Journal of University College of Medicine & Dentistry

Original Article

Ultrasound-Estimated Index Versus Measured Volume of Amniotic Fluid at Caesarean Delivery: Accuracy and Perinatal Outcomes

Shaherzad Sohail*, Faiza Iqbal, Sanya Imran, Rabia Mushtaq, Omar Altaf

Shalamar Medical and Dental College, Lahore, Pakistan

*Corresponding Author

Shaherzad Sohai

shaherzad.sohail@sihs.org.pk

Submission: 11th March, 2025
First Revision: 4th May, 2025
Second Revision: 21st May, 2025
Final Revision: 4th June, 2025
Acceptance: 10th June, 2025

DOI: https://doi.org/10.51846/jucmd.v4i2.4013

Cite this article as:

Sohail S, Iqbal F, Imran S, Mushtaq R, Altaf O. Ultrasound-estimated index versus measured volume of amniotic fluid at caesarean delivery: Accuracy and perinatal outcomes. Journal of University College of Medicine & Dentistry. 2025;4(2):127-130

Abstract

Objective: To assess the reliability of ultrasound-based amniotic fluid index (AFI) in estimating amniotic fluid volume by comparing it with intraoperative findings during caesarean section, and to evaluate its association with neonatal clinical outcomes in low-risk term pregnancies.

Methodology: This prospective observational study was conducted at the Department of Obstetrics and Gynaecology, Shalamar Hospital, Lahore, from January to June 2024. A total of 100 pregnant women between 37 and 40 weeks of gestation who underwent caesarean section, were enrolled. Participants were divided into two groups based on AFI measured by ultrasound: Group 1 with low AFI (<5 cm) and Group 2 with normal AFI (5–25 cm). Intraoperative amniotic fluid volume was estimated using a suction apparatus. Neonatal outcomes, including Apgar scores at 1 and 5 minutes and NICU admissions, were recorded and compared.

Results: In the low AFI group, 74% of patients had low amniotic fluid volume confirmed during surgery, while 26% had normal levels. In the normal AFI group, 80% had normal intraoperative fluid volume, and 20% showed reduced levels. Poor Apgar scores at 1 minute were seen in 62% of neonates in the low AFI group versus 16% in the normal group. At 5 minutes, 12% in the low AFI group and 2% in the normal group had low scores. NICU admission was required in 34% of neonates in the low AFI group compared to 8% in the normal group ($p < 0.05$).

Conclusion: This prospective observational study demonstrates a moderate correlation between AFI and intraoperative fluid volume. Low AFI is associated with adverse neonatal outcomes, supporting its role in antenatal risk assessment.

Keywords: Amniotic Fluid Index (AFI), Cesarean Section, NICU Admission, Neonatal Outcomes, OLIGOHYDRAMNIOS, ULTRASOUND.

Introduction

Amniotic fluid is a clear liquid contained within the amniotic sac that surrounds the fetus in the pregnant uterus, providing a protective and supportive environment throughout gestation. It plays a vital role in fetal well-being by cushioning the fetus from external trauma, preventing umbilical cord compression, and allowing space for movement and growth. In addition, its bacteriostatic properties help protect the intra-amniotic environment from infection.[1,2]

The amount of amniotic fluid can be assessed non-invasively using ultrasonography, making it a key parameter in monitoring fetal health. Amniotic fluid is one of the major determinants of the fetal biophysical profile and is predictive of pregnancy outcomes.[3]

Most commonly for determining amniotic fluid volume via ultrasound the AFI is measured. In this technique, the maternal abdomen is divided into four quadrants using the midline and umbilicus as reference points. The transducer is held perpendicular to the floor and the deepest vertical pocket of fluid is measured in each quadrant—excluding pockets containing fetal extremities or the umbilical cord.[3] The sum of these four measurements yields the AFI. Values between 8 and 25 cm are considered normal, 5–8 cm are considered low normal, and values less than 5 cm indicate oligohydramnios.[4]

AFI measurement has become an essential component of antepartum surveillance programs aimed at reducing the risk of intrauterine fetal demise.[5] The detection of oligohydramnios during the antenatal period has been associated with increased risks of meconium-stained liquor, abnormal fetal heart rate patterns, and operative deliveries due to fetal distress.[6,7] Therefore, routine AFI assessment is particularly important in women at risk.

However, despite its widespread use, the reliability of ultrasound-based AFI in accurately reflecting actual amniotic fluid volume remains a subject of debate. Variations in technique, operator dependency, and the indirect nature of the estimation can all influence AFI accuracy. In order to address these concerns and provide context-specific evidence, we conducted this study to assess the relationship between AFI measured antenatally by ultrasound and the actual volume of amniotic fluid observed during caesarean section. This investigation, carried out in a low-risk term pregnancy population, aims to evaluate the reliability of AFI as a diagnostic tool for oligohydramnios and its association with neonatal outcomes. The findings are

intended to support clinical decision-making and contribute to the optimization of fetal surveillance practices in our local population.

Methodology

This was a prospective study which was conducted in the Department of Obstetrics and Gynaecology at Shalamar Hospital, Lahore, from January to June 2024, after obtaining approval from the Institutional Review Board of Shalamar Medical and Dental College (Ref: SMDC-IRB/AL/22/2022). A total of 100 pregnant women between 37 and 40 weeks of gestation, with singleton pregnancies and intact membranes, undergoing caesarean section, were included. Women were excluded if they had ruptured membranes, multiple gestation, diabetes, pregnancy-induced hypertension, chronic medical conditions, or gestational age outside the 37–40-week range. Participants were recruited through convenient sampling and divided into two groups based on the AFI measured by ultrasound within 24 hours prior to delivery. Group 1 included 50 women with low AFI (<5 cm), while Group 2 comprised 50 women with normal AFI (ranging from 5 to 25 cm). A detailed medical history was obtained for all participants, followed by general physical and obstetric examinations. Ultrasound was performed within 24 hours prior to the caesarean section to measure the AFI. Patients were followed up until delivery, at which point intraoperative findings and neonatal outcomes were recorded.

At the time of caesarean section, amniotic fluid volume was collected using a suction apparatus immediately upon rupture of membranes. This intraoperative fluid volume was compared with the preoperative ultrasound-based AFI to assess concordance. Neonatal outcomes which were measured included Apgar scores at 1 and 5 minutes, and the need for NICU admission. Data analysis was conducted using Microsoft Excel and SPSS version 25.To summarise variables, descriptive statistics were described by mean, standard deviation, frequencies, and percentages. Student's t-test was applied to assess differences in amniotic fluid volume, and a p-value <0.05 was considered statistically significant.

Results

A total of 100 patients were included in the study, with 50 women in the low AFI group and 50 in the normal AFI group. The mean gestational age was 37.93 ± 0.91 weeks. The majority of participants were primigravida (55%), while the highest recorded parity was 5, observed in 1% of the study population.

Table 1. Demographic Characteristic of Participants

Characteristic	Mean
Age (years)	29.5
Parity	2.4
Gestational age (weeks)	37.93

Out of 50 patients who had low AFI on ultrasound, 74% were found to have low amniotic fluid volume intraoperatively. In the second group of patients with normal AFI on ultrasound, 80% of them had normal amniotic fluid volume calculated at the time of c-section and 20% were found to have low amniotic fluid volume.

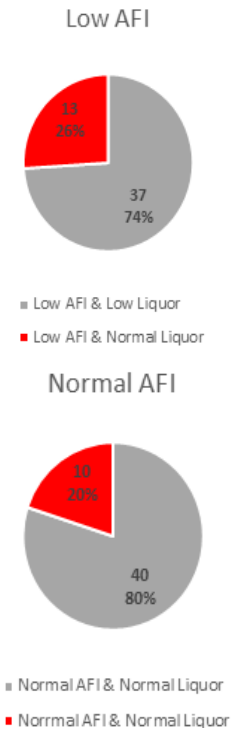

Figure 1: Comparison of Amniotic Fluid Index Determined by Ultrasound and Amniotic Fluid Volume Measured at the Time of C-Section

Moreover, 62% of neonates born to mothers in the low AFI group had poor Apgar scores at 1 minute, compared to 16% in the normal AFI group. At 5 minutes, 12% of neonates in the low AFI group continued to have low Apgar scores, whereas only 2% in the normal AFI group showed similar findings.

Figure 2: Apgar Scores at 1 Minute in Normal and Low AFI Groups

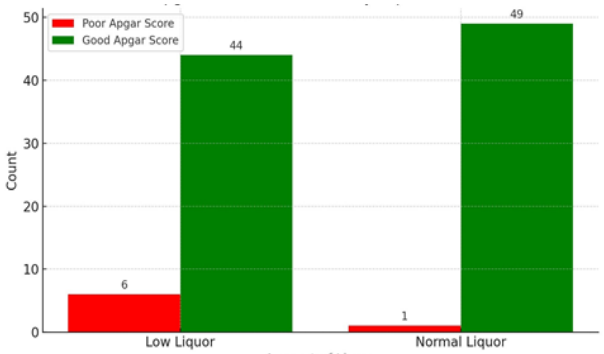

Figure 3: Apgar Scores at 5 Minute in Normal and Low AFI Groups

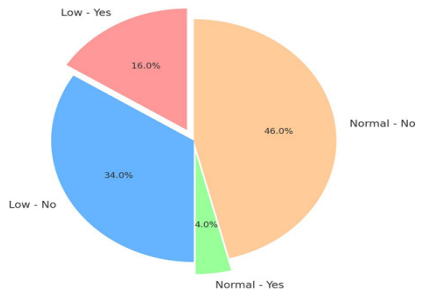

Figure 4: NICU Admission by Amount of Liquor in ml

Out of the total, 34% neonates of low AFI group needed NICU admission, and in normal AFI group 8% needed NICU admission.

Discussion

This prospective study assessed the accuracy of ultrasound-based AFI in reflecting actual amniotic fluid volume observed during caesarean section and to correlate both with neonatal outcomes in low-risk term pregnancies. Hundred pregnant females were divided into two groups—those with low AFI and those with normal AFI. The primary objective was to explore whether ultrasound alone is sufficient for fetal surveillance or if intraoperative findings offer additional value in predicting perinatal outcomes.

Our results revealed, as shown in Figure 1 by pie chart, a moderate correlation between antenatal ultrasound findings and intraoperative fluid volume. Among women with low AFI on ultrasound, 74% were confirmed to have low amniotic fluid volume at the time of caesarean section, while 26% had normal volumes. In the normal AFI group, 80% had normal intraoperative volumes, while 20% unexpectedly had low fluid. These findings affirm the value of ultrasound as a clinical standard but also highlight its limitations. As Everett et al. concluded, AFI is a reasonable third-trimester screening tool for detecting oligohydramnios, though not infallible. Other studies have similarly stressed the clinical significance of low AFI. Our findings align with those of Wax et al. (2022), who critically evaluated the clinical implications of using the amniotic fluid index (AFI) to diagnose oligohydramnios. In their study, they questioned the diagnostic reliability and clinical relevance of isolated AFI measurements, particularly in low-risk pregnancies. This supports our conclusion that clinical decisions should not rely solely on AFI but must consider the broader maternal-fetal context.[9] A cross-sectional study was conducted from November 2019 to March 2020 in Mbarara Regional Referral Hospital in Southwestern Uganda also emphasized enhanced surveillance at term to enable early detection and management of oligohydramnios.[10] Our data support these findings. Figure 2 and 3 elicits the association of apgar scores in low and normal AFI groups.In the low AFI group, 62% of neonates had poor Apgar scores at 1 minute compared to 16% in the normal AFI group. Low amniotic fluid volume has traditionally been regarded as a marker of placental insufficiency and fetal compromise, often prompting obstetric intervention. [11]

Regarding 5-minute Apgar scores, 12% of neonates in the low AFI group had poor scores compared to just 2% in the normal AFI group. These outcomes align with previous research, which reported a high frequency of poor Apgar scores, NICU admissions, low birth weight, and respiratory distress among pregnancies with AFI <5 cm.[12] NICU admission rates in our study further underscore the significance of AFI. Among neonates of mothers with low AFI, 34% required NICU admission, while 68% were roomed-in with the mother. In contrast, only 8% of neonates in the normal AFI group required NICU care. This finding is comparable to a study by Lajber et al. (2019–2020), which reported a NICU admission frequency of 12.5% in the low AFI group and none in the normal group.[13]

A descriptive study conducted at Lady Reading Hospital, Peshawar, in collaboration with Karachi Metropolitan University, observed adverse pregnancy events in 59% of oligohydramnios cases, including 30% caesarean deliveries, 15% fetal distress, 8% stillbirths, 11% meconium-stained liquor, 18% NICU admissions, and 18% of neonates with Apgar scores < 7 at 5 minutes.[14] Another study at Cantt general Hospital, Rawalpindi from October 2022 to March 2023 involving 224 pregnant woman, concluded that the frequency of AFI <50 mm in term pregnancies was quite high and was associated with poor Apgar scores.[15]

Furthermore, a large retrospective analysis involving 12,940 participants from Guatemala, Pakistan, Zambia, and the Democratic Republic of the Congo demonstrated a significant association between oligohydramnios and adverse perinatal outcomes, including stillbirth, neonatal death within 28 days, low birth weight, and preterm birth.[16] In obstetrics, detection of oligohydroamnios always indicate the need for close monitoring and specialised antenatal care. An observational study was conducted from July 2019 to June 2020 among pregnant women admitted to the labour room or antenatal ward of a tertiary care hospital in Nizamabad, Telangana, India.[17] The study included women with a gestational age of more than 37 weeks and an AFI of ≤ 5 cm. Outcomes assessed which were assessed included the onset of labour whether induced or spontaneous, mode of delivery, Apgar scores at 1 and 5 minutes, birth weight, NICU admissions, and perinatal mortality. The findings of this study indicate that patients with oligohydramnios face an increased risk of maternal complications and adverse perinatal outcomes. Therefore, assessing the amniotic fluid index should complement other fetal monitoring techniques to help identify infants at greater risk for poor perinatal outcomes.[17] Obstetric ultrasound contributes significantly in antepartum surveillance and World health organisation recommends ultrasound as part of routine antenatal care to improve maternal and fetal outcomes.[18] Use of ultrasound in the management of pregnancies in low-income countries is always beneficial. However, the ultimate goal of improving perinatal outcome can not be achieved only by this diagnostic tool. Scientific approach is essential.

Although ultrasound remains the gold standard for estimating amniotic fluid volume, our findings suggest that intraoperative fluid assessment—while not standardized—may offer important supplementary information, especially when AFI results are borderline or discordant with clinical presentation. Fetal outcomes should thus be evaluated not solely on ultrasound findings, but in conjunction with intraoperative observations and overall clinical context to improve perinatal care. This approach may help clinicians make more informed decisions,

Limitations

This research was carried out at a single tertiary care facility, which may restrict the broader applicability of its findings. The sample size was relatively small, and intraoperative fluid volume was measured using a suction apparatus, which is not a standardized method and may introduce observer variability. Additionally, AFI was measured by different sonologists, which may have introduced interobserver

variation. Nonetheless, the study provides valuable insight into the real-world reliability of AFI and highlights the importance of using multimodal assessment for better neonatal outcomes.

Conclusion

Our study demonstrated that ultrasound-based estimation of amniotic fluid volume using AFI correlates reasonably well with intraoperative findings and serves as a reliable tool for fetal surveillance. Pregnancies complicated by low AFI were significantly associated with poor Apgar scores, higher NICU admission rates, and overall adverse fetal outcomes. These findings support the use of AFI as a quick, non-invasive, and dependable predictor of neonatal risk. However, given its limitations, AFI should be interpreted in conjunction with intraoperative assessments and clinical context. Patients identified with low AFI should be closely monitored, and appropriate neonatal care arrangements should be made in advance to ensure timely intervention and improved perinatal outcomes.

Authors' Contributions: SS Conception and conduction of study, manuscript writing, critical review; FI Analysis and interpretation of results; SI manuscript writing, interpretation, facilitation and material analysis; RMOA Conduction of study, analysis of results, critical review.

Conflict of interest: None

Funding: None to report

References

1. Rathod S, Samal SK. Evaluation of Maternal and Perinatal Outcomes of Induction in Borderline Oligohydramnios at Term. Journal of Clinical and Diagnostic Research. 2017 11(9): QC05-QC07. doi:10.7860/JCDR/2017/26313.10612

2. Madaan S, Mendiratta SL, Jain PK, Mittal M. Amniotic Fluid Index and its Correlation with Fetal Growth and Perinatal Outcome. Journal of Fetal Medicine. 2015;2(2):61–67 DOI 10.1007/s40556-015-0049-8

3. Chaudhary R, Dhama V, Singh S, Singh M. Correlation of Reduced Amniotic Fluid Index with Neonatal Outcome. International Journal of Reproduction Contraception Obstetrics and Gynecology. 2017;6(6):2401.DOI:10.18203/2320-1770.ijrcog20172320

4. Magann FE, Sandlin TA, Ounpraseuth TS. Amniotic Fluid and the Clinical Relevance of the Estimated Amniotic Fluid Volume. Journal of Ultrasound in Medicine.2011;30(11):1573–1585. DOI:10.7863/jum.2011.30.11.1573

5. Hou L, Wang X, Hellerstein S, Zou L, Ruan y, Zhang W. Delivery mode and perinatal outcomes after diagnosis of oligohydramnios at term in China. Journal of Maternal Fetal Neonatal Medicine.2020;33(14):2408-2414. DOI: 10.1080/14767058.2018.1553944

6. Bynarowicz T, Jenkins SM, Shanks AL. Oligohydramnios [Internet]. Treasure Island (FL): StatPearls Publishing. 2025; 4(16);2-4.

7. Rabie N, Magann E, Steelman S, Ounpraseuth S. Oligohydramnios in complicated and uncomplicated pregnancy: a systematic review and meta-analysis. Ultrasound in Obstetrics and Gynecology. 2017;49(4):442-449. DOI: 10.1002/uog.15929

8. Magann FE, Doherty AD, Chauhan PS, Busch WJF, Mecacci F, Morrison CJ. How well do the amniotic fluid index and single deepest pocket indices (below the 3rd and 5th and above the 95th and 97th percentiles) predict oligohydramnios and hydramnios? American Journal of Obstetrics and Gynecology. 2004;190(1):164–9. doi:10.1016/S0002-9378(03)00859-7.

9. 9.Wax RJ, Joseph W, Pinette GM. The amniotic fluid index and oligohydramnios: a deeper dive into the shallow end. American Journal of Obstetrics & Gynecology.2022;227(3):462-470. DOI: 10.1016/j.ajog.2022.04.016

10. Wesigomwe G, Migisha R, Agaba DC, Owaraganise A, Aheisibwe H, Tibaijuka L et al. Prevalence and associated factors of oligohydramnios in pregnancies beyond 36 weeks of gestation at a tertiary hospital in southwestern Uganda. BMC Pregnancy Childbirth. 2022;22(1):610. doi: 10.1186/s12884-022-04939-x. PMID: 35918640; PMCID: PMC9344782.

11. Huri M, Di Tommaso M, Seravalli V. Amniotic Fluid Disorders: From Prenatal Management to Neonatal Outcomes. Children (Basel). 2023;10(3):561. doi: 10.3390/children10030561.

12. 12.Saxena, R., Patel, B., & Verma, A. Oligohydramnios and its perinatal outcome. International Journal of Reproduction, Contraception, Obstetrics and Gynecology.2020; 9(12):4965–4969.

13. Lajber F, Habib H , Khaliq S , Kareem R , Inayat S, Lajber M. Role of Low Amniotic Fluid Index (AFI) on Perinatal Outcome in Women with Term Pregnancy. Pakistan Journal of Medical & Health Sciences.2020;14(3):1498-1500.

14. Qazi FK ,Wali S, Tariq L, Begum A, Bibi N, Sahito M. Adverse Pregnancy Outcome in Oligohydroamnios measured by Amniotic Fluid. Journal of Population Therapeutics and Clinical Pharmacology.2024;31(6):3321-3329. https://doi.org/10.53555/hpfq5v1

15. Marwat HS, Naz KM, Riaz M, Sardar N, Hassan S, Nasreen H. Amniotic Fluid Index and Its Relationship with Poor Apgar Score in Term Pregnancy. Journal of Health and Rehabilitation Research. 2023;3(2):650-654 DOI:10.61919/jhrr.v3i2.205

16. 16.Figueroa L, McClure EM, Swanson J, Nathan R, Garces AL, Moore JL et al. Oligohydramnios: A Prospective study of Fetal, Neonatal and Maternal outcomes in Low-Middle Income Countries. Reproductive Health. 2020; 30;17(1):19. doi: 10.1186/s12978-020-0854-y.

17. Ingle AA, Anupama D, Adapa S, Aparna G. Maternal and fetal outcome in oligohydramnios: A study from a Government tertiary care hospital, Nizamabad. International Journal of Health Sciences. 2022;6(S1):13973–13982. doi:10.53730/ijhs.v6nS1.8607.

18. 18.Stefanovic V. Role of obstetric ultrasound in reducing maternal and neonatal mortality in developing countries: from Facts to Acts. Journal of ultrasound in obstetrics and gynecology.2020;14:43-49.