by Preeti where there were 61% males & 38% were female babies.[20] The results of 2 Asian studies were in contrary reporting equal male to female ratio.[21,22] The reasons for this male predominance warrant further investigation and may include differences in lung maturity or hormonal influences. One potential explanation is that within our societal framework, there exists a bias towards prioritizing boys over girls within families, resulting in a tendency to seek medical treatment more frequently for boys.

The average birth weight of neonates in our study was 3.1 kilograms, reflecting the typical weight range of infants affected by MAS. Similar results were observed in various studies where weight range was 2.5 to 3.5 kg [16] & 2.5-3 kg.[20] A study conducted by Ahmed et al reported mean birth weight of 2.7 kg with similar range of 2.5-3 kg highlighting the commonest weight range affected by MAS.[17] Few other studies also reported the same mean weight of 2.7 kg [21,22] reflecting that MAS is more common in babies with weight range of 2.5- 3 kg.

Our study found a relatively high incidence of persistent pulmonary hypertension of the newborn (PPHN) among neonates with MAS, with 17.4% of cases affected which is similar to the results of 2020 study reporting incidence of 17.1%.[23] While this incidence rate is lower than that reported in some previous studies, (40-60 %)[8,15,24,25] it underscores the significant cardiovascular consequences associated with MAS. The lower incidence observed in our study may be attributed to advances in neonatal care and improved management strategies for MAS and PPHN. Another study also reported higher incidence of PPHN being the second most common complication observed.[18] shukla et al observed PPHN in 24.7% of babies with MAS which is higher than the present study.[19] reported much lower incidence of 9.50%.[1]

Air leak complications were observed in 12 % cases in our study, which is similar to the results of a local study conducted at Lahore reporting 14.6% incidence.[15] Air leak complications, including pneumothorax, pneumomediastinum, and pulmonary interstitial emphysema, pose significant challenges in the management of MAS. These complications can lead to respiratory compromise and require prompt intervention to prevent further morbidity and mortality. The results from other Asian studies reported 1.6% 4% & 6% incidence of pneumothorax which is much lower than the results of present study.[17,19,21,22] while another study revealed higher incidence (18.40%).[1] A study conducted at Bahawalpur in 2018 reported much higher incidence (23%).[14] Authors couldn't find any association of age or sex with the development of these complications.

The discrepancy between our findings and those of previous studies regarding the incidence of PPHN & air leak highlights the variability in clinical presentations and outcomes associated with MAS. This diversity may be caused by variables including gestational age, the degree of meconium aspiration, comorbidities, and the accessibility of cutting-edge treatment facilities. These factors need more research.

In our study, 18% of the babies died and 82% of the babies were discharged. Compared to other research, which have shown fatality rates typically ranging from 10% to 14%, this rate is significantly higher. [15,20,22] Remarkably, a survey carried out in 2023 revealed an even worse death rate of 21.5%. [18] Furthermore, Preeti et al.'s data show that babies weighing between 2.5 and 3 kg experienced the highest mortality.[20] On the other hand, lower death rates, ranging from 2.5% [23], 6.7% [26], to 7.80%, [1] have been recorded in certain investigations. The reasons for these discrepancies in mortality rates amongst studies could be attributed to variations in sample size, patient demographics, healthcare facilities, treatment practices and above all home deliveries conducted by untrained birth attendants followed by delay in approaching the health facility well equipped with neonatal intensive care unit. In order to determine the causes of these differences and to create plans for lowering the infant mortality rate linked to MAS, more research is necessary. Furthermore, our study's noteworthy mortality rate highlights the severity of the negative consequences linked to MAS even in the presence of strict measures and state-of-the-art medical facilities. The fatality rates that have been found underscore the imperative necessity of ongoing enhancements in the practices of newborn care and the execution of focused therapies aimed at reducing the hazards linked to Meconium Aspiration Syndrome. In countries like Pakistan, where home births account for a large portion of births, it is imperative that inexperienced birth attendants in the outskirts of urban areas receive training. By providing comprehensive training at a national level, these attendants can learn essential skills to prevent meconium aspiration syndrome and ultimately reduce neonatal mortality rates. In addition to ensuring safer delivery, empowering these frontline careers expands the reach of the healthcare system, especially in underprivileged areas.

One of the study's limitations is the rather small sample size, which could restrict how broadly our conclusions can be applied to other populations. Prospective, multicentre studies should be the main emphasis of future research to clarify the epidemiology, risk factors, and appropriate management protocols for MAS and the associated complications. In conclusion, our study highlights the ongoing challenges faced by neonatologists in managing MAS and its associated complications. Despite advancements in neonatal care, MAS remains a significant cause of morbidity and mortality among newborns. Further research is needed to improve our understanding of MAS pathophysiology and enhance clinical outcomes for affected infants.

Conclusion

This study concluded that the frequency of pulmonary hypertension and air leak was high in neonates with MAS at a tertiary care hospital. There is need to develop specific strategic measures to prevent the occurrence of MAS so as to reduce the incidence of its complications hence preventing long-term morbidity as well as reducing high neonatal mortality rate in our country.

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