Prevalence and Factors Associated with Meconium Staining of Amniotic Fluid, Meconium Aspiration Syndrome and Clear Liquor in South Indian New-born—Part II

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Abstract

Meconium staining of amniotic fluid (MSAF) is a commonly observed phenomenon in day-to-day practice of obstetrics, advocates the quick delivery of baby as priority since majority 84% of newborns with MSAF were asphyxiated at birth OR 8.42 [CI95%] 5.1-14, P=0.0001 compared to those newborns with clear liquor. The prevalence of MSAF 7.8% however incidence of Meconium Aspiration Syndrome (MAS) was 1.8%, but constituted 23% of MSAF parturient. Various high risk factors include primigravida, young mothers with obstetric complications of premature rupture of membranes (PROM) of more than one hour before labor occurred in 9.1% of 207MSAF pregnancies compared to only 7.3% in overall births. Similarly also Pregnancy induced hypertension (PIH) occurred in 9% with MSAF compared to an overall 5.6%. Gestational diabetes (GDM) was least 3.4% in MSAF pregnancies compared to overall 5.3%. While Grade II MSAF peaked in birth weight category 300-3499g category, most newborn of remaining parturient weighed between 2,500-2,999g. Peak births at 38 weeks comprised of newborns with clear liquor delivered normally, contrasted to peak births at 39 weeks for newborns with MSAF and MAS delivered mainly by emergency Lower Segment Caesarean Section (LSCS). Surprisingly commonest parturient blood group was AB+ve. In conclusion, effective preventive strategy would be early delivery by 38 weeks gestation preferably by elective LSCS, obviating intra-partum events in high risk cases, resulting in improvement of fetal and neonatal morbidity and mortality.

Keywords

Meconium Stained Amniotic Fluid, Meconium Aspiration Syndrome, Clear Liquor, Parturient Blood Group, Preventive Strategy

1. Introduction

Meconium staining of amniotic fluid been reported in 8%-20% of all deliveries [1-5]. Aspiration and may occur antepartum, intrapartum or even at infant's first breath, however its significance is as a sign of fetal distress, indicating an asphyxial event in fetus that results in-utero gasping with aspiration of meconium and its complications [6, 7]. Meconium aspiration syndrome (MAS) occurs worldwide in about 2%-9% neonates, often results in severe mental retardation and cerebral palsy, accounting for 12% of neonatal mortality and 2% of perinatal mortality rate

[7]. Transient umbilical cord compression during contractions triggers foetal hypoxic stress causing vagal stimulation, resulting in mesenteric vasoconstriction, increased peristalsis and relaxation of anal sphincter leading to intrauterine passage of meconium, stimulating gasping movements that result in meconium aspiration [8]. Fetuses that have passed meconium during labor are in the state of temporary compensated fetal distress with peripheral hypoxia but well-oxygenated vital organs. At this stage, the fetal blood pH will not show acidemia and Apgar score will be good if delivered soon [6, 9]. Late deceleration of fetal heart rate (FHR) pattern, most commonly associated with lower fetal scalp blood pH <7.25 indicate a state of decompensated fetal distress in which quick intervention becomes necessary [10-12].

The extent of lung destruction in MAS with obstruction of both large and small airways depends on degree of hypoxia and acidosis present at birth as well as volume and more so the concentration of the meconium aspirated [13]. Fetal lungs normally contain, alveolar liquid about 40 ml of body weight, differs from amniotic fluid or plasma ultra-filtrate having low 25mg/dl protein, but there is reduced production of pulmonary fluid in fetal hypoxemia with acidotic foetus and meconium inhibits foetal lung fluid reabsorption at birth disturbing the ability of lungs to adapt to extra uterine life [13, 14]. Continuous positive pressure ventilation (CPPV) with oxygen in both MSAF and MAS new-borns with birth asphyxia facilitates the reabsorption of lung fluid into interstitial, thence to lymphatic, triggering smooth complex fetal cardiovascular changes adapting to adult life [14, 15].

MAS on X-ray chest may show coarse, patchy infiltrates radiating from the hilum into the peripheral lung fields with focal areas of atelectasis, consolidation, or emphysema [16]. Histopathology show meconium with squamous epithelial cells and yellow to brown granular amorphous material deposited in alveoli and bronchioles with focal alveolar haemorrhages and evidence of bronchopneumonia but no organism can be cultured from these lung specimens, except in preterm fetus, meconium passage usually occurs with infections such as *Listeria monocytogenes*, *Ureaplasma urealyticum*, and rotavirus which may cause fetal enteritis [17, 18]. However, meconium concentrations exceeding 1% enhances the ability of amniotic fluid to sustain bacterial growth by inhibition of neutrophil phagocytic activity [19].

Hence, it is fetal hypoxia in MAS that enhances the potential for poor outcome, as it is the antepartum chronic or acute hypoxial damage to the lungs that causes persistent pulmonary hypertension, or else it is mild, benign and self-limiting [20]. The partial or complete airway obstruction in MAS leads to hyperinflation with surrounding atelectasis and increased lung resistance that decreases lung compliance with resultant acute hypoxemia, hypercapnia, respiratory acidosis, pulmonary vasoconstriction, persistent pulmonary hypertension, ventilation perfusion mismatch and right to left shunting of blood through the foramen ovale and patent ductus arteriosus [16, 21, 22], with subsequent asphyxiated fetal death or distressed neonates [7, 12, 23]. The incidence of respiratory failure, diagnosed by $PO_2 50$ mm of Hg, $PCO_2 75$ mm of Hg or repeated or prolonged episodes of apnoea and circulatory failure occurs in 53% in MAS with neonatal mortality of 20%, necessitating prompt intervention and delivery with MSAF [7, 23].

Aim

The retrospective study was undertaken:

- ❖ To estimate prevalence of MSAF, subdivided into significant and non-significant MSAF as well incidence of newborns with MAS and clear liquor;
- ❖ To determine association of birth asphyxia in newborns with MSAF compared to those with clear liquor;
- ❖ To compare various biological risk factors of new-born with MSAF, MAS and clear liquor;
- ❖ To estimate distribution of parturient blood group compared to general population;
- ❖ To identify preventive strategy to improve fetal and neonatal outcome in MSAF and MAS.

2. Materials and Methods

The study comprised 2,750 consecutive singleton live births during the period January 1st 2015 to May 31st 2017 at Shifa Hospital, a multispecialty centre in the metropolitan city of Bangalore. There were 207 cases with MSAF and 49 cases of MAS. The exclusion criteria were 22 twin delivery and 46 stillbirths. Consistency of meconium was graded as non-significant Grade I, meconium staining being thin, light yellow-green meconium stained amniotic fluid, and significant Grade II, meconium staining defined as thick, dark green, viscous with particles or 'pea soup'. Meconium Aspiration Syndrome (MAS) is defined as presence thick, dark green, viscous MSAF at birth followed subsequently by sign and symptoms of MAS (i.e., tachypnoea, dyspnoea, retraction, grunting or cyanosis).

Simultaneous biological risk factors such as parity, mother's age, and obstetric complications, mode of delivery, birth weight and gestation of newborns with MSAF, MAS and Clear Liquor were compared and strategy determined as effective preventive measures for MSAF in reducing birth asphyxia, thereby promoting fetal and neonatal wellbeing.

All women received adequate prenatal care, gestation was assessed by Last Menstrual Period (LMP) and correlated with ultrasound measurement of Crown-rump length (CRL) undertaken within 18 to 20 weeks of gestation to determine fetal age. If CRL and menstrual dates agreed to within the normal range of error (± 7 days) days then LMP was used to establish fetal age. Birth weight was recorded within 24 hours on a digital weighing machine accurate up to ± 10 g. Sources of data were Labor room register, new born register and neonatal records. Data was entered into EPI data version 3.1 and then exported to SPSS Version 21 for analysis of distribution statistics like frequencies and cross tabulation and statistical significance was performed.

3. Results

During the study period 207 newborns with MSAF, constituted 7.5% of singleton live births, seen in Table 1. A majority 83.6% (n=173) of newborns had MSAF and were asphyxiated at birth with OR 8.42 [CI95%] 5.1-14 being highly statistically significant $P=0.0001$, being 30 times at higher risk as compared to 92.45% (n=2543) controls with clear liquor that constituted only 16% birth asphyxia cases. In contrast, all 100% of newborns who developed MAS were asphyxiated at birth.

Table 1. Frequency of Meconium staining of amniotic fluid

Group	No. of cases	Percent
Clear Liquor	2,543	92.47
MSAF	207	7.52

Two groups with MSAF were graded based on the consistency of meconium as thin or thick. Grade I, non-significant, thin meconium stained amniotic fluid and Grade II, significant, thick meconium or particulate matter at spontaneous or artificial rupture of membranes. Of 207 MSAF cases, Grade I or thin meconium staining of amniotic fluid constituted 68.1% (n=141) while Grade II with thick meconium staining comprised 31.9% (n=66) seen in Table 2.

Table 2. Severity of Meconium staining

Groups	No. of cases	Percent
Thin MSAF	141	68.1
Thick MSAF	66	31.9
	207	100

While 2,543 cases with clear liquor comprised 92.5% of 2,750 live births, 207 MSAF cases with Grade I or thin meconium staining constituted 5.1% (n=141/2750) and Grade II, thick meconium staining was a low 2.4% (n=66/2750), the frequency and type of Meconium seen in Table 3.

Table 3. Frequency and type of Amniotic Fluid

Group	No. of cases	Percent
Clear Liquor	2,543	92.5
Thin MSAF	141	5.1
Thick MSAF	66	2.4

Newborns with MSAF who did not develop MAS constituted 5.7% (n=158/ 2750) births seen in Table 4. The incidence of Meconium Aspiration Syndrome (MAS) was 1.9% (n=49/207) with sign and symptoms of respiratory distress such as tachypnoea, dyspnoea, retraction, grunting or cyanosis after birth but constituted 24% (n=49/207) new-borns with MSAF seen in Table 5.

Table 4. Frequency of Meconium Aspiration Syndrome (MAS)

Group	No. of cases	Percent
Clear Liquor	2,543	92.5
Thin MSAF	158	5.7
MAS	49	1.9
	2,750	100

Table 5. Meconium Aspiration Syndrome among MSAF cases

Group	No. of cases	Percent
MSAF without MAS	158	76.3
MAS	49	23.7
	207	100

4. Distribution by Gravida

Grade I MSAF occurred in 50.4% (n=70/139) primigravida similarly also Grade II MSAF with 50.6% (n=29/57) as also MAS with 46% (n=21/46). In contrast, 31% (n=793/2,518) newborns with clear liquor were primigravida with almost similar distribution of 30% (n=764) for second gravid followed by 22% (n=551/2,518) third gravida mothers, distribution seen in Figure 1 and Table 6.

Figure 1. Percentage distribution of newborn with Grade I & II MSAF, MAS and Clear Liquor according to Gravida.**Table 6. Distribution by Gravida**

	Gravida						
Groups	1	2	3	4	5+	No.	Missing
Grade I	70	31	23	9	6	139	2
Grade II	29	14	8	3	3	57	9
MAS	21	11	5	6	3	46	3
Clear Liquor	793	764	551	262	148	2,518	21

4.1 Distribution by Mother's Age

Grade I MSAF newborns were mostly 44% (n=6/139) were born to mothers aged 20-24 years, similarly also 42% (n=25/60) with Grade II MSAF. However, newborns with MAS peaked at 45% (n=20/46) in older mothers aged 25-29 years. Newborns with clear liquor majority 39% (n=940/2,413) were born to young mother's aged 20-24 years, distribution seen in Figure 2 and Table 7.

Figure 2. Percentage distribution of Grade I & II MSAF, MAS and Clear Liquor according to Mother's Age.

Table 7. Distribution by Mother's Age

Groups	Mother's Age in Years					No.	Missing
	<19	20-24	25-29	30-34	>35		
Grade I	5	61	52	18	3	139	2
Grade II	4	25	23	7	1	60	6
MAS	3	18	20	4	1	46	3
Clear Liquor	240	940	803	352	78	2,413	126

4.2 Distribution by Obstetric Complications

Most 78.3% (n=162) of 207 pregnancies with MSAF had no obstetric complications while 22% (n=45) had obstetric complications seen in Table 8. Premature rupture of membranes (PROM) of more than one hour before labor occurred in 9.1% of 207 pregnancies with MSAF compared to only 7.3% in overall births. Similarly also Pregnancy induced hypertension (PIH) occurred in 9% with MSAF compared to an overall 5.6%. Gestational diabetes (GDM) was least 3.4% in MSAF pregnancies compared to overall 5.3%.

Table 8. Obstetric Complications with Meconium staining of amniotic fluid

Obstetric Complications	Number of cases	Percentage
Nil Obstetric complications	162	78.3
Obstetric complications	45	21.7
Total	207	100

While PROM was commonest in pregnancies with Grade II MSAF 57% (n=8/14), followed by Grade I MSAF 35% (n=11/31) and newborns with clear liquor peaked 40% (n=181/457) with PROM. In contrast PIH occurred maximum with MAS 57% (n= 4/7) followed by Grade I MSAF 52% (n=16/31). GDM was least 13% (n=4/31) with Grade I MSAF to maximum 43% (n=3/7) in MAS and Grade II MSAF 21% (n=3/14). Newborns with clear liquor showed almost equal 30% distribution for PIH and GDM, distribution seen in Figure 3 and Table 9.

Figure 3. Percentage distribution of New-born with Complications of pregnancy in Grade I, II MSAF, MAS and Clear Liquor.**Table 9. Obstetric Complications associated with MSAF, MAS and Clear Liquor**

Groups	Obstetric Complications			No.
	PROM	PIH	GDM	
Grade I	11	16	4	31
Grade II	8	3	3	14
MAS	1	4	3	7
Clear Liquor	181	136	140	457

4.3 Distribution by Birth weight

Most 38% (n=53/138) of newborns with Grade I thin MSAF weighed between 2,500-2,999g with 34% (n=47/138) weighing 3,000-3,499g. However, Grade II thick MSAF peaked 30% (n=20/152) in birth weight group of 3,000-3,499g, similarly also MAS peaked 31% (n=14/45) with equal distribution 29% (n=13/45) in 2,500-2,999g and 2,000-2,499g with minimal or none in lower birth weights. In contrast newborns with clear liquor peaked 38% (n=902/2,342) in 2,500-2,999g birth weight category followed by 35% (n=808) in 3,000-3,499g birth weight and 15% (348) in 2,000-2,499g, distribution seen in Figure 4 and Table 10.

Figure 4. Percentage Distribution of New-borns by birth weight in Grade I & II MSAF, MAS and Clear Liquor.

Table 10. Distribution by Birth weight category

		Birth weight in grams								
Groups		≤999	1,000-1,499	1,500-1,999	2,000-2,499	2,500-2,999	3,000-3,499	3,500-3,999	>4,000	
Grade I	-	2	4	21	53	47	11	-	138	3
Grade II	-	-	4	12	13	20	2	1	52	14
MAS	-	-	3	13	13	14	2	-	45	4
Clear Liquor	16	27	46	348	902	808	169	26	2,342	201

4.4 Distribution by Gestation

Grade II thick MSAF peaked 38% (n=22/58) with birth at 39 weeks gestation followed by 35% (n=16/46) newborns with MAS as well as Grade I thin MSAF 32% (n=43/133) at 39 weeks gestation. However, peak 27% (n=663/2,467) newborns with clear liquor were born at 38 weeks gestation with 26.6% (n=658/2,467) at 39 weeks gestation, reveals increased risk of MAS and Grade I and II MSAF for births at 39 weeks and beyond as compared to 38 weeks gestation or below, distribution seen in Figure 5 and Table 11.

Figure 5. Percentage Distribution of New-borns with Grade I & II MSAF, MAS and Clear Liquor according to Gestation.

Table 11. Distribution by Gestation

Gestation in Weeks												
Groups	33	34	35	36	37	38	39	40	41	No.	Missing	
Grade I	1		3	3	15	36	43	30	2	133	8	
Grade II	1		1	3	7	14	22	10		58	8	
MAS	1			1	7	9	16	11	1	46	3	
Clear Liquor	42	20	57	121	344	663	658	518	44	2,467	72	

4.5 Distribution by Mode of Delivery

According to mode of delivery, majority 54% (n=1,378/2,532) normal vaginal births had clear liquor. In contrast, in MAS peaked 52% (n=24/47), Grade II thick MSAF 51% (n=28/55) and Grade I thin MSAF 47% (n=65/139) were delivered by emergency LSCS with common indication being fetal distress, had high risk of birth asphyxia, OR 4.91, [CI 95%] 3.94-6.10 times normal delivery, being highly statistically significant P=0.0001 being 83% in MSAF cases. A comparatively low one-fourth incidence 26% (n=662/2532) with clear liquor were delivered by emergency LSCS. However, newborns delivered by elective section had low risk of birth asphyxia, OR 1.67 [CI 95%] 0.84-1.63, but statistically insignificant P=0.358, most had clear liquor 15% (n=388/2532) with less than 8% with Grade I, II MSAF and MAS. Majority of newborns with vacuum extraction suffered high incidence of MAS associated with a significant higher risk of birth asphyxia, OR 8 [CI 95%] 5.58-11.69, being highly statistically significant P=0.0001. Quick intervention by emergency section, indicated by fetal distress in MSAF probably reduced severity of MAS with most clinical features resolving in 2-3 days' time, distribution seen in Figure 6 and Table 12.

Figure 6. Percentage Distribution of New-borns with Grade I & II MSAF, MAS and Clear Liquor according to Mode of delivery.

Table 12. Distribution by Mode of Delivery

Groups	Mode of Delivery					No.	Missing
	Normal	Emergency LSCS	Elective LSCS	Vacuum Ext	LPF		
Grade I	58	65	12	3	1	139	2
Grade II	18	28	4	5	-	55	11
MAS	17	24	3	3	-	47	1
Clear Liquor	1,376	662	388	91	39	2,532	7

4.6 Distribution of Parturient Blood Group

The commonest blood group was AB+ve, incidence 33% (n=774/2283) parturient, followed by 31%, A+ve (n=706/2283), and O+ve 23% (n=528/2283), distribution seen in Table 13. Most 56% (n=23/41) of cases with MAS had mothers with AB+ve blood group, while 39% (n=50/127) of mothers with Grade I MSAF as also 33%

(n=2081) newborns with clear liquor had AB+ve blood grouping. While O+ve occurred among 24% (n=30/127) in Grade I MSAF as well as with clear liquor 24 % (n=488/2081). In contrast, Grade II MSAF had mainly 34% (n=21/61) parturient with B+ve followed 21% (n=13/61) with blood groups of A+ve and AB+ve, distribution seen in Figure 7 and Table 14.

Figure 7. Percentage distribution of Parturient Blood Group with Grade I & II MSAF, MAS and Clear Liquor.

Table 13. Number and Percentage distribution of Parturient by Blood Group

	Parturient Blood Group							
	O+ve	O-ve	A+ve	A-ve	B+ve	B-ve	AB+ve	AB-ve
Overall								
Number	528	30	706	40	187	10	744	38
Percent	23	1	31	2	8	.1	33	2

Table 14. Distribution by Blood Group among Parturient with MSAF, MAS and Clear Liquor

Groups	Parturient Blood Group								No.	Missing
	O+ve	O-ve	A+ve	A-ve	B+ve	B-ve	AB+ve	AB-ve		
Grade I	30	2	28	2	10	1	50	4	127	109
Grade II	9	1	13	-	4	21	13	-	61	5
MAS	5	1	10	-	1	-	23	1	41	8
Clear Liquor	488	27	662	38	173	9	682	2	2,081	458

5. Discussion

Meconium is a germ-free thick black green odorless material first recognized in fetal intestine around 10th to 16th week of gestation, stored in colon containing gastrointestinal and pancreatic secretions, bile, bile acids, mucus, cellular debris and swallowed vernixcaseosa and lanugo. Meconium is usually passed 24-48 hours after birth, while meconium passage in utero is a normal physiological event in term fetus and not a sign of fetal distress in the absence of fetal heart rate abnormalities [24, 25]. MSAF is present in 8%-20% of all deliveries increasing to 23%-52% after 42 weeks of gestation and rarely found in amniotic fluid before 34 weeks gestation, with about 21% MSAF, developing MAS, one-third of these requiring intubation and mechanical ventilation [1-6, 23, 24]. In the present study, prevalence of MSAF was 7.5% and MAS 1.8% but which constituted 23% of MSAF cases. Grading of MSAF revealed 68% thin MSAF and 32% with thick MSAF however other studies report Grade I thin MSAF 11.6% to 12.5% and thick meconium 87% to 90%, with MAS in 21.2% [4, 5]. Risk factors associated with passage of meconium in utero include primiparity 50% with MSAF and 45% in MAS, subsequently decreasing with increasing gravida also reported in other studies [4, 5].

Peak delivery with Grade II thick MSAF 38% occurred at 39 weeks gestation followed by newborns with MAS 35% as well as Grade I thin MSAF 32% also at 39 weeks gestation. However, peak births with clear liquor 27% tookplace at 38 weeks gestation followed by 26.6% at 39 weeks gestation. Hence, later delivery at 39 weeks and

beyond was associated with higher risk of MSAF and MAS signifying fetal distress with asphyxia injury as compared to 38 weeks gestation or less [1, 4, 5].

MSAF and MAS was more common in young mothers with mean age 25 years, other studies reported MAS at 28 years, and mean birth weight varying between 2,855g in present study to 3,187g reported in other studies but with almost similar mean gestation at 38.2 to 38.9 weeks [1, 4, 5]. Factors associated with passage of meconium in utero include obstetric complications of placental insufficiency with PIH, non-reassuring foetal heart rate, foetal acidosis, emergency LSCS, meconium below cords and low Apgar score [2, 7, 11, 12].

Obstetric complications of PROM, though was commonest in pregnancies with clear liquor 40%, however Grade II MSAF peaked 57% followed by Grade I MSAF 35%. PIH occurred mainly with MAS 57% (n=4/7) with GDM at 43% as also Grade I MSAF at 52% with least GDM of 13% to 21% in Grade II MSAF reported also in other studies [4, 5]. Emergency LSCS was undertaken in 52% of MAS cases, 51% with Grade II thick MSAF and 47% with Grade I thin MSAF. Other studies revealed 60.2% LSCS in MSAF and 46.8% in MAS [5]. In contrast, most births with clear liquor had a normal vaginal delivery between 38-39 weeks gestation, in younger mothers aged 20-24 years with second to third gravida and higher birth weight 2,500-3,499g.

Most parturient 33% had AB+ve blood group followed by B+ve 31% and O+ve 23%, contrasts to general Caucasian and Asian population with majority 38% O+ve followed by 34% A+ve in former and 32% B+ve with least 3-7% AB+ve³⁹. Could the unique predominance of AB+ve mothers in pregnant women, be associated with fertility issues being universal recipients, as opposed to prevalence of O+ve in general population being universal donors but have anti A and anti B of varying titers [26]. Mother's blood group type and Rh-ve factor is known to impact fetus and newborns.

The major goal of obstetric care is to prevent or reduce maternal, fetal and neonatal morbidity and mortality. In the present study, 207 cases of MSAF were associated with 84%, asphyxiated newborns, OR 8.42 [CI 95%] 5.1-14 being 30 times higher compared to newborns with clear liquor (P=0.0001) indicating that all cases with MSAF should be closely monitored with active management of labor and judicious intervention. The incidence of LSCS was high 42% with 60% being emergency LSCS, fetal distress being commonest indication reported in earlier study [27]. The early identification of markers of fetal distress assumes importance as in the presence of hypoxia, plenty of meconium is passed and is dangerous, if aspirated. Management during prelabor with meconium staining includes ultrasonography which may reveal echogenic or particulate amniotic fluid [28] although; vernix may also have this appearance [29]. Amnioscopy first introduced by Saling [30], later replaced by modified contact endoscope and amniocentesis, however, amnioscopy is now used for the detection of meconium during antenatal period and in early labor. Amino-infusion is not recommended for routine treatment of suspected fetal compromise with MSAF as immediate delivery is a priority. Delivery attended by skilled birth attendant competent in neonatal intubation and tracheal suction recommended in Neonatal resuscitation program with intermittent positive pressure ventilation [31]. There is also limited evidence for the use of grading system for MSAF as its impact on neonatal outcome is on the volume aspirated that determines outcome of neonate more than concentration of MSAF, that inhibits fetal lung fluid reabsorption at birth and disturb the ability of the lungs in transition to extra uterine life continuous positive pressure (CPP) with oxygen facilitates fetal lung fluid reabsorption at birth, transiting smoothly from fetal to extra uterine life [13-15].

During the first and second stage of labor, foetal wellbeing is monitored by continuous electronic fetal heart rate tracing, the baseline fetal heart rate (FHR) best assessed between uterine contraction, by listening and counting for 60 seconds [10]. Features regarded as non-reassuring trace are baseline bradycardia<110 or tachycardia>160 bpm, moderate to severe variable deceleration, late deceleration, loss of beat to beat variability and prolonged fetal bradycardia. Significantly higher non-reassuring foetal heart rate tracing was noted with MAS (p<0.0001) [32, 33]. Decreased or absent beat to beat variability is an index of low fetal reserve or tolerance to hypoxic insults. In some circumstances of sudden, severe fetal hypoxia as in abruptio placenta or severe cord compression, exaggerated fetal movements is a warning sign as it is followed by loss of movement, necessitates prompt delivery, persistent FHR with tachycardia >180 bpm is an indication for quick intervention, while bradycardia<100 bpm, if persistent indicates the terminal response of dying fetus, is an ominous pattern [32, 33].

Thus late decelerations, fetal bradycardia with MSAF becomes ominous if they occur along with decreased or absent beat to beat variability, however with several variable decelerations, cord prolapse or cord presentation should be ruled out, which is also an indication for caesarean section. However, there is no evidence that electronic fetal heart rate monitoring (EFM) without blood gas and acid base assessment reduces the risk of fetal or neonatal mortality or morbidity [32-34].

The classical signs or markers of fetal hypoxia are loss of, or decreased fetal movements, variations in fetal heart rate pattern, presence of meconium in amniotic fluid, presence of fetal moulding and decrease in fetal scalp blood pH. A fetal scalp pH value below 7.20 is indicative of fetal acidosis, values between 7.20 and 7.25 are suspicious or pre acidotic, require further evaluation. If <7.20 or 7.17 immediate delivery by LSCS is recommended [31-33]. The best way to evaluate beat to beat variability is with fetal scalp pH determination by fetal pulse oximetry, which will improve decision-making in timing of delivery and may reduce the incidence of MSAF and MAS [34-36].

Biochemical parameters include fetal blood sampling for pH, pO_2 , pCO_2 and base deficits indicated in all high-risk patients with MSAF, fetal heart variation, with obstetric complications in pregnancy [33]. During contractions of normal labor, there is a decrease in utero-placental blood flow and subsequent increase in pCO_2 , decrease in pO_2 and pH. In severe variable decelerations pattern if, recurrent or un-correctable or the scalp pH shows fetal acidosis then the infant must be delivered by caesarean section [34, 35]

Increased moulding without descent of the head is a grave sign of fetal distress. Rapid development of moulding is also particularly serious. Stewart's scoring system is used to assess the degree of moulding assessed at least at two locations on the fetal head, i.e., parieto-occipital, parieto-parietal and if possible parieto frontal. It is scored in three grades. The moulding score is 0-6. When there is 3+ moulding at two sites, the fetus is in danger, if labour is allowed to proceed. Stewart as a sign of distress calling for early delivery considers excessive moulding an indication for LSCS.

The "Time Factor" between the discovery of the signs of fetal distress with fetal heart rate variation and delivery, is crucial as delivery should occur within 30 minutes with fetal distress. If delivered within 15 minutes of detection of fetal distress, the perinatal mortality was 0.5%, if between 15-29 minutes, then it was 3.65% and after 30 minutes it was 11 [25]. The fetal pH at this level will show no acidemia, and if the fetus is delivered within reasonable time, with immediate cord clamping and normal Apgar score will maintain umbilical and blood pH, pCO_2 partial pressure and base deficit values at optimum levels [25, 34].

At birth, intrapartum suctioning of the neonate mouth and pharynx on the perineum before delivery of shoulders is not recommended for routine practice [37, 38], however, immediate new born care is cleaning mouth and nose of any visible meconium. Suctioning is not required if neonate is term and vigorous with good respiratory effort and muscle tone at birth, baby wiped dry and shifted to mothers' side after routine care. A vigorous preterm should be assessed and started on CPAP with low flow of oxygen at 4 L/min and $FiO_2 < 30\%$ shifted to NICU for observation [38].

A non-vigorous neonate at birth should not be stimulated include drying but laryngoscopy with endotracheal intubations and tracheal suctioning done under direct vision, the meconium aspirator device attached to adapter of endotracheal tube and connected to a negative pressure source not exceeding 100mmHg, occluding the side port and withdrawing over a few seconds. Repeated intubation is not recommended as it may cause further delay in resuscitation [37]. About one-third of infants with MAS may require intubation and mechanical ventilation [23, 31, 37]. Delivery room use of sustained inflation during neonatal resuscitation with CPPV and oxygen facilitates movement of meconium stained fetal lung fluid into interstitial to drain into lymphatic, aerating lungs, which triggers rapid complex physiological cardiovascular changes from fetal to neonatal circulation. CPPV is discontinued with regular breathing, $SpO_2 > 90\%$ and heart rate > 100 bpm and plethysmograph tracing indicate how well heart is pumping oxygen through the body by showing pulsatile changes determined on pulse oximeter [13-15, 36].

After birth SpO_2 is monitored for next 2 hours and assessed 2 hourly until 12 hours of age, normal temperature maintained between $36.5 - 37.4^\circ$, heart rate 120-160 bpm, respiratory rate 30-60/min and $SpO_2 > 95\%$. Neonate observed for features of respiratory distress such as chest wall movement, tone, color feeding and general well-being. Asymptomatic well babies with non-significant meconium stained liquor require observation at 1 and 2 hours of age and those with significant meconium staining of liquor require observation at 1 and 2 hours of age and then 2 hourly till 12 hours of age. Signs of respiratory distress are increase in respiratory rate, intercostal or subcostal retraction chest wall retraction, nasal flaring, head bobbing, cyanosis or grunting. Circulatory impairment monitored by heart rate, skin color, capillary refill checked. Investigations include CXR, FBC, ABG, blood cultures, CRP [37, 38].

Continuous positive airway pressure (CPAP) is a non-invasive respiratory support in preterm infants at birth with mild respiratory distress, early arterial and venous access required, nutrition maintained and humidified oxygen if required to keep pre-ductal oxygen saturation 95-98% [38, 39]. In severe MAS with respiratory failure use of surfactant and inhaled nitric oxide (iNO) has led to decreased mortality and the need for extracorporeal membrane oxygenation (ECMO) [40, 41]. However, aggressive management during and immediately after delivery does not always prevent fatal meconium aspiration syndrome hence prevention is better with quick intervention and delivery.

6. Conclusion

The identification of high risk factors with close supervision, active management of labor, and judicious obstetric intervention is essential to improving fetal and neonatal outcome as 84% of MSAF were associated with birth asphyxia, resulted in emergency LSCS in over 50% with MSAF and MAS, while most new-borns with clear liquor were delivered normally at 38 weeks with only one-fourth by emergency section. MSAF incidence was 7.8% and MAS was 1.8%, but it constituted 23% of MSAF parturient. Since fetal asphyxia may result in fatal MAS, hence prevention pays as peak MSAF and MAS births took place at 39 weeks gestation, indicates that early delivery preferably at 38 weeks in high risk cases would preclude to birth asphyxia and its consequences of MSAF and MAS, thereby improving fetal and neonatal outcome.

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