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Research Article

# Does cesarean section prevent adverse neonatal outcomes associated with meconium amniotic fluid?

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ABSTRACT

*Background:* Making decisions regarding the mode of delivery in the cases of meconium amniotic fluid (MAF) presents a challenge for healthcare providers. We aimed to compare the neonatal outcome of MAF cases delivered via cesarean section (CS) versus those delivered vaginally to determine if CS is a protective factor against the adverse neonatal outcomes.

*Methods:* In this retrospective study, we assessed singleton pregnant mothers diagnosed with MAF who gave birth at a tertiary hospital in Bandar Abbas, Iran, between January 2020-2022. Mothers with certain adverse pregnancy conditions were excluded from the study. These conditions included: abnormal fetal heart rate and pattern, bloody amniotic fluid, malpresentation, abnormal placentation, chorioamnionitis, intrauterine growth restriction, intrauterine fetal death, obstructed labor, and maternal comorbidities. The MAF mothers were divided into two groups based on the method of delivery: those who had CS and those who had a normal vaginal delivery (NVD). Demographic factors, obstetrical factors, and neonatal outcomes were compared between the two groups.

*Results:* Out of 746 MAF mothers, 213 (28.5%) underwent CS, while 533 (71.4%) had NVD. There were no significant differences between the groups in terms of demographic characteristics. Among MAF mothers who had CS, 66.2% were primiparous, and 33.8% were multiparous. For those who had NVD, 35.1% were primiparous, and 64.9% were multiparous. The first and 5-min Apgar values, rates of asphyxia, neonatal intensive care unit (NICU) admission, and neonatal death were not statistically different between the two delivery modes. The rate of newborns who breastfed within the first hour did not differ depending on the mode of delivery. Although initial resuscitation steps were required more frequently in MAF mothers with NVD than in those with CS (11.1% vs. 2.3%), no correlation was found between the mode of delivery and the need for resuscitation using logistic regression.

*Conclusions:* Our research findings suggest that there were no superior neonatal outcomes in terms of CS compared to NVD in MAF mothers. Further studies are needed to provide more substantial evidence to support this conclusion.

## 1. Introduction

Meconium, the dark and viscous material that constitutes a newborn's first stool, providing an unusual glimpse into the fetal environment. It is created in utero and grows within the fetus's intestinal tract as it develops. During fetus development, the ingestion of amniotic fluid

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contributes to the formation of meconium later on. Its presence in the intestinal tract makes it a potential marker for environmental exposures, including drug exposure. Meconium is sometimes expelled when the fetus is stressed around delivery, but in full-term neonates, the first meconium is usually passed within the first day after birth.[1]

The presence of meconium amniotic fluid (MAF) may indicate either the normal maturation of the gastrointestinal tract or serve as a potential sign of fetal distress caused by acute or chronic hypoxic events.[1] Distinguishing between these two scenarios can be challenging. Fetal heart pattern monitoring may provide valuable insights into the fetus's condition with MAF, helping to differentiate between physiologic or pathologic.[2] Although the MAF is not an absolute indication for a cesarean section (CS), it does cause concerns among mothers and health care providers. Consequently, some obstetricians may choose to perform CS in cases of MAF, even when the fetal heart rate and pattern are normal, believing it will protect against adverse neonatal outcomes.

In this study, our primary objective was to investigate whether meconium alone, without the presence of any other risk factors, can serve as a basis for deciding on CS. To achieve this, we took care to exclude all other potential risk factors that could influence the decision for CS and focused only on low-risk mothers with MAF who had either CS or normal vaginal delivery (NVD) to compare neonatal outcomes. The study was conducted in a center equipped with continuous electronic fetal heart monitoring, taking into account advancements in antenatal and intrapartum care that have contributed to a decline in stillbirth rates and improved neonatal outcomes. Through this investigation, we aim to determine whether CS acts as a protective factor against adverse neonatal outcomes in cases of MAF.

## 2. Materials and methods

We conducted a retrospective assessment of singleton pregnant mothers diagnosed with MAF following spontaneous or artificial rupture of membranes during the active phase of labor at Khaleej-e-Fars Hospital (a tertiary hospital) in Bandar Abbas, Iran, between January 1st, 2020, and January 1st, 2022.

Mothers with specific conditions that could impact the mode of delivery were excluded from the study. These conditions included fetal distress (abnormal fetal heart pattern), bloody amniotic fluid, malpresentation (breech or transverse), placenta acreta, placenta abruption, chorioamnionitis, intrauterine growth retardation, intrauterine fetal death, obstructed labor, and maternal comorbidities (overt or gestational diabetes mellitus, chronic hypertension, cardiovascular disease, thyroid dysfunction, drug addiction, hepatitis, anemia, infertility, preeclampsia, and COVID-19 at the time of admission. Demographic factors (age, educational level, residency place, medical insurance, access to prenatal care facilities, smoking status), obstetrical factors (gestational age, parity, newborn sex, newborn weight, and method of delivery), and neonatal outcome (need for resuscitation, asphyxia, neonatal intensive care unit (NICU) admission, neonatal death, first and 5 min Apgar, and the rate of breastfeeding at the first hour of birth) were extracted from electronic data of each mother. MAF mothers were divided into two groups: those who had NVD and those with a CS. The Chi-square test was used to compare the groups' demographic factors, obstetrical factors, and neonatal outcomes. Logistic regression models were conducted to investigate whether CS had a protective impact against adverse neonatal outcomes.

The IBM Statistical Package for the Social Sciences Statistics, version 25, was used to examine the data (IBM Corp, Armonk, NY). Categorical variables are presented as numbers and frequencies (%). Continuous variables are presented as mean ± standard deviation and were analyzed by an independent sample *t*-test. The Chi-square test was used to compare differences between the groups for categorical variables. Logistic regression models were used to assess the impact of CS on neonatal outcomes. The result was presented as odds ratio (OR) or adjusted odds ratio (aOR) after adjusting for confounders and a 95% confidence interval (CI). $P < 0.05$ was considered statistically significant; all statistical tests were two-tailed.

## 3. Results

During the study period, a total of 1085 mothers were diagnosed with MAF, but 339 of them were excluded due to the specified exclusion criteria. Hence, a total of 746 were included in the analysis, out of which 213 (28.5%) underwent CS and 533 (71.4%) had NVD. Table 1 compares the demographic characteristics of MAF mothers with CS and those with NVD. There were no statistically significant differences between the groups in terms of demographic characteristics.

Among the obstetrical factors analyzed, the only statistically significant difference between the two groups was observed in terms of parity. Among the MAF mothers who had CS, 66.2% were primiparous and 33.8% multiparous. On the other hand, among the MAF mothers who had NVD, 35.1% were primiparous and 64.9% were multiparous, indicating that the majority of primiparous mothers diagnosed with MAF underwent CS compared to those who had NVD (as shown in Table 2).

Table 3 presents a comparison of the neonatal outcomes of MAF mothers who underwent CS and those who had NVD. The study found that there were no statistically significant differences in umbilical artery blood gas PH, first and 5-min Apgar values, and the rates of asphyxia, NICU admission, and neonatal death between the two groups. Furthermore, the rate of newborns who breastfed within the first hour did not differ depending on the mode of delivery. Although the initial resuscitation steps were required more frequently in MAF mothers who had NVD than in those who had CS (11.1% vs. 2.3%) (Table 3), no correlation was found between the mode of delivery and the need for resuscitation using logistic regression (Table 4).

## 4. Discussion

MAF is a common complication during labor. Though it is difficult to distinguish between physiologic and pathologic MAF, there is a small body of evidence linking it to adverse neonatal outcomes such as meconium aspiration syndrome,[3] respiratory distress,[4] neonatal sepsis,[5] need for resuscitation,[6] NICU admission,[7] and low Apgar score.[8]

Abnormal fetal heart rate tracing patterns in MAF mothers are linked

**Table 1**
Demographic characteristics of the study population.

| Demographic characteristics | NVD | CS | Total | P-value |
|---|---|---|---|---|
| **Age (Mean ± SD)** | 27.94 ± 6.21 | 26.92 ± 6.00 | 27.65 ± 6.10 | 0.257 |
| **Age (Years)** | | | | 0.560 |
| 13-19 | 47 (8.8) | 24 (11.3) | 71 (9.5) | |
| 20-34 | 409 (76.7) | 161 (75.6) | 570 (76.4) | |
| 35 and above | 77 (14.4) | 28 (13.1) | 105 (14.1) | |
| **Educational level** | | | | 0.377 |
| Illiterate | 37 (6.9) | 12 (5.6) | 49 (6.6) | |
| Elementary | 163 (30.6) | 65 (30.5) | 228 (30.6) | |
| High school/Diploma | 238 (44.7) | 93 (43.7) | 331 (44.3) | |
| Advanced | 95 (17.8) | 43 (20.2) | 138 (18.5) | |
| **Residency place** | | | | 0.987 |
| Urban | 324 (60.8) | 130 (61) | 454 (60.9) | |
| Rural | 209 (39.2) | 83 (39) | 292 (39.1) | |
| **Access to prenatal care** | | | | 0.783 |
| Yes | 513 (96.2) | 208 (97.6) | 721 (96.6) | |
| No | 20 (3.7) | 5 (2.3) | 25 (3.4) | |
| **Medical insurance** | | | | |
| Yes | 525 (98.5) | 213 (100) | 738 (98.9) | 0.113 |
| No | 8 (1.5) | 0 | 8 (1.1) | |
| **Smoking** | | | | 0.714 |
| Yes | 532 (99.8) | 211 (99.1) | 743 (99.6) | |
| No | 1 (0.2) | 2 (0.9) | 3 (0.4) | |

Data are presented as n (%), or mean ± standard deviation (SD).
NVD: Normal vaginal delivery; CS: Cesarean section.

**Table 2**
Obstetrical characteristics of the study population.

| Obstetrical characteristics | NVD | CS | Total | *P*-value |
|---|---|---|---|---|
| **Gestational age** (Weeks) | 38.98 ± 1.44 | 38.89 ± 1.70 | 38.95 ± 1.52 | 0.457 |
| **Gestational age** (Weeks) | | | | 0.560 |
| 13-19 | 47 (8.8) | 24 (11.3) | 71 (9.5) | |
| 20-34 | 409 (76.7) | 161 (75.6) | 569 (76.3) | |
| 35 and above | 77 (14.4) | 28 (13.1) | 105 (14.1) | |
| **Parity** | | | | <0.001 |
| Primiparous | 187 (35.1) | 141 (66.2) | 328 (44.0) | |
| Multiparous | 346 (64.9) | 72 (33.8) | 418 (56.0) | |
| **Newborn sex** | | | | 0.97 |
| Male | 268 (50.3) | 119 (55.9) | 387 (51.9) | |
| Female | 265 (49.7) | 94 (44.1) | 359 (48.1) | |
| **Newborn weight** (g) | | | | 0.771 |
| Less than 2500 | 37 (6.9) | 18 (8.4) | 55 (7.4) | |
| 2500-4000 | 484 (90.8) | 191 (89.7) | 675 (90.5) | |
| More than 4000 | 12 (2.3) | 4 (1.9) | 16 (2.1) | |
| **Newborn weight** (kg) | 3.10 ± 0.45 | 3.25 ± 0.24 | 3.15 ± 1.35 | 0.190 |
| **Congenital malformation** | | | | 0.589 |
| No | 527 (98.9) | 211 (99.1) | 738 (98.9) | |
| Yes | 6 (1.1) | 2 (0.9) | 8 (1.1) | |

Data are presented as n (%), or mean ± standard deviation (SD).
NVD: Normal vaginal delivery; CS: Cesarean section.

**Table 3**
Neonatal outcome of the study population.

| Neonatal outcome | NVD | CS | Total | *P*-value |
|---|---|---|---|---|
| **Umbilical artery blood gas PH** | 7.31 ± 0.24 | 7.33 ± 0.18 | 7.32 ± 0.31 | 0.973 |
| **First minute Apgar** | 8.70 ± 1.07 | 8.73 ± 0.91 | 8.71 ± 1.03 | 0.748 |
| **Five minute Apgar** | 9.76 ± 0.94 | 9.83 ± 0.58 | 9.78 ± 0.86 | 0.267 |
| **Need for resuscitation** | | | | |
| No | 466 (87.4) | 200 (93.9) | 666 (89.3) | 0.058 |
| Initial resuscitation steps | 59 (11.1) | 5 (2.3) | 64 (8.6) | <0.001 |
| Advanced resuscitation | 8 (1.5) | 8 (3.8) | 16 (2.1) | 0.091 |
| **NICU admission** | | | | 0.370 |
| No | 495 (92.9) | 202 (94.8) | 697 (93.4) | |
| Yes | 38 (7.1) | 11 (5.2) | 49 (6.6) | |
| **Asphyxia** | | | | 0.558 |
| No | 529 (99.2) | 212 (99.5) | 741 (99.3) | |
| Yes | 4 (0.8) | 1 (0.5) | 5 (0.7) | |
| **First-hour breastfeeding** | | | | 0.389 |
| No | 173 (32.5) | 77 (36.2) | 250 (33.5) | |
| Yes | 360 (67.5) | 136 (63.8) | 496 (66.5) | |
| **Newborn death** | | | | 0.789 |
| No | 532 (99.8) | 213 (100) | 745 (99.9) | |
| Yes | 1 (0.2) | 0 | 1 (0.1) | |

Data are presented as n (%), or mean ± standard deviation (SD).
NVD: Normal vaginal delivery; CS: Cesarean section; NICU: Neonatal intensive care unit.

to an increased risk of adverse neonatal outcomes.[9] When facilities such as electronic fetal heart monitoring and fetal blood sampling are unavailable, it is difficult to decide whether to allow labor to continue or perform a CS.[2] Even after CS, meconium aspiration syndrome can still occur, resulting in significant morbidity and mortality in newborns.[10] This implores the critical question of whether the presence of meconium alone, even in a normal fetal heart rate and pattern, indicates CS or whether a vaginal delivery can be allowed. Obstetricians in our tertiary center take two approaches to MAF mothers with normal fetal heart patterns: those who allow the vaginal delivery to continue and those who perform CS immediately after detecting the meconium. To the best of our knowledge, our study is the second to compare the neonatal outcome of MAF pregnancies based on delivery method.

**Table 4**
Association of method of delivery with the need for newborn resuscitation.

| VARIABLES | | OR (95% CI) | *P*-value | aOR (95% CI) | *P*-value |
|---|---|---|---|---|---|
| **CS** | **Need for CPR** | | | | |
| | No | Ref | | | |
| | Primary level of CPR | 0.42 (0.21-0.98) | 0.178 | 0.56 (0.32-1.01) | 0.238 |
| | Advanced PCR | 1.78 (1.34-1.96) | 0.548 | 1.89 (1.54-2.41) | 0.788 |
| **NVD** | **Need for CPR** | | | | |
| | No | Ref | | | |
| | Primary level of CPR | 1.6 (0.88-2.34) | 0.233 | 1.43 (0.98-2.07) | 0.278 |
| | Advanced CPR | 0.86 (0.23-0.98) | 0.138 | 0.97 (0.76-2.66) | 0.413 |

OR: Odds Ratio; CI: Confidence interval; aOR: adjusted Odds Ratio; NVD: Normal vaginal delivery; CS: Cesarean section; CPR: Cardio-pulmonary resuscitation.

The first study in 1995 on 150 mothers diagnosed with MAF showed that despite the high rate of neonatal mortality and morbidity, the mode of termination did not affect the incidence of these outcomes.[10] In line with a previous study, our findings also revealed no significant differences in neonatal outcomes in terms of first and 5-min Apgar score, asphyxia, NICU admission, and neonatal death rates between those who underwent CS and those who gave birth vaginally. Another retrospective study on all patients undergoing elective CS with singleton pregnancies revealed that the incidental finding of MAF during elective CS was not associated with increased risks of adverse neonatal outcomes.[11]

Based on our findings, initial resuscitation steps were required more frequently in MAF mothers with NVD than in those with CS. According to the updated recommendation of the American Academy of Pediatrics and the American Heart Association in 2015, the MAF newborn with reasonable respiratory effort and muscle tone should be allowed to stay with the mother for the first steps in newborn care. A bulb syringe can gently clear meconium from the mouth and nose if necessary. If the MAF newborn has poor muscle tone and inadequate breathing, the initial resuscitation steps should be completed under the radiant warmer. The remainder of the initial resuscitation steps should be performed on the vigorous meconium-stained infant. After intrapartum suctioning, the non-vigorous infant should be placed in the radiant warmer bed, and direct laryngoscopy should be performed to suction residual meconium from the hypopharynx (under direct vision) and to intubate and suction the trachea. Both drying and stimulation should be postponed. Suction should be applied through a meconium aspirator device attached directly to the endotracheal tube, and suction should be applied as the endotracheal tube is withdrawn from the airway. Advanced resuscitation intervention to support ventilation and oxygenation, including intubation or suction, should be initiated for each infant as indicated if the airway is obstructed.[12]

Breastfeeding in the first hour of life is essential for good neonatal outcomes. In our study, we decided to include this aspect as it is an essential part of newborn care. According to our findings, the ratio of breastfed infants within the first hour did not differ between the CS and NVD groups, suggesting that both methods of delivery did not significantly impact early breastfeeding initiation.

Overall, our study provides valuable insights into the management of MAF pregnancies and underscores the importance of adhering to updated guidelines for neonatal care and resuscitation to optimize outcomes for MAF newborns.

The current study has several strengths that contribute to its reliability and validity. One major strength is the meticulous exclusion of all variables that could potentially confound the results, such as underlying maternal disease, abnormal labor, and fetal heart rate. Only single mothers without underlying disease or abnormal conditions were examined. In other words, the net effect of meconium as an independent variable on neonatal outcomes in mothers who gave birth vaginally versus mothers who underwent CS solely because of meconium was investigated in this study. We did not divide the cases in our study based on meconium consistency. Thin or thick meconium may result in a different neonatal outcome. Another limitation was the small sample size. These limitations must be considered in future research.

## 5. Conclusions

Our research findings indicate that there was no significant correlation between the delivery method and overall outcomes for MAF mothers and their infants. Additionally, no notable advantages were observed in terms of outcomes between CS and NVD in MAF mothers. However, due to the retrospective nature of the study, and due to the inability to provide precise timing of meconium contamination during labor it is hard to fully conclude if the MAF mothers with normal fetal heart tracing should have a trial of labor safely or undergo CS. Further studies are needed to support our conclusion. This study was conducted in a facility with continuous electronic fetal heart monitoring and a full-time obstetric and gynecologist and pediatric attending residency. As a result, the findings of this study cannot be generalized to all hospitals.

## Author contributions

AR was responsible for conceptualization and methodology; SR handled data curation; ET was in charge of visualization and investigation; VM provided supervision; FD was responsible for writing, reviewing, and editing.

## Ethical approval

This study complied with the Declaration of Helsinki and was performed according to ethics committee approval. The Ethics and Research Committee of the Hormozgan University of Medical Sciences approved the study.

## Consent to participate from patients

The records of all patients who provided informed consent for using their data for research purposes were analyzed. In cases of illiteracy, their legal guardians provided informed consent. Statistical analysis was performed with patient anonymity following ethics committee regulations.

## Consent for publication

Not applicable.

## Availability of data and materials

The datasets generated or analyzed during the current study are available from the corresponding author upon reasonable request.

## Declaration of competing interest

The authors declare that they have no competing interests.

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## References

1. Mitchell S, Chandraharan E. Meconium-stained amniotic fluid. *Obstet Gynaecol Reprod Med*. 2018;28(4):120–124. https://doi.org/10.1016/j.ogrm.2018.02.004.
2. Adnan M, Mydam J, Hageman JR, et al. Fetal heart tracing patterns and the outcomes of newborns with meconium-stained amniotic fluid. *Cureus*. 2022;14(4):e24545. https://doi.org/10.7759/cureus.24545.
3. Hutton EK, Thorpe J. Consequences of meconium-stained amniotic fluid: what does the evidence tell us? *Early Hum Dev*. 2014;90(7):333–339. https://doi.org/10.1016/j.earlhumdev.2014.04.005.
4. Shekari M, Jahromi MS, Ranjbar A, et al. The incidence and risk factors of meconium amniotic fluid in singleton pregnancies: an experience of a tertiary hospital in Iran. *BMC Pregnancy Childbirth*. 2022;22(1):930. https://doi.org/10.1186/s12884-022-05285-8.
5. Tolu LB, Birara M, Teshome T, et al. Perinatal outcome of meconium stained amniotic fluid among labouring mothers at teaching referral hospital in urban Ethiopia. *PLoS One*. 2020;15(11):e0242025. https://doi.org/10.1371/journal.pone.0242025.
6. Ziadeh SM, Sunna E. Obstetric and perinatal outcome of pregnancies with term labour and meconium-stained amniotic fluid. *Arch Gynecol Obstet*. 2000;264(2):84–87. https://doi.org/10.1007/s004040000088.
7. Shrestha A, Singh SD, Tamrakar D. Associated factors and outcome of babies born through meconium stained amniotic fluid. *Kathmandu Univ Med J*. 2018;16(61):65–68. PMID: 30631020.
8. Kumari R, Srichand P, Devrajani BR, et al. Foetal outcome in patients with meconium stained liquor. *J Pakistan Med Assoc*. 2012;62(5):474–476. PMID: 22755313.
9. Xu H, Mas-Calvet M, Wei SQ, et al. Abnormal fetal heart rate tracing patterns in patients with thick meconium staining of the amniotic fluid: association with perinatal outcomes. *Am J Obstet Gynecol*. 2009;200(3). https://doi.org/10.1016/j.ajog.2008.08.043, 283.e1-283.e7.
10. Sasikala A, Raghavan S, Mishra N, et al. Perinatal outcome in relation to mode of delivery in meconium stained amniotic fluid. *Indian J Pediatr*. 1995;62(1):63–67. https://doi.org/10.1007/BF02752185.
11. Itzhaki-Bachar L, Meyer R, Levin G, et al. Incidental finding of meconium-stained amniotic fluid in elective cesarean deliveries: features and perils. *Int J Gynaecol Obstet*. 2022;158(2):418–423. https://doi.org/10.1002/ijgo.13997.
12. Wyckoff MH, Aziz K, Escobedo MB, et al. Part 13: neonatal Resuscitation: 2015 American heart association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2015;132(18 Suppl 2):S543–S560. https://doi.org/10.1161/CIR.0000000000000267.