ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 8, Issue – 4, August – 2023 , Page No. : 92 – 101

Maternal and fetal outcome in cases of meconium-stained amniotic fluid (MSAF) during perinatal period at tertiary care center

[1]Chandraja Keluskar, Resident Doctor, Department of Obstetrics and Gynaecology, Dr. Vasant Rao Pawar Medical College, Nashik.

[2]Manasi Kathaley, Professor and Head, Department of Obstetrics and Gynaecology, Dr. Vasant Rao Pawar Medical College, Nashik.

Corresponding Author: Chandraja Keluskar, Resident Doctor, Department of Obstetrics and Gynaecology, Dr. Vasant Rao Pawar Medical College, Nashik.

Citation this Article: Chandraja Keluskar, Manasi Kathaley, "Maternal and fetal outcome in cases of meconium-stained amniotic fluid (MSAF) during perinatal period at tertiary care center", IJMSIR- August - 2023, Vol – 8, Issue - 4, P. No. 92 – 101.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aims and objectives: The goal of this observational study is to see how meconium-stained liquor affects maternal outcome and delivery method, as well as neonatal morbidity and mortality.

Material and methods: A observational study design was held at a medical college and tertiary healthcare center from December 2019 to December 2021. Total 200 of patients were included in this study after satisfying inclusion and exclusion criteria.

Results: On comparison, fetal HR, mode of delivery, fetal weight, duration of labor, need for intubation, meconium type and NICU admission had statistically significant results. On comparison, APGAR 1 minute and 5 minutes with meconium type showed statistically significant results. Intubation was done in 144 patients, NICU admission required for 152 patients, Meconium aspiration syndrome (MAS) was found in 8 patients and neonatal death was found in 10 patients among thick MSL group while only intubation (2) and NICU admission (12) recorded among thin MSL group.

Conclusion: Thick meconium-stained amniotic fluid is associated with increased rate of intervention, neonatal morbidity and mortality compared with thin meconium-stained amniotic fluid.

Keywords: Meconium-stained amniotic fluid (MSL), fetal heart rate, cesarean section, intubation, Meconium aspiration syndrome (MAS), Neonatal intensive care unit (NICU), APGAR score.

Introduction

Meconium is the first stool of a newborn infant. It is a viscous greenish-black tarry substance made up of denuded intestinal epithelial cells, ingested lanugo hair, swallowed amniotic fluid, mucus, digestive enzymes, bile acids, and water. Its formation begins around 10-12 weeks of gestation and quantity increases as gestation advances. Meconium-stained amniotic fluid is noted in approximately 12% -16% of all deliveries.

MSAF rarely occurs before 34 weeks of gestation. Meconium passing increases with gestational age, reaching roughly 30% at 40 weeks and 50% at 42 weeks. The increased incidence of MSAF with increasing gestational age is most likely due to peristalsis maturation, in the intestine of the foetus. Vagus nerve stimulates the parasympathetic nervous system, which causes meconium to pass, when fetus suffers from hypoxia or ashyxia. Fenton and Steer have suggested that if the foetal heart rate was more than 110 bpm, meconium passing was unimportant. Even in the face of a normal reassuring heart rate, it is safe to assume that the passing of meconium is an indication of foetal distress in a post-dated pregnancy or a pregnancy with growth restriction. Myelination of nerve fibres, a rise in parasympathetic tone, and an increase in motilin concentration causes the mature foetus to pass meconium. In most situations, thin consistency meconium passed as a maturational event. The newborns who have passed meconium during labour or in utero are in a state of compensated fetal distress. For short periods the state of compensation would persist. Perhaps a change in the fetal heart beats or a fall in the fetal scalp ph would suggest the end of the compensatory equilibrium and the intervention is indicated. Hypertension, gestational diabetes mellitus, maternal chronic respiratory or cardiovascular disorders, post term pregnancy, preeclampsia, and eclampsia are all maternal risk factors for meconium staining of amniotic fluid. Oligohydramnios, intrauterine growth restriction, and a poor biophysical profile are all fetal factors. MSAF is linked to a greater rate of caesarean section, more newborn resuscitation, and meconium aspiration syndrome. Meconium aspiration by the fetus is still a common cause of perinatal morbidity and mortality. Meconium aspiration during the first breath after birth is more likely, and neonates are more vulnerable to obstetric interventions and meconium's local inflammatory effects. Long-term respiratory and neurological complications are more common in these babies. Babies born with MSAF are 100 times more likely than those born with clear amniotic fluid to experience significant respiratory distress. Meconium aspiration syndrome (MAS) affects roughly 10.5 percent of newborns born with MSAF and has a 12-percent death risk. Furthermore, infants born with MSAF have much greater odds of severe mental impairment and cerebral palsy. Thick MSAF has been found to be responsible for the bulk of MAS cases in neonates, accounting for 73 to 87.6% of cases. , Regardless of MSAF's controversies, the following remains true: Clear amniotic fluid is reassuring; thick new meconium, on the other hand, is a high-risk scenario that should be avoided at all costs. In the presence of MSAF, an aberrant fetal heart rate (FHR) pattern is a clear indication of fetal distress. According to recent research, meconium is not a reliable indicator of foetal distress. The kind of meconium in early labour has a major impact on perinatal outcome. Increased perinatal morbidity and mortality are linked to thick meconium-stained amniotic fluid with cephalic presentation, low foetal scalp blood PH, low levels of PO2, and aberrant foetal heart rate patterns (late decelerations, severe varied decelerations, and decreased variability). MSAF is linked to more surgical interventions during labour, including forceps and caesarean section, as well as NICU admission.

An obstetrician and a neonatologist work together to manage meconium-stained amniotic fluids. Early detection of meconium staining of liquor during delivery interventions such as forceps or caesarean section, as well as oral and nasopharyngeal suctioning shortly after head delivery, has been found to improve perinatal

outcome. Suction of the pharynx as soon as possible after delivery of the head is acceptable as long as care is taken not to traumatize the pharynx or larynx, because this may precipitate meconium aspiration. Over the last two decades, there has been a lot of focus on the need to improve neonatal care at the tertiary level. In a developing country like ours, where domiciliary births account for more than 60% of all births, anticipation and prompt referral play a critical role. It has maternal consequences in addition to reducing newborn morbidity and mortality. The goal of this observational study is to see how meconium-stained liquor affects maternal outcome and delivery method, as well as neonatal morbidity and mortality.

Materials and methods

Study design: Observational study design.

Study settings: The study was held at a medical college and tertiary healthcare center.

Study duration: From December 2019 to December 2021

Study population: All full-term antenatal patients come in labor.

Sample size-

Expected frequency-20.83%

Confidence limit- 6% margin of error

Confidential level-90%

Total Sample-200

This sample size is obtained by:

Formula:

$N \geq z2 \times p \times q / l2$

Z= 1.96, critical value at 95% confidence level

=1.64, critical value at 90% confidence level

P=12 % q=100-p

L=margin of error=6 n≥200

Inclusion criteria

- All full-term pregnant women with meconium stained amniotic fluid during labor.

Exclusion criteria

- Multiple pregnancy.
- Breech presentation.
- Participant not willing to participate
- Incidental finding of meconium during elective cesarean for any other indication.

Methodology

This study was conducted in the department of OBGY of a medical college and tertiary health care centre.

Total 200 of patients were included in this study after satisfying inclusion and exclusion criteria. Written informed consent was taken from all the study participants. Detailed history, antenatal risk factors, complete general examination and obstetric examination was done. All patients admitted in labor ward and having meconium were included. All patients were monitored by partograph in labour. All required investigations such as blood investigations, cardiotocography, ultrasonography and Doppler studies were done. All the information was recorded in the predetermined proforma. Maternal outcome in the form of period of gestation, mode of delivery, any high-risk factor, perineal tear, amount of bleeding was assessed. Perinatal outcome in the form of live birth or still birth, Apgar score, intra natal complications, NICU admission, duration between detection of meconium-stained amniotic fluid to delivery, neonatal resuscitation, presence or absence of meconium below vocal cord, neonatal morbidity and mortality was noted.

Statistical analysis

The data was coded and entered into Microsoft Excel spreadsheet. Analysis was done using SPSS version 20 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) Windows software program. Percentages, means, and standard deviations were all part of descriptive statistics. For quantitative data comparison of all clinical

parameters, the unpaired t test (for quantitative data to compare two independent two groups) was utilised. When comparing qualitative data between two or more groups, the Chi-square test was applied. The significance level was established at P≤0.05.

Observation and results

In thick meconium, mean fetal HR was 130.68 and in thin meconium, mean fetal HR was 135.208 years. On comparison, fetal HR and meconium type had statistically significant results.

Amongst gestational age of 37-38 weeks, 16 patients had thick meconium-stained amniotic fluid and 23 patients had thin meconium-stained amniotic fluid. Amongst gestational age of 38-39 weeks, 32 patients had thick meconium-stained amniotic fluid and 1 patient had thin meconium-stained amniotic fluid. Amongst gestational age of 39-40 weeks, 55 patients had thick meconium-stained amniotic fluid. Amongst. Gestational age of 40-41 weeks, 41 patients had thick meconium-stained amniotic fluid and 24 patients had thin meconium-stained amniotic fluid. Amongst gestational age of 41-42 weeks, 8 patients had thick meconium-stained amniotic fluid.

Hypertension was found in 11 patients, postdated pregnancy was found in 49 patients, placental insufficiency was found in 28 patients and prolonged labour was found in 12 patients among thick MSL group while hypertension was found in 5 patients, postdated pregnancy was found in 24 patients, placental insufficiency was found in 4 patients and prolonged labour was found in 4 patients among thin MSL group.

In thick meconium, LSCS was done in 82.2% and vaginal delivery was in 17.7%. In thin meconium, LSCS was done in 31.3% and vaginal delivery was in 68.7%. On comparison, mode of delivery and meconium type showed statistically significant results.

Mean APGAR 1 score was 6.69 and mean APGAR 2 score was 8.14. In thin meconium, mean APGAR 1 minute was 7.34 and in thick meconium, mean APGAR 1 minute was 4.65. In thin meconium, mean APGAR 5 minute was 8.77 and in thick meconium, mean APGAR 5 minute was 6.15. On comparison, APGAR 1 minute and 5 minutes with meconium type showed statistically significant results. Thin meconium did not need for intubation while 94.7% patients with thick meconium need intubation. NICU admission was found in all 152 (100%) patients among thick MSL groups while only 12 (25%) patients in thin MSL group required NICU admission. On comparison, need for intubation and NICU admission with meconium type showed statistically significant results.Intubation was done in 144 patients, NICU admission required for 152 patients, Meconium aspiration syndrome (MAS) was found in 8 patients and neonatal death was found in 10 patients among thick MSL group while only intubation (2) and NICU admission (12) recorded among thin MSL group.

Table 1: Fetal HR and meconium type wise distribution of the study

	N	Mean	Std. Deviation	P value
Thick meconium	152	130.68	9.35	0.001 (S)
Thin meconium	48	135.208	8.41	

In thick meconium, mean fetal HR was 130.68 and in thin meconium, mean fetal HR was 135.208 years. On comparison, fetal HR and meconium type had statistically significant results.

Table 2: GA and meconium type wise distribution of the study.

GA	Thick MSL	Thin MSL	Total
37-38	16	23	39
38-39	32	1	33
39-40	55	0	55
40-41	41	24	65
41-42	8	0	8

Amongst gestational age of 37-38 weeks, 16 patients had thick meconium-stained amniotic fluid and 23 patients had thin meconium-stained amniotic fluid.

Amongst gestational age of 38-39 weeks, 32 patients had thick meconium-stained amniotic fluid and 1 patient had thin meconium-stained amniotic fluid.

Amongst gestational age of 39-40 weeks, 55 patients had thick meconium-stained amniotic fluid.

Amongst gestational age of 40-41 weeks, 41 patients had thick meconium-stained amniotic fluid and 24 patients had thin meconium-stained amniotic fluid.

Amongst gestational age of 41-42 weeks, 8 patients had thick meconium-stained amniotic fluid.

Table 3: Risk factors for MSAF

			Hypertension	Post dated pregnancy	Placental insufficiency	Prolong labor
Amniotic fluid	Thick meconium	N	11	49	28	12
		%	7.2%	32.3%	18.4%	7.9%
	Thin meconium	N	5	24	4	4
		%	10.4%	50%	8.3%	8.3%
Total		N	16	73	32	16
		%	8%	36.5%	16%	8%

Hypertension was found in 11 patients, postdated pregnancy was found in 49 patients, placental insufficiency was found in 28 patients and prolonged labor was found in 12 patients among thick MSL group while hypertension was found in 5 patients, postdated pregnancy was found in 24 patients, placental insufficiency was found in 4 patients and prolonged labor was found in 4 patients among thin MSL group.

Table 4: Mode of delivery wise distribution of the study

			Mode of Delivery		Total
			LSCS	Vaginal	
Amniotic Fluid	Thick meconium	N	125	27	152
		%	82.2%	17.7%	100.0%
	Thin meconium	N	15	33	48
		%	31.3%	68.7%	100.0%
Total		N	140	60	200
		%	70%	30%	100.0%

P value=0.03 (S)

In thick meconium, LSCS was done in 82.2% and vaginal delivery was in 17.7%. In thin meconium, LSCS was done in 31.3% and vaginal delivery was in 68.7%.

On comparison, mode of delivery and meconium type showed statistically significant results.

Table 5: APGAR and meconium type wise distribution of the study

		N	Mean	Std. Deviation	P value
APGAR 1	Thick meconium	152	4.65	2.756	0.001 (S)
	Thin meconium	48	7.34	.700	
	Total	200	6.69	1.86	
APGAR 5	Thick meconium	152	6.15	2.552	0.001 (S)
	Thin meconium	48	8.77	.635	
	Total	200	8.14	1.76	

Mean APGAR 1 score was 6.69 and mean APGAR 2 score was 8.14.

In thin meconium, mean APGAR 1 minute was 7.34 and in thick meconium, mean APGAR 1 minute was 4.65. In thin meconium, mean APGAR 5 minute was 8.77 and in thick meconium, mean APGAR 5 minute was 6.15. On comparison, APGAR 1 minute and 5 minutes with meconium type showed statistically significant results.

Table 6: Need for intubation and meconium type wise distribution of the study

			Need for intubation	NICU admission
Amniotic Fluid	Thick meconium	N	144	152
		%	94.73%	100.0%
	Thin meconium	N	0	12
		%	0	25%
Total		N	140	164
		%	70%	82%
p value			0.001 (S)	0.001 (S)

Intubation was done in 144 patients, NICU admission required for 152 patients, Meconium aspiration syndrome (MAS) was found in 8 patients and neonatal death was found in 10 patients among thick MSL group while only intubation (2) and NICU admission (12) recorded among thin MSL group.

Discussion

Meconium-stained amniotic fluid is associated with adverse neonatal outcome particularly in thick meconium. Meconium aspiration syndrome occasionally develops from thin meconium. When amniotic fluid is ample the thick meconium is diluted and cleared by fetal physiological mechanisms. This protection is lost in cases of placental insufficiency where the liquor is less. Majority of our cases had medical disorders in which there was chronic placental insufficiencies. During labour, the chances of cord compression is more and there is increased likelihood of meconium passage that is thick and undiluted. Most of the studies done worldwide are in concurrence to this fact. , , In the study, thick

meconium was present in 76% and thin meconium was present in 48%. In the studies conducted by Debdas (78.75%) and Sheikh EM (78%) the incidence of thin meconium was 78.75% and 78% respectively. The present study correlates with the study conducted by GhokrooK (2001) and Sandhu SK (1993) et al as maximum number of patients belonged to age group 25-30 years. Mean gestational age was 38.95 weeks in the present study. RosarioMC and Seshadri L in his study found mean gestational age of 39.62 weeks. Saunders (2002) et al reported that cesarean sections were performed twice as frequently in subjects with meconium stained amniotic fluid. This higher rate may be due to lack of facilities such as, foetal scalp pH monitoring and tracings of foetal electronic monitoring. In accordance with their study results, this study also showed higher cesarean section rates (70%). Such higher rates partly reflect the abnormal fetal heart rate patterns associated with MSAF and they partly reflect the obstetricians' dilemma in managing such labour, as at this time, they become more concerned about the fetuses and any minute alterations in normal labour patterns end up in cesarean sections. In contrast to this study, Wong SF (2002) et al found that 13.2% of MSAF had undergone cesarean sections as compared to8.8% cases who had undergone them in clear amniotic fluid. The fact that their study included scalp pH sampling, unlike ours, could explain the reduced rates of cesarean section. Naveen S (2006) et al also reported a cesarean section rate of 49.1% in MSAF. In the study, fetal heart rate was significantly higher in thick meconium than thin meconium. Oyelese Y (2006) et al was also showed significantly association with fetal heart rate and thick meconium. Moreover, the absence of facilities for continuous electronic fetal monitoring and fetal scalp blood pH monitoring added with the fear of poor neonatal outcome in obstetricians in low resource setting, increases the incidence of operative as well as instrumental delivery. MSAF was associated with significantly high rates of cesarean section even in low-risk pregnancies at term, possibly reflecting a combination of labor dystocia and a lower threshold for obstetric intervention. In the study, thick meconium (2.56) has significantly higher birth weight than thin meconium (2.43). Fujikura et al, observed that the incidence of meconium staining was significantly more with increased birth weight more than 3 kgs. Admission to NICU was found in all 152 (100%) patients among thick MSL groups while only 12 (25%) patients in thin MSL group; it is due to associated meconium aspiration in study group babies. Wong SF (2002) et al and Patil KP (2006) et al found similar results in their study. In the study, intubation was found in 144 patients, NICU admission was found in 152 patients, Meconium aspiration syndrome (MAS) was found in 8 patients and death was found in 10 patients among thick MSL group while only intubation 2 and NICU admission 12 were recorded among thin MSL group. The consistency of meconium had direct bearing on the neonatal outcome. Gupta V et al showed that severe birth asphyxia (SBA) occurred in 27.0 and **6.3**% of babies with thick and thin meconium staining, respectively. Meconium aspiration syndrome was observed in 9 babies of thick meconium group and 8 of these were depressed at birth. All deaths occurred in thick meconium group and were associated with severe birth asphyxia (SBA). Four randomized studies have addressed the problem of endotracheal intubation of vigorous meconium-stained infants born at term. In this study, the 1 minute and 5-minute poor APGAR scores of infants with thick meconium were compared to the thin group, and a statistically significant number of children with thick meconium had low Apgar

scores. The most significant factor determining fetal outcome appears to be thick meconium as a single variable. The findings of this investigation are similar to those of Nayak et al. Manganaro R et al was showed that no significant difference in maternal age, parity, gestational age, sex, low 1- and 5-minute Apgar scores, metabolic acidemia, or need for endotracheal intubation was found between MSAF and non-MSAF infants. According to the literature, meconium has the ability to harm the tissues and organs of the fetus. It causes umbilical vascular constriction and necrosis, as well as the formation of thrombi, which leads to tissue ischemia. Meconium is sterile, but it lowers the antibacterial properties of amniotic fluid by modifying zinc levels, making intra-amniotic infections more likely. Gasping activities of the fetus in the face of fetal stress, such as hypoxia, may result in aspiration of meconium into the lungs, causing lung tissue inflammation and respiratory distress.

Conclusion

Thick meconium-stained amniotic fluid is associated with increased rate of intervention, neonatal morbidity and mortality compared with thin meconium-stained amniotic fluid. Meconium-stained amniotic fluid per se is not an indicator for fetal distress especially thin MSAF but in correlation with non-reassuring fetal heart rate pattern it should be taken as an alarming sign for the neonatal outcome.

In recent years there is a dramatic fall in the rates of stillbirths and neonatal deaths due to improvement in antenatal, intra natal care of pregnant woman and improved NICU care.

References

1. Greenwood C, Lalchandani S, Macquillan K. Meconium passed in labour: how reassuring is clear amniotic fluid. ObstetGynecol 2003; 102(1):89-93
2. Steer PJ. Eigbe F, Lissauer TJ, Berad RW. Inter relationships among Abnormal CTG in Labour, Meconium-Stained Amniotic Fluid, Arterial Cord Blood pH and APGAR Scores. Obstetrics and Gynaecology 1989;74: 715 – 21
3. James DK, Steer PJ, Weiner CP, Gonik B. High Risk Pregnancy Management Options. Third Edition. Saunders/ Elsiever; 2006. 1463-1468
4. Fenton AM, Steer CM. Fetal Distress. American Journal of Obstetrics & Gynaecology. 1962; 83:354-62.
5. Klinger, Celeste M, Kruse. Meconium Aspiration Syndrome: Pathophysiology and Prevention. JAM Board Fan Practice1999;12(6):446-50
6. Cleary GM, Wiswell T E. Meconium-stained amniotic fluid and the meconium aspiration syndrome, an update. PediatrClin North Am 1998; 45:511-29
7. Maymon E, Chaim W, Furman B et al. Meconium-stained amniotic fluid in very low risk pregnancies at term gestation. Eur J ObstetGynecolReprodBiol1998; 80:169-73.
8. Katz VL, Bowes WAJ. Meconium Aspiration Syndrome: Reflections on a Murky Subject. American Journal of Obstetrics & Gynaecology 1992;166: 171-183.
9. Patil KP, Swamy MK, Samatha K. A one-year cross sectional study of management practices of meconium-stained amniotic fluid and perinatal outcome. ObstetGynecol India 2006; 56:128–30
10. Shaikh EM, Mehmood S, Shaikh MJ. Neonatal outcome in meconium-stained amniotic fluid- One year experience. J Pak Med Assoc 2010;60(9):711
11. Steer PJ, Eigbe F, Lissauer TJ, Beard RW. Interrelationships among abnormal cardiotocograms in labor, meconium staining of the amniotic fluid,

arterial cord blood pH, and Apgar scores. Obstet Gynecol1989; 74:715–21

12. Carson BS, Losey RW, Bowes WW et al. Combined obstetric and pediatric approach to prevent meconium aspiration syndrome. American journal of obstetrics and gynecology1976; 126:712-715
13. Korones SB, Bada-Ellzey HS. Meconium aspiration. In: Neonatal Decision Making 1993:128-9.
14. Vain NE, Szyld EG, Prudent LM, Wiswell TE, Aguilar AM, Vivas NI. Oropharyngeal and nasopharyngeal suctioning of meconium-stained neonates before delivery of their shoulders: multicentre, randomised controlled trial.Lancet 2004;364(9434):597-602
15. Nair MKC.Indian Academy of Pediatrics and National Neonatology Forum - Areas of partnership. Indian Pediatr 2004; 41:987-8
16. Hanoudi BM, Murad AM, Ali AD. Meconium staining of amniotic fluid: a clinical study. Br J Med Res 2013;4(3):914-921.
17. Mohammad N, Jamal T, Sohaila A et al. Meconium-stained liquor and its neonatal outcome. Pak J MedSci 2018;34(6):1392-1396
18. Balchin I, Whittaker JC, Lamont RF et al. Maternal and fetal characteristics associated with meconium-stained amniotic fluid. ObstetGynecol 2011;117(4):828-835
19. Debdas AK, Kaur T. Meconium-stained liquor - reappraisal. J ObstetGynaecol India 1981; 31:924-9.
20. Shaikh EM, Mehmood S, Shaikh MA. Neonatal outcome in meconium-stained amniotic fluid-one-year experience. J Pak Med Assoc 2010; 60:711-4.
21. Gokhroo K, Sharma U, Sharma M. Various maternal factors responsible for meconium-stained amniotic fluid. J ObstetGynaecol India 2001;52(6):40
22. Sandhu SK, Singh J, Khura H, Kaur H. Critical evaluation of meconium staining of amniotic fluid and foetal outcome. J ObstetGynaecol India 1993; 43:528-3
23. Rosario MC, Seshadri L. Meconium staining of amniotic fluid in low risk parturient. Journal of Obstetrics and Gynecology of India 1996; 46:642-646
24. Saunders K. Should we worry about meconium? A controlled study of neonatal outcome. Trop Doct 2002;32(1):7–10
25. Wong SF, Chow KM, Ho LC. The relative risk of fetal distress in pregnancy associated with meconium-stained liquor at different gestation. Journal of Obstetrics and Gynecol 2002; 22(6): 594–99.
26. Naveen S, Kumar SV, Ritu S, Kushia P. Predictors of meconium-stained amniotic fluid: a possible strategy toreduce neonatal morbidity and mortality. J ObstetGynecol India 2006; 56: 514–7.
27. Oyelese Y, Culin A, Ananth CV, Kaminsky LM, Vintzileos A, Smulian JC et al. Meconium-stained amniotic fluid across gestation and neonatal acid base status. ObstetGynecol2006; 108:345.
28. Hiersch L, Krispin E, Aviram A, Wiznitzer A, Yogev Y, Ashwal E. Effect of Meconium-Stained Amniotic Fluid on Perinatal Complications in Low-Risk Pregnancies at Term. Am J Perinatol 2016;33(04):378-84
29. Fujikura T, Klionsky B. The significance of meconium staining. Am J ObstetGynecol 1975;121(1):45-50.
30. Patil KP SM, Samatha KA. One-year cross sectional study of management practices of meconium-stained amniotic fluid and perinatal outcome. J ObstetGynecol India2006;56(2):128-30.

31. Gupta V, Bhatia BD, Mishra OP. Meconium-stained amniotic fluid: antenatal, intrapartum and neonatal attributes. Indian Pediatr. 1996;33(4):293-7
32. Linder N, Aranda JV, Tsur M, Matoth I, Yatsiv I, Mandelberg H, Rottem M, Feigenbaum D, Ezra Y, Tamir I. Need for endotracheal intubation and suction in meconium-stained neonates. Journal of Pediatrics 1988; 112:613-615
33. Daga SR, Dave K, Mehta V, Pai V. Tracheal suction in meconium-stained infants: a randomized controlled study. Journal of Tropical Pediatrics 1994; 40:198-200
34. Liu WF, Harrington T. The need for delivery room intubation of thin meconium in the low-risk newborn: a clinical trial. American Journal of Perinatology 1998; 15:675-82
35. Wiswell TE, Gannon CM, Jacob J, et al. Delivery room management of the apparently vigorous meconium-stained neonate: results of the multicenter, international collaborative trial. Pediatrics 2000; Vol. 105:1-7
36. Nayak AH, Dalal AR. Meconium staining of amniotic fluid significance and fetal outcome. J ObstetGynaecol India 1991; 41:480-3.
37. Manganaro R, Mamì C, Palmara A, Paolata A, Gemelli M. Incidence of meconium aspiration syndrome in term meconium-stained babies managed at birth with selective tracheal intubation. J Perinat Med. 2001;29(6):465-8
38. Tayade S. The significance of meconium-stained amniotic fluid–A cross sectional study in a rural setup. IJBAR 2012; 12(3):861-6.