REVIEW ARTICLE

Meconium-stained Amniotic Fluid Revisited: A Holistic Perspective

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Abstract

Since historical times, the presence of meconium in the amniotic fluid has been worrisome for midwives and accoucheurs alike. Its association with a neonate who does not cry has often been a chill factor in delivery suites. Having said that, all cases of meconium-stained amniotic fluid (MSAF) do not necessarily result in low APGAR scores. In addition to in utero fetal hypoxia, meconium passage has also been associated with maternal drug abuse, use of vaginal misoprostol for induction of labor, chorioamnionitis, and maternal diabetes. The main pathology associated with MSAF is the aspiration of meconium during intrauterine gasping or during the first few breaths. This causes meconium aspiration syndrome (MAS) which has serious consequences on neonatal outcome. MAS is a common cause of severe respiratory distress in term neonates, with an associated highly variable morbidity and mortality. The pathophysiology of MAS is multifactorial and includes acute airway obstruction, surfactant dysfunction or inactivation, chemical pneumonitis, and persistent pulmonary hypertension of a newborn. Concepts regarding meconium and the management of MSAF to prevent MAS have changed in the last two decades or so. Guidelines published by the American Academy of Pediatrics/American Heart Association have changed the immediate neonatal management following delivery in the presence of MSAF. Initially, amnioinfusion was considered an important tool in the management of MSAF. However, evidence to support this view has not been forthcoming and current guidelines recommend amnioinfusion only in controlled and research settings. The future thrust should be aimed at early detection of MSAF and prevention of MAS. Needless to say, the obstetrician and the neonatologist need to work in consonance for achieving a better neonatal outcome in the presence of MSAF.

Keywords: Aspiration, Chill factor, Meconium, Perinatal mortality, Perinatal outcome, Pregnancy, Prevention.

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Aristotle was believed to have observed the tranquilizing effect of meconium on the newborn which probably explains the etymology of meconium from the Greek mēkōnion meaning the juice of the opium poppy.[1] MSAF is seen in 8–20% of all deliveries and may increase to 23–52% after 42 weeks of gestation which has been attributed to the gastrointestinal maturation.[2,3] MSAF is more common among women of African and Asian ethnicity.[4]

Meconium is a dark-green substance which contains gastrointestinal secretions, amniotic fluid, bile acids, bile pigments, blood, mucus, cholesterol, pancreatic secretions, lanugo, vernix caseosa, and cellular debris.[5] Meconium is the first intestinal discharge following delivery and it is believed that it accumulates within the fetal gastrointestinal tract throughout the third trimester of pregnancy. It is usually released within the first 48 hours after birth.

MSAF continues to be a chill factor in delivery suites primarily because of the association with fetal hypoxia and poor APGAR scores which is why the attending staff scurry around for help at the time of delivery.[6,7] Though MSAF has been considered as a marker for fetal hypoxia, this association between fetal distress and in utero passage of meconium has not been conclusively substantiated. Meconium passage has also been associated with maternal drug abuse, use of vaginal misoprostol for induction of labor, chorioamnionitis, and maternal diabetes.[8] Apart from these associations, very little is known about in utero passage of meconium. Since the process of labor and delivery are stressful to the fetus, it is possible that this stress could result in biochemical events that result in the passage of meconium during the normal course of labor.

The main pathology associated with MSAF is the aspiration of meconium during intrauterine gasping or during the first few breaths. This causes MAS which has serious consequences on neonatal outcome.

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What's New and What's Changed

Meconium has been considered to be sterile. However, researchers have isolated bacterial remnants and communities within meconium. These are mainly of two types, namely those bacteria that produce lactic acid, such as lactobacillus, and those that belong to the family of the so-called enteric bacteria, such as *Escherichia coli*.[9] Needless to say, this has clinical significance. In one study of the singleton pregnancies that ultimately had a cesarean delivery after a trial of labor, 5,883 had MSAF and those with MSAF had a significantly increased incidence of surgical site infection.[10]

The mechanisms underlying meconium passage in utero are not clear and appear to be complex. As mentioned before, the association of MSAF with fetal distress has been known since historic times. The explanation could lie in increased parasympathetic activity causing increased intestinal peristalsis and relaxation of the

anal sphincter secondary to enhanced vagal output during episodes of fetal hypoxia. A study has also shown that the corticotropin-releasing factor, a known mediator of colonic motility, has been implicated in the pathogenesis of hypoxia-induced MSAF in a rat model.[11] Having said that, can we conclusively state that the presence of MSAF is a reliable sign of fetal hypoxia? The nuanced answer to that is that the current evidence does show an association between MSAF and fetal hypoxia, but are all cases of MSAF a reliable indicator of acute fetal distress, the answer has to be no.

Clinicians have associated the consistency and time of passage of meconium with adverse fetal outcomes. The risk of perinatal death is increased five to seven times when freshly passed or thick meconium is present at the onset of labor.[12] Infants with thin or old meconium are more likely to have passed meconium as a physiologic maturational process and they are more likely to be healthy at birth.[13] Moreover, there is evidence that MSAF was associated with an increase in the rate of pathological intrapartum fetal heart rate patterns, intrapartum fevers, and operative vaginal and cesarean section deliveries, and these complications increased with the staining and thickness of the amniotic fluid.[14] As a consequence of this, the consistency of meconium was an important factor in determining whether a neonate needs immediate endotracheal suctioning at birth. However, current evidence no longer supports this practice. If the infant is vigorous with good respiratory effort and a heart rate >100 beats/minutes, tracheal intubation to aspirate meconium should not be attempted; only the mouth and nose may be suctioned with a bulb or suction catheter. If the neonate is depressed, traditional teaching has always been that in the presence of MSAF, any form of positive pressure ventilation should be preceded by endotracheal suctioning or else it could result in the meconium being pushed further into the air passages. However, the current American Academy of Pediatrics/American Heart Association guidelines no longer recommend endotracheal suctioning before positive pressure ventilation even in depressed infants (2015 guidelines).[15]

Perineal suctioning of the oropharynx was recommended in the past in the presence of MSAF. However, based on available evidence, routine perineal suctioning of all babies in the presence of MSAF does not prevent MAS and has the potential risk of delaying proper resuscitative measures.[13,16]

In the past, transcervical amnioscopy has been performed to visualize the color of the membranes, to predict the presence of MSAF. This was considered as a means of antenatal assessment of fetal wellbeing. However, this procedure is invasive and is no longer performed in a clinical setting, as meconium staining is no longer considered to be a reliable sign of acute fetal hypoxia.

Amnioinfusion, or transcervical infusion of normal saline, at body temperature, into the amniotic cavity, has been proposed as a method of reducing the risk of the MAS in patients with MSAF. The potential mechanisms include dilution of meconium, thus, reducing its mechanical and inflammatory effects, and cushioning of the umbilical cord, thus, correcting recurrent umbilical-cord compressions that lead to variable fetal heart rate decelerations and fetal acidemia. However, it must be kept in mind that this procedure is not without risk and the complications include uterine overdistension, hypertonus, infection, and amniotic fluid embolism. According to the ACOG Committee report 2006 (reaffirmed in 2018), the current evidence does not show that amnioinfusion reduces the incidence of MAS in patients with MSAF. NICE guidance of Nov 2006 also states that amnioinfusion should not be used routinely as a therapeutic tool and may be used only in a research setting.

Can ultrasonogram (USG) be used to predict the presence of meconium in the amniotic fluid? There is some evidence to show that echogenic amniotic fluid is associated with an increased incidence of MSAF; however, the sensitivity of this investigative modality appears to be poor.[17]

Meconium Aspiration Syndrom

Meconium aspiration syndrom (MAS) has been defined as respiratory distress in an infant born through meconium-stained amniotic fluid with radiologic changes suggestive of this syndrome and whose symptoms cannot be otherwise explained.[18] It is a common cause of severe respiratory distress in term neonates, with an associated highly variable morbidity and mortality. The pathophysiology of MAS is multifactorial and includes acute airway obstruction, surfactant dysfunction or inactivation, chemical pneumonitis, and persistent pulmonary hypertension of a newborn.[18] Short-term complications include death, respiratory failure, ventilator-induced barotrauma, and development of pulmonary hypertension. Long-term complications include pulmonary sequelae such as wheezing in infancy and asthma in childhood. Long-term complications also include adverse neurodevelopmental outcomes.

This disorder is often life threatening, and approaches to the prevention of MAS have changed over time with collaboration between obstetricians and pediatricians forming the foundations for care. The wide use of surfactant and inhaled nitric oxide as therapeutic tools has led to decreased mortality and the need for extracorporeal membrane oxygenation.[18] In developed countries, mortality rates have been reduced to below 5%.[19]

Approximately 30–50% of infants diagnosed with MAS will require continuous positive airway pressure (CPAP) or mechanical ventilation and these conventional ventilatory methods still remain the mainstay in the management of MAS. The optimum modes of ventilation for MAS, however, are yet to be formulated.[20]

Does cesarean section reduce the incidence of MAS in patients with MSAF? This question has troubled both pediatricians and obstetricians. However, there is no evidence to show a difference in the neurodevelopmental outcomes of surviving infants born by normal spontaneous vaginal delivery vs cesarean section delivery.[21]

Future Research and Guidance

Divon et al. evaluated the National Swedish Medical Birth Registry. In 181,524 singleton pregnancies with reliable dates delivered at greater than 40 weeks, the authors found a significant increase in the odds ratio for fetal death, due to MAS, at greater than 41 weeks of gestation.[22] Hence, there could be grounds for deliberations on the current definition of postterm pregnancy which still remains 42 weeks or more.

Research in the area of prevention and treatment of MAS is ongoing especially on the role and timing of surfactant therapy and the role of antibiotics. Studies are also being conducted to determine "best" ventilatory strategies for the different grades of MAS.[20]

A device to visualize the amniotic fluid prior to the rupture of membranes was tried out in the past without much success.[23] This is one area where technology and high-resolution ultrasound can be focused to provide a noninvasive method of detecting MSAF in the future.

Conclusion

In conclusion, we can say that the problem of MSAF will be faced by clinicians and the best way to reduce the "chill factor" would be

to understand the pathogenesis of meconium release and its effect on the fetal respiratory system, and to be prepared to manage MAS. Multimodal management involving the obstetrician and the neonatologist would be the ideal approach to this problem. Strategies for the prevention of MSAF and MAS need to be formulated and standardized by consultative cooperation between the neonatologist and the obstetrician.

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