

## Meconium-stained amniotic fluid viscosity and chest x-ray findings

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### Abstract

**Background** Approximately 8-15% of all infants are born with evidence of meconium-stained amniotic fluid (MSAF). Many of these infants rapidly initiate a good respiratory response and are otherwise vigorous. Other infants present with a variety of respiratory distress. Chest x-ray imaging is the main test done to evaluate respiratory distress in order to differentiate pulmonary and extrapulmonary etiologies.

**Objective** To determine the relationship between viscosity of MSAF and chest x-ray imaging results.

**Methods** This cross-sectional study was held from January to June 2011, as a continuation of a previous study from August 2009 to May 2010 at Kariadi Hospital, Semarang, Indonesia. Data was taken from medical records of babies who were born with MSAF. MSAF viscosity measurements by the investigator and laboratory technician were assessed by Kappa test in the previous study with a result of 0.74. X-ray findings were determined by the radiologist on duty at that time. Chi square and logistic regression tests were used for statistical analysis.

**Results** There were 48 subjects consisting of 26 males and 22 females. Chest x-ray imaging results showed normal findings in 33.3% of subjects, pneumonia in 58.3% of subjects and meconium aspiration syndrome in 8.3% of subjects. Thick viscosity MSAF was significantly correlated to abnormal x-ray imaging (RR=2.046; P=0.004; 95%CI 1.12 to 3.72).

**Conclusion** Thick MSAF viscosity significantly increased the risk of abnormal chest x-ray findings. [Paediatr Indones. 2012;52:336-40].

**Keywords:** meconium viscosity, MSAF, chest x-ray

Approximately 13% of all live births are complicated by MSAF.<sup>1</sup> Under normal circumstances, the passage of meconium from the fetus into the amnion may be prevented by the lack of intestinal peristalsis. Peristalsis may be inhibited by low motilin levels, tonic contraction of the anal sphincter, and a terminal cap of viscous meconium.<sup>2</sup> Meconium has been found below the vocal cords in 20-45% of infants born with MSAF.<sup>3</sup> The passage of meconium in utero indicates acute or chronic hypoxia, and has been observed primarily in cases of advanced fetal maturity.<sup>4,5</sup>

The viscosity of meconium in amniotic fluid has been classified as thick, medium, or thin.<sup>6</sup> This viscosity depends on the constituents of meconium, the relationship between asphyxia and meconium release, the time and cause of the passage of meconium into amniotic fluid, and the amount of amniotic fluid. Meconium stained amniotic fluid has been associated with an increased risk for pulmonary dysfunction. The

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risk for pulmonary disease, however, is not manifested equally in all infants, as thick meconium staining is thought to increase the overall risk for pulmonary disease to a significantly greater degree than that in infants with thin meconium staining.<sup>4,6</sup>

Chest radiography is the preferred examination for assessing pulmonary dysfunction.<sup>7</sup> The inflammatory process of meconium aspiration may result in a variety of presentations on chest radiography, initially indistinguishable from neonatal pneumonia. Without visualization of meconium below the vocal cords during resuscitation, a diagnosis may be made on the basis of the clinical course and the results of follow-up imaging studies.<sup>6,7</sup> In two-thirds of neonatal pneumonia cases, patchy opacities representing consolidation with pleural effusion may be observed. Lung volumes are usually normal, but the lung fields may be hyperinflated. Although classic x-ray findings of meconium aspiration syndrome are described as diffuse and patchy infiltrates, the diverse mechanisms involved in the pathogenesis may lead to a wide variety of radiographic findings.<sup>7</sup>

The purpose of this study was to determine the relationship between MSAF viscosity and chest x-ray findings.

## Methods

This cross-sectional study was held from January to June 2011 as a continuation of a previous study

from August 2009 to May 2010 at Kariadi Hospital, Semarang, Indonesia.<sup>8</sup> The previous study was approved by the Ethics Committee of Diponegoro University Medical School/Kariadi Hospital.

Data was taken from medical records of babies born with MSAF. MSAF viscosity measurements by the investigator and laboratory technician were assessed by Kappa test for interobserver agreement in the previous study.<sup>8</sup> MSAF was categorized on the basis of meconium viscosity into thick or thin MSAF. Chest x-ray findings were assessed once by the radiologist on duty at that time.

Pearson's chi-squared test was used to compare categorical variables. Risk factors of chest x-ray abnormality due to MSAF viscosity were analyzed with a 95% confidence interval. Forward logistic regression analysis was used to estimate the risk of abnormal chest x-ray finding. A P value of < 0.05 was considered to be statistically significant.

## Results

Forty-eight term neonates were enrolled in our study. The majority were male and born of primiparous mothers. Subjects' mean gestational age was 39.9 (SD 1.73) weeks. Kappa test result was 0.74, indicating good interobserver agreement.<sup>8</sup> **Table 1** shows the characteristics of subjects, divided into 2 groups: thick and thin MSAF.

Chest x-rays findings of subjects with MSAF

**Table 1.** Characteristics of subjects

Characteristics	Meconium-stained amniotic fluid	
	Thick (n=10)	Thin (n=38)
Male gender	8	18
Mean birth weight (SD), g	3000 (569.6)	3104.1 (444)
Mean maternal age (SD), years	33.1 (6.2)	27.6 (6.8)
Mean gestational age (SD), weeks	39.6 (2.3)	40 (1.6)

**Table 2.** MSAF and chest x-ray findings

MSAF viscosity	Chest x-ray		
	Pneumonia n=16	Meconium aspiration syndrome n=4	Normal n=28
Thin	12	1	25
Thick	4	3	3



**Figure 1.** Meconium aspiration syndrome



**Figure 2.** Neonatal pneumonia

**Table 3.** Association between MSAF viscosity and chest x-ray findings

MSAF viscosity	Chest x-ray finding		RR	95% CI
	Abnormal	Normal		
Thick	7	3	2.046	1.124 to 3.725
Thin	13	25		

P=0.004

are shown in **Table 2**. There were 16 subjects with pneumonia (33.3%), 4 with meconium aspiration syndrome (8.3%), and 28 with normal findings (58.3%). Of the 16 pneumonia cases, 12 had thin MSAF and 4 had thick MSAF. Of the 4 meconium aspiration syndrome cases, 1 had thin MSAF, while 3 had thick MSAF. Of the 28 cases with normal chest x-rays, 25 had thin MSAF and 3 had thick MSAF.

**Table 3** shows the association between MSAF viscosity and abnormal chest x-ray findings. We found that thick MSAF had 2.046 times the risk for abnormal x-ray imaging (P= 0.004, 95%CI 1.12 to 3.72).

**Figure 1** and **Figure 2** show the abnormal chest x-rays of meconium aspiration syndrome and pneumonia, respectively.

## Discussion

Meconium aspiration is a frequent problem in newborns, with MSAF noted in 10-15% of deliveries. Both sexes are equally affected. In such deliveries, 5-15% of the infants develop symptoms of respiratory distress. In fact, infants born with MSAF are at a 100-fold greater risk of developing respiratory distress than those born with clear amniotic fluid.

In addition to obstruction of the airway, aspiration leads to an inflammatory response in the lung parenchyma (chemical pneumonitis). It is this inflammation, not the meconium itself, that results in the patchy infiltrates seen on chest radiography. It is not clear which component(s) of meconium trigger the inflammatory response. However, bile and liver enzymes have been suggested as the causative agents.<sup>9</sup>

The increase in pulmonary distress and mortality among infants born with MSAF has been well recognized.<sup>10</sup> In our study, the mean gestational ages of subjects in the thick and thin meconium groups were 39.6 (SD 2.3) weeks and 40 (SD 1.6) weeks, respectively. A study by Narli *et al.*,<sup>6</sup> found that the presence of MSAF increased with gestational age. The hormone, motilin, may be responsible for this

observation, as it is secreted in increasing quantities by the fetus as gestational age advances. Most meconium discharge is thought to occur in post dated gestations, since motilin levels are highest at that time.<sup>11,12</sup> MSAF may be a fetal response to hypoxia, vagal stimulation from transient umbilical cord entrapment, or decreased sympathetic nervous system activity with a loss of sphincter tone.

We classified MSAF viscosity as thick or thin, with 23% and 77% of MSAF samples, respectively, in our study. Sheiner *et al.*<sup>13</sup> reported that most (78%) of their cases had thin MSAF, however, Khazardoost *et al.*<sup>14</sup> found a higher percentage of thick (90%) than thin meconium. MSAF viscosity depends on the constituents of meconium, the relationship between asphyxia and meconium release, the time and cause of the passage of meconium into amniotic fluid, and the amount of amniotic fluid.<sup>15</sup>

A study by Kosim *et al.* reported that in 48 male subjects with mean gestational age of 39.9 (SD 1.73) weeks, MSAF tested positively for stercobilin and bilirubin in 12/48 and 17/48 subjects, respectively. Classification of MSAF as thick or thin was done by macroscopic examination with Kappa test=0.741. Thick MSAF correlated significantly to meconium aspiration syndrome with a relative risk of 10.1 (P=0.03, 95% CI 1.2 to 87.6), while the presence of stercobilin and bilirubin presence did not.<sup>8</sup>

The viscosity of MSAF and the response to aspiration are highly variable, and pulmonary hypertension is a significant comorbidity that is not obvious on chest radiography. Therefore, the clinical picture may be poorly correlated with the radiographic findings.<sup>9</sup>

We found that MSAF viscosity was associated with chest x-ray imaging, with thick MSAF as a risk factor for abnormal chest x-ray findings.

Ziadeh *et al.* found that the incidence of meconium aspiration syndrome and respiratory distress were significantly increased in those with MSAF.<sup>16</sup> Meconium aspiration syndrome was primarily associated with acute hypoxic events late in labour or chronic prenatal disease related to acute events occurring late in labour or after birth. Meconium aspiration syndrome also depends on increasing consistency of meconium.<sup>10</sup> Meconium aspiration can occur either during labour or at the time of the baby's first breath.<sup>8</sup>

From our 48 subjects, 8.3% developed meconium aspiration syndrome in chest x-ray findings, while 33.3% developed neonatal pneumonia. From all MSAF subjects, the incidence of meconium aspiration syndrome was 8.3%. From subjects with thick MSAF, a higher proportion (3 out of 10) had meconium aspiration syndrome. Narli *et al.* observed the incidence of meconium aspiration syndrome for all neonates with MSAF to be 15.1%, while in infants with thick meconium, it was 38.5%.<sup>6</sup>

Chest x-ray findings may vary, but often demonstrate bilateral infiltrates, areas of consolidation, and/or atelectasis (lung collapse), of which the latter findings have been associated with more severe neonatal illness. Complications include pneumothorax (collapsed lung due to gas trapping distal to obstructed airways or uneven aeration of the lung), and persistent pulmonary hypertension of the newborn (PPHN) with hypoxia. Typical chest x-rays are shown in **Figure 1** and **Figure 2**.

Meconium aspiration syndrome involves aspiration of meconium through the trachea into the bronchial tree, sometimes down to the alveoli. Three classes of alveoli have been described: (1) those not ventilated due to complete proximal obstruction (atelectatic), (2) those with partial meconium obstruction, and (3) those with no proximal obstruction. Alveoli with partial meconium obstruction are thought to trap air because of a ball-valve mechanism by which gas reaches the alveoli on inflation, but is trapped secondary to reduced airway diameter during expiration. It is challenging to oxygenate babies with meconium aspiration syndrome, because the alveoli in which gas trapping occurs may rupture, leading to air leaks. Also, meconium in the alveoli may deactivate surfactants.<sup>9</sup>

A report by Clark suggested that imaging studies, such as chest radiograph are essential to do the following: determine the extent of intra-thoracic pathology, identify areas of atelectasis and air block syndromes, as well as ensure appropriate positioning of the endotracheal tube and umbilical catheters. Later in the course of meconium aspiration syndrome when the infant is stable, imaging procedures of the brain, such as MRI, CT scan, or cranial ultrasound, may be indicated if the infant's neurologic examination is abnormal.<sup>17</sup>

Furthermore, Clark reported the following x-ray findings in infants with obstruction: air trapping and hyperexpansion from airway obstruction, acute

atelectasis, pneumomediastinum from gas trapping and air leak, left pneumothorax with depressed diaphragm and minimal mediastinal shift because of noncompliant lungs, and diffuse chemical pneumonitis from constituents of meconium.<sup>17</sup>

A limitation of our study was that we were unable to perform a Kappa test for interobserver agreement among radiologists in x-ray assessments, due to the retrospective nature of the study.

In conclusion, thick MSAF was a risk factor for abnormal chest x-ray findings. Serial chest x-rays are recommended for babies born with MSAF and subsequent respiratory distress.

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