ORIGINAL ARTICLE

Recent Advances in Meconium Aspiration Syndrome

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ABSTRACT

Meconium Aspiration Syndrome (MAS) is a disorder affecting the infants who born with meconium stained amniotic fluid causing significant morbidity & mortality. Post-term infants are affected more. Thick meconium and birth asphyxia are important risk factors. In severe cases, development of pulmonary hypertension is common. In vigorous infants' endotracheal intubation and suctioning are not effective & in non-breathing infants these are controversial. The treatment modalities include oxygen therapy, mechanical ventilation, and nitric oxide inhalation. Infants with severe parenchymal involvement are benefited by surfactant. In some cases, Extracorporeal Membrane Oxygenation (ECMO) & high-frequency ventilation are considered.
Keywords: Aspiration, Meconium, Pulmonary hypertension, Persistent, Neonates, Post-term, Meconium stained, Mechanical ventilation, Nitric oxide. Surfactant, Membrane oxygenation, Extracorporeal.

INTRODUCTION

Meconium is the fecal material that accumulates in the fetal colon. Meconium is referred to the earliest stool found in fetal intestine during the third month of gestation, it presents as an odorless, black green thick material. It is sterile and usually can be found in amniotic fluid at 32 weeks of gestation. In 8 to 25% of all deliveries the passage of meconium in utero results in meconium stained amniotic fluid (MSAF). Infants delivered more than 37 weeks of gestation are found with MSAF. After aspiration of meconium stained amniotic fluid, meconium stimulates the release of cytokine and other vasoactive substances resulting in inflammatory responses[1].

Fetus passes meconium due to hypoxic-ischemic episodes. Infants delivered with MSAF are mostly above 37 weeks of gestation[2,3].

Nulliparity and maternal smoking (50% increased risk) are maternal factors that is linked with increased risk in MAS. On other hand LSCS or instrumental delivery are associated with the reduced risk of MAS[4]. Aspirated meconium interferes normal breathing by chemical irritation, airway obstruction, surfactant inactivation and infection. Infant born with meconium stained amniotic fluid develops respiratory dysfunction[5].

AETIOLOGY

The aetiology of MAS is complex and the therapeutic approaches are symptomatic & supportive. MAS is quite similar to sepsis and the pathophysiology needs to be well understood in order to improve therapy and prognosis [6]. MAS has been reported mostly in relation with fetal distress, post-maturity and black population[7]. Factors like maternal hypertension, preeclampsia, chorioamnitis and other maternal infection during labor are also associated with increased risk or MAS. Decrease in post term delivery reduces the MAS incidences[8].

Incidence: Meconium Aspiration Syndrome is a major cause of morbidity and mortality in the neonatal period[9,10,11]. The incidence of meconium staining of the amniotic fluid occurs in approximately 10-15% of deliveries with an occasional increasing range of 5-25%[12] of which 5% develop meconium aspiration syndrome[13].

With the Improved obstetric practices like the avoidance of post term deliveries and caesarian sections before the development of fetal distress, studies show, the meconium staining of the amniotic fluid occurs in about 4-5% of pre-term babies[14] with an increase incidence of 12% in neonates born beyond 37 weeks of gestation[15].

Pathophysiology: Meconium aspiration can occur in utero due to fetal distress as well as immediately after delivery with the initial breath of the baby[16]. The airways could be either completely or partially blocked by meconium, leading to atelectasis and ventilation perfusion mismatch. Inflammatory reaction is initiated by the meconium in the airways by inhibiting oxidative burst and phagocytic function of neutrophil[19].

Meconium inhibits surfactant synthesis and also deactivates surfactant[20,21]. Meconium aspiration can cause alveolar atelectasis due to local inflammation of the airways and inactivation of surfactant[22]. As a result, hypoxemia, acidosis and hypercapnia occur resulting in pulmonary vasoconstriction which in turn leads to the development of pulmonary hypertension. Lindenskov *et al* in 2015 hypothesized, that the toll-like receptors and complement system are activated by meconium, causing lung dysfunction as well as leading to a systemic inflammatory response[23]. The inflammatory response occurs at first in the lungs as a part of local defense system. With continuing excess production of inflammatory mediators like cytokines, tumor necrosis factor (TNF-α), interleukin (IL-6, IL-8, IL-13) wide spread chemical pneumonitis occurs. Occasionally systemic inflammatory response occurs which leads to multiple organ dysfunction[24].

RESULTS

Diagnosis of MAS can be made by clinical as well as radiographic findings. The clinical findings are: i) evidence of meconium-stained amniotic fluid (MSAF) on infant, ii) respiratory distress (nasal flaring, sub-costal and intercostal

recessions and grunting) at birth or shortly after birth, iii) barrel-shaped (increased anterior-posterior diameter) due to hyperinflation.

The typical radiographic features are; initially chest x-ray may show streaky, linear densities. With the disease progression the lungs will be hyper-inflated with flattening of the diaphragms[25,26]. Diffuse patchy densities may alternate with areas of expansion. In severe disease, the lungs may develop an appearance of homogeneous density. MAS may be complicated with air leak in10 to 30 percent of cases[27]. Arterial blood gas (ABG) measurement is necessary to assess the respiratory status.

DISCUSSION

The treatment of the newborns with MAS are with mechanical ventilation (about 30% of cases), nitric oxide, surfactant administration and extracorporeal membrane oxygenation (ECMO)[28,29,30].

Ventilation: Mechanical ventilation requires in about 30% of the affected newborn. As initial management generally conventional ventilation is used. However, in alternative therapies high-frequency oscillation and jet ventilation are used. Oxygen saturations should always be maintained at 90-95%.

Previous studies have shown that Prolonged alkalosis leads to neuronal injury in humans and animals[31]. Hence, hyperventilation, to induce hypocapnia and to compensate metabolic acidosis, is not used to treat pulmonary hypertension.

Jet ventilator therapy is used to minimize mean airway pressure and tidal volume in cases of pulmonary interstitial emphysema or pneumothorax. Continuous Positive Airway Pressure (CPAP) could be used in cases where air trapping is not a major problem[32]. High frequency Ventilation (HFV) benefits by increasing mobilization of airway secretions.

Surfactant: In order to achieve the desired response numerous doses of surfactant may be required. Meconium is a potent inhibitor of surfactant function[33] surfactant replacement in infants with severe meconium aspiration syndrome improves oxygenation and reduces the severity of respiratory failure, air leaks, need for extracorporeal membrane oxygenation and decrease the length of hospital stay[34,35].

Nitric oxide: It is used to treat persistent pulmonary hypertension of newborn (PPHN) which is a complication develops in many infants of Meconium Aspiration Syndrome (MAS). Inhaled nitric oxide had been the treatment of choice for near term infants as it reduces the need of Extracorporeal Membrane Oxygenation (ECMO)[36,37].

ECMO: Extracorporeal membrane oxygenation (ECMO), also known as extracorporeal life support (ECLS), is the treatment of choice when all other therapeutic options have failed. No increased rate of disability or neurological damage found in survivors of infants with MAS treated with ECMO[38].

Tracheal suction: MAS incidences was previously believed to have reduced using tracheal suction[39]. However, a large multicentered trial shown that routine tracheal suction in vigorous infants had no benefits[40]. Tracheal suction also not recommended by American Academy of Pediatrics in infants who are not vigorous at delivery[41].

Broncho- Alveolar Lavage: the Broncho- Alveolar Lavage is efficient method and efficiency of bronchoscopy of lung lavage in removing large quantities of meconium and improving lung function is well documented. It is reported that the ventilation duration and illness severity become less by Broncho-Alveolar Lavage[42].

Steroid therapy: Corticosteroids are not recommended. On meta-analysis of two trials, by Wu 1999, and Yeh 1977, there was no significant reduction in mortality, in duration of hospital stay and also in the duration of mechanical ventilation using corticosteroids[43].

Antibiotics: Use of antibiotic should be reserved for the patients with meconium aspiration syndrome (MAS) having definite evidence of infection (positive blood culture)[44,45].

Prognosis: The overall mortality rate of babies with MAS is 5 to 37%[46]. Pneumothorax & other air leaks can occur in about 10% of ventilated patients, convulsions develop in 4% of cases. Pulmonary hemorrhage can occur in a small proportion of cases[10].

CONCLUSION

Meconium aspiration syndrome occurs in newborn infants born with meconium stained amniotic fluid (MSAF) & it ranges from mild tachypnea to severe respiratory distress which requires intensive therapy to reduce the potential morbidity & mortality. The injuries caused by meconium are mainly due to mechanical obstruction of airways, surfactant inactivation, chemical pneumonitis, and PPHN. The frequency of meconium aspiration syndrome (MAS) increases in post-term pregnancies. A significant reduction of MAS incidence is seen in cases where elective labor induction for pregnancies at or beyond 41 weeks was performed. Persistent pulmonary hypertension plays an important role in the outcome of MAS.

Supportive care is the gold standard of management of meconium aspiration syndrome. Important modalities of treatment include oxygen therapy, mechanical ventilation, and nitric oxide inhalation. In infants with severe parenchymal injury surfactant is beneficial. ECMO has been used as a final rescue therapy in Meconium aspiration syndrome (MAS) with severe hypoxemia. Antibiotics can only be used in cases with the evidence of infection. Steroids are ineffective.

In conclusion, in order to reduce the mortality and morbidity of MAS, there should be continual and more focused studies on prevention and early treatment.

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