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Predictive Value of Amniotic Fluid Index in Term Small for Gestational Age with Normal Doppler Studies for Perinatal Outcomes

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Abstract

Background and Aim: Delivery of a fetus with SGA is associated with increased risk of perinatal morbidity and mortality. Evidence is limited for the accuracy of Oligohydramnios to predict substantive perinatal morbidity and mortality in non–anomalous SGA fetuses monitored with normal Doppler studies. The aim of this study is to determine the association between amniotic fluid index and adverse perinatal outcomes in term SGA fetuses with normal Doppler studies. **Method:** This is a prospective observational study carried out by 340 pregnant women who were admitted to obstetrics unit, Sri Jayewardenepura from January 2019 to January 2023. Singleton pregnancies at term who were diagnosed with SGA (EFW < 10^{th} centile or AC < 10^{th} centile) with normal umbilical artery and middle cerebral artery Doppler studies were included. AFI was assessed predelivery and data were collected according to demographic details, mode of delivery, time of delivery, intrapartum events, and neonatal outcomes. **Results:** A total of 340 term pregnant women were studied. Out of them, 44% were in AFI more than 10 groups and 37% and 19% were in AFI 5 - 10 and less than 5 groups respectively. More obstetrics interventions were reported in AFI < 5 groupa in terms of induction of labor (P 0.04) and emergency caesarean sections (P 0.003). No significant deference in immediate neonatal outcome was detected between each group. (Meconium-stained liquor (P 0.634), 1 minute APGAR (P 0.575) and 5-minute APGAR P 0.165)). Neonatal unit admission (P < 0.001) and long-term neonatal complications were more reported from AFL < 5 groups. **Conclusion:** This study implies that AFI in term SGA fetuses has predictive value of adverse perinatal outcomes particularly neonatal unit admission and neonatal complications rather than immediate fetal complications.

Keywords

Term SGA, AFI, Doppler, Perinatal Outcomes

1. Introduction

Small for gestational age (SGA) fetus is defined as an estimated fetal weight (EFW) or abdominal circumference (AC) less than 10th centile and severe SGA as an EFW or AC less than 3rd centile [1]. Fetal growth restriction (FGR) and SGA are two separate entities. A new definition for FGR is given by using Delphi consensus methodology by reviewing 18 literature base parameters for defining FGR [2]. Fifty to seventy percent of diagnosed SGA fetuses are constitutionally small with growth compatible to maternal characteristics and ethnicity [3]. Growth restricted fetuses are at higher risk of developing adverse perinatal outcomes, and long-term sequelae such as poor cognitive development, endocrinal and cardiovascular diseases in their later life [3]. Clinical examination is unreliable in detecting SGA fetuses and the diagnosis relies on ultrasonographic measurement of either estimated fetal weight or abdominal circumference [4]. Umbilical artery Doppler is the primary tool for monitoring SGA fetuses, and it is considered abnormal when pulsatility index (PI) or resistance index (RI) is more than 2SDs for mean gestational age or either absent or reversed end diastolic frequencies (AREDV) [5]. Amniotic fluid measurement is a very important part of evaluation of fetal well-being in terms of Meconium aspiration, fetal heart rate deceleration, emergency caesarean delivery, low Apgar score and perinatal morbidity and mortality [6] [7] [8]. Amniotic fluid volume changes with advancing gestational age from 200 - 250 ml at 16 weeks of gestation to 1000 ml at 28 weeks and 800 ml at term [9] [10]. Amniotic fluid volume is usually measured as either single deepest vertical pool (SDVP) or as amniotic fluid index (AFI) however both methods poorly represent actual amniotic fluid volume [10]. Amniotic fluid index is the measurement of amount of amniotic fluid by calculating depths in centimeters of largest vertical pockets in each quadrant [5]. When either AFI is less than 5 cm or SDVP is less than 2 cm, it is referred to Oligohydramnios [1] [6] [11]. The relationship between severe Oligohydramnios and adverse perinatal outcomes was observed in 113 patients which revealed all the end of adverse perinatal outcomes were significantly increased in with group with severe Oligohydramnios compared to group with normal liquor volume [7]. Delivery of a fetus with SGA is associated with increased risk of perinatal morbidity and mortality. Even though Some studies show that high risk pregnancies with lower single deepest vertical pool of amniotic fluid or low AFI are associated with increased rates of adverse perinatal outcomes [7] [12]. A meta-analysis was carried out by reviewing all investigations that were published related to antepartum and intrapartum AFI with adverse perinatal outcomes from year 1987 to 1997. There was a significant relationship between antepartum or intrapartum AFI ≤ 5 cm with increased risk of emergency caesarean delivery for foetal distress and

low Apgar score at 5 minute [13]. According to available literature, adverse perinatal outcomes in term SGA fetuses depend on birth weight, gestational age of delivery, mode of delivery and antenatal fetal heart rate anomalies [8] [14] [15] [16]. The aim of this study is to determine the association between amniotic index and adverse perinatal outcomes in term SGA fetuses with normal Doppler studies with a reasonable degree of confidence. This will also help to achieve standard time duration for the re-evaluation of SGA pregnancies and to manage them without undue delay.

2. Material and Methods

This is a prospective observational study of patients who were admitted to the Obstetrics unit, Sri Jayewardenepura General Hospital from January 2019 to January 2023. Study population was pregnant women who are diagnosed to have SGA (EFW < 10^{th} centile or AC < 10^{th} centile) with normal umbilical artery and middle cerebral artery Doppler studies. From every patient informed written consent was obtained prior to allocation into the study. A special prepared questionnaire was provided to all participants to gather demographic detail, obstetrics history, delivery outcomes and neonatal outcomes. Ultrasound parameters were taken following complete examination of the patient. Estimated fetal weight, SDVP, AFI, umbilical artery pulsatility index (UA PI) and middle cerebral artery pulsatility index (MCA PI) was taken. EFW was calculated automatically by using Hadlock's formula [17]. AFI was calculated by measuring of four quadrant vertical length as described by Phelan *et al*. [18]. Pulse wave of Doppler gate focuses on one of umbilical artery with making an angel of less than 30 degrees and the sample volume encompass the entire width of vessel. Three similar consecutive wave forms were obtained, and mean PI of these wave forms were taken as UA PI [19]. MCA is obtained by achieving the axial plane of brain, including the thalamic and sphenoid wings. Then color Doppler was used to identify circle of wills and proximal third of MCA. Pulse wave of Doppler gate focuses to MCA with making an angle less than 30 degrees and encompass entire width of vessel. Three similar wave forms will be used to calculate mean MCA PI [20]. To minimize inter observer variation in obtaining data of ultrasound parameters by the principal investigator, all ultrasound parameters were cross validated with the finding of supervisor of the study (senior consultant Obstetrician and Gynecologist). All ultrasound measurements were obtained by using Toshiba nemio XG ultrasound scan machine with 3.75 MHz transducer with pulse wave Doppler facility B mode imaging. Ethical approval was taken from postgraduate institute of medicine, Colombo, Sri Lanka. All the participants who are diagnosed with SGA and normal umbilical arterial and MCA Doppler studies were followed up to term. Pregnancies with pre labor rupture of membrane, multiple pregnancies, malpresentation, congenital anomalies and abnormal doppler studies were excluded from study. Based on obstetrics factors, clinical judgment and maternal wish, mode of the delivery and time of the delivery was

decided. All decisions were taken by staff specialist with input of second opinion from another staff specialist. Continuous electronic fetal monitoring and one to one care was offered to all women in labor. Decision to admit neonatal unit based on assessment of pediatric medical officer who presented at the time of delivery. Data were collected according to demographic details, mode of delivery, time of delivery, intrapartum events, and neonatal outcomes. Data were entered in Microsoft excel spread sheet and adhered to best clinical practice to ensure confidentiality. Pregnancies were divided into three groups based on their AFI values (less than 5, 5 to 10 and more than 10). Pregnancy outcomes evaluated are meconium-stained liquor, intrapartum abnormal CTG, emergency caesarean sections, assisted vaginal birth, 5- and 10-minute APGAR score, neonatal unit admission and other neonatal complications while controlling gestational age. Data were analyzed using SPSS version 28. Descriptive analyses were performed in all data and t Test and ANOVA used for comparing means of continuous variables. Categorical variables compared using fisher's exact test. P value < 0.05 consider as significant. P values were obtained by Kruskal-Wallis test for nonparametric data.

3. Results

Three hundred and forty pregnant women met the inclusion criteria for study. Total population divided in to three groups based on predelivery AFI value according to their gestational age. Majority (44%) were in AFI more than 10 group and 37% and 19% were in AFI 5 - 10 and less than 5 groups respectively. Mean age of the population is 28.9 years (SD 5.3). There was no significant difference noted in mean maternal age between each group (P 0.558). Mean body mass index in the population is 28.2 kg/m^2 (SD 2.9) with no significant difference between each group (P 0.603). Majority of the population (44.1%) were in their first pregnancy and 29.5%, 19% and 7.5% were their 2nd, 3rd, and 4th pregnancies respectively. No significant difference noted in parity between each group. Gestational diabetes and gestational hypertension are common maternal complications encountered. However, there was no statistically significant difference noted in maternal complications between each group (P 0.487 and 0.081 respectively). Maternal characteristics show in Table 1.

Differences in delivery details are between these groups presented in Table 2. There is no significant difference of mean gestational age of delivery between each AFI group (P 0.082). Its distribution shows in Figure 1. More women had induction in AFI < 5 group 60.6% vs 40.5% and 46% (P 0.04). Meconium-stained liquor at birth reported 15.2% (n = 10) in AFI < 5 group compared to 11.1% (n = 14) and 10.8% (n = 16) in AFI 5 to 10 and AFI > 10 groups respectively. However, it is not statistically significant (P 0.63). When comes to delivery mode, low AFI was linked to greater chance of emergency caesarean section. 28.7% (n = 19) emergency caesarean section rate reported in AFI < 5 group vs 14.3% (n = 18) and 18.9% (28) in AFI 5 to 10 group and AFI > 10 group respectively (P 0.003).

Table 1. Demographic characteristic.

	AFI Group			P value
	>10 (n = 148)	5 - 10 (n = 126)	<5 (n = 66)	
Maternal age (years)	26.62 ± 2.034	30.62 ± 1.987	27.84 ± 1.242	0.558
Parity				
1	43.9% (65)	46.8% (59)	39.3% (26)	0.187
2 or more	56.1% (83)	53.2% (67)	60.7% (40)	0.139
BMI	27.1 ± 0.793	30.27 ± 1.403	28.75 ± 0.962	0.603
Smoking during pregnancy	4% (6)	1.58% (3)	-	0.02
GDM	7.4% (11)	6.34% (8)	6% (4)	0.487
GHTN	10.8% (16)	11.9% (15)	9% (6)	0.081
Pre-eclampsia	1.3% (2)	2.3% (3)	1.51% (1)	0.792
Other medical condition	2.% (3)	7.1% (9)	1.51% (1)	0.021

AFI represent Amniotic Fluid Index, GDM: Gestational Diabetes mellites, GHTN: Gestational hypertension, data are mean ± SD.

Table 2. Delivery out comes.

Neonatal outcomes	AFI Group			P value
	>10 (n = 148)	5 - 10 (n = 126)	<5 (n = 66)	
Birth weight (Kg) (Mean ± SD)	2.23 ± 0.228	2.31 ± 0.287	2.18 ± 0.213	0.062
Meconium liquor	10.8% (16)	11.1% (14)	15.2% (10)	0.634
Neonatal Unit Admission	16.8.% (25)	17.4% (22)	36% (24)	<0.001
Number of days (Mean ± SD)	1.09 ± 0.410	1.10 ± 0.470	2.16 ± 0.865	0.003
1-minute APGAR < 7	2% (3)	1.5% (2)	0	0.575
5-minute APGAR < 7	0.6% (1)	7.9% (1)	0	0.165
Neonatal complications				
Respiratory distress (clinical)	44% (11/25)	45.4% (10/22)	33.3% (8/24)	0.483
Meconium aspiration	4% (1/25)	-	-	0.06
Hypoglycemia	8% (2/25)	13.6% (3/22)	25% (6/24)	0.002
Jaundice	32% (8/25)	27.2% (6/22)	41.6% (10/24)	0.014
Anemia	8% (2/25)	4.5% (1/22)	-	0.33
Polycythemia	4% (1/25)	4.5% (1/22)	-	>0.99

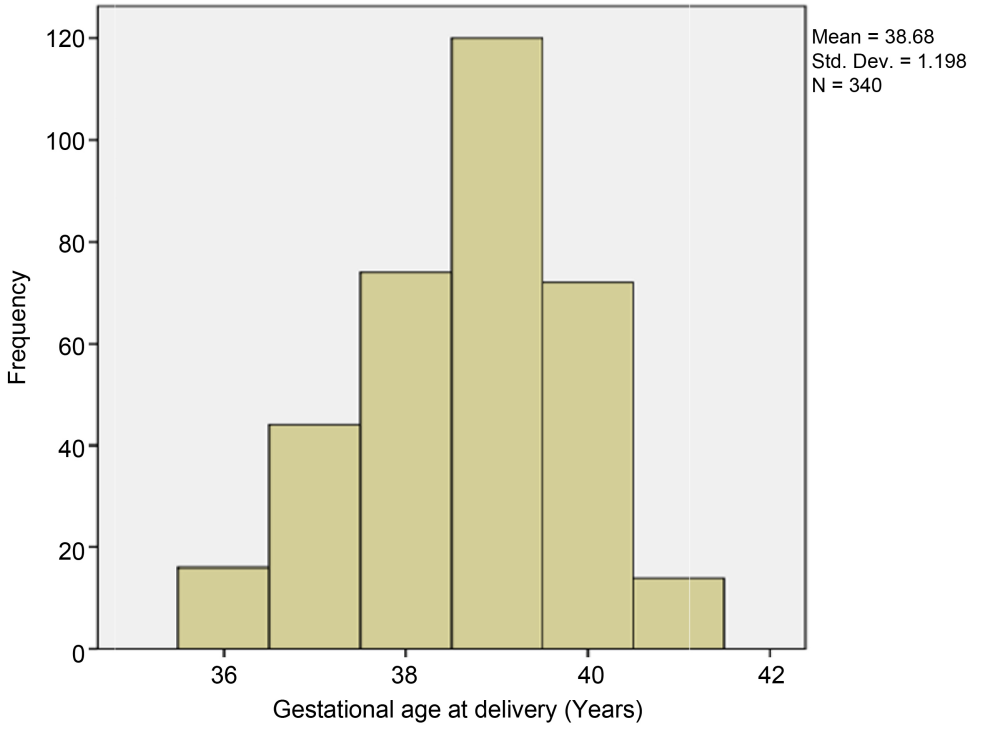

Figure 1. Gestational age of delivery distribution in the study sample.

Even though high assisted delivery rate (10.6% vs 7.1% and 5%) reported in AFI < 5 group, it is statistically not significant (P 0.18). Vaginal delivery rate is 54.6% in AFI < 5 group and 65.1% and 60.8% in AFI 5 to 10 and AFI > 10 groups respectively (P 0.04). Abnormal intrapartum CTG was the main reason for emergency caesarean section in AFI < 5 group (57.6% n = 15) compared to other two groups (42.3% n = 11 and 40% n = 14 in AFI 5 to 10 group and AFI > 10 respectively which is statistically significant (P 0.003). Other indications for immediate delivery were failure to progress and failed induction which were not associated with AFI level (P 0.24 and 0.06 respectively).

There is no significant difference in mean birth weight noted between each group (P 0.062). AFI < 5 is linked with higher rate of neonatal unit admission compare with other 2 groups (36% vs 17.4 % and 16.8% in AFI 5 - 10 and AFI > 10 groups respectively), P < 0.001. However, there is no significant difference in mean number of days of stay in neonatal unit between each group (P 0.418). There is no significant 1 minute and 5-minute APGAR score difference reported between each group. Only five children reported with low APGAR in 1st minute and 2 children in 5 munits (P 0.575 and 0.165). Indication for neonatal unit admissions included clinical suspicion of respiratory distress, meconium aspiration, hypoglycemia, jaundice, anemia, and polycythemia. Low AFI (<5) with small for gestational age associated with more neonatal complications compare with small for gestational age with normal AFI (>5). Neonatal hypoglycemia and neonatal jaundice are more reported from AFI < 5 group compared to other two (P 0.002 and 0.014 respectively). However, there is no significant difference in

respiratory depression and Meconium aspiration between each group (P 0.483 and 0.06). If gestational age controlled with logistic regression module, it is demonstrated that small for gestational age with low AFI compare with small for gestational age with normal AFI is a strong predictor for neonatal unit admission (RR 10.5, 95% CI 1.8 - 55.2) (Table 3).

Table 3. Neonatal outcomes.

Neonatal outcomes	AFI Group			P value
	>10 (n = 148)	5 - 10 (n = 126)	<5 (n = 66)	
Birth weight (Kg) (Mean ± SD)	2.23 ± 0.228	2.31 ± 0.287	2.18 ± 0.213	0.062
Meconium liquor	10.8% (16)	11.1% (14)	15.2% (10)	0.634
Neonatal Unit Admission	16.8.% (25)	17.4% (22)	36% (24)	<0.001
Number of days (Mean ± SD)	1.09 ± 0.410	1.10 ± 0.470	2.16 ± 0.865	0.003
1-minute APGAR < 7	2% (3)	1.5% (2)	0	0.575
5-minute APGAR < 7	0.6% (1)	7.9% (1)	0	0.165
Neonatal complications				
Respiratory distress (clinical)	44% (11/25)	45.4% (10/22)	33.3% (8/24)	0.483
Meconium aspiration	4% (1/25)	-	-	0.06
Hypoglycemia	8% (2/25)	13.6% (3/22)	25% (6/24)	0.002
Jaundice	32% (8/25)	27.2% (6/22)	41.6% (10/24)	0.014
Anemia	8% (2/25)	4.5% (1/22)	-	0.33
Polycythemia	4% (1/25)	4.5% (1/22)	-	>0.99

Data presented as mean ± SD for continuous variables. Comparisons by X^2. Pairwise comparison by Fisher exact test with all P > 0.05. Continuous variables compared with the Kruskal-Wallis test for nonparametric data.

4. Discussion

Main purpose of this study to evaluate association between adverse intrapartum outcomes and adverse neonatal outcomes with amniotic fluid Index in term SGA fetuses with normal umbilical artery and middle cerebral artery Doppler studies. Total population categorized to 3 group based on their AFI value (Phelan's methods was used to calculate AFI). AFI < 5 group more likely to undergo obstetrics interventions compare to other two groups. Induction rate and emergency caesarean delivery rates are significantly high in AFI < 5 group compared to other (P 0.04 and P 0.003 respectively). Assisted delivery rate also more in AFI < 5 group, but it is not statistically significant. Emergency caesarean deliveries mainly due to CTG abnormalities (Variable decelerations, late deceleration and prolong decelerations). This consists with Chauhan *et al*. which review estimated

fetal weight and intrapartum outcomes [21]. This is reported to be due to SGA with low AFI may compromise fetal ability to tolerate labor stress and increase chance cord and head compression which lead to emergency delivery. Furthermore, systematic review and metanalysis by Rossi AC et al revealed similar findings where examine perinatal outcomes of isolated oligohydramnios in term pregnancies [22].

Interestingly, there was no significant difference in mean gestational age of delivery between each group despite of having high rate of intervention in low AFI group. There was no difference in meconium-stained liquor between each group (P 0.634). This consists with Shrem G *et al*. which analyzed on isolated oligohydramnios in term pregnancies [23].

There was no mean birth weight difference in between each AFI group as total population was being diagnosed with SGA (P 0.062). More neonates were admitted to neonatal unit from AFI < 5 group compared to other two groups (P < 0.001). Average days of neonatal unit stay also significantly high in neonates from AFI < 5 group (P 0.003). However, there were no difference noted in 1 minute and 5 minutes APGAR score between each group (P 0.575 and 0.165 respectively). Sub analysis of Magann EF *et al*. revealed SGA with oligohydramnios were presence the risk of NICU admission and newborn complication was additive [24]. But inconsistence with meta-analysis by Rossi AC *et al*. where focused on isolated oligohydramnios at term rather fetal weight [24]. It appears that SGA with low AFI more associated with long term complications like neonatal unit admission and neonatal complications rather immediate fetal complications like meconium-stained liquor and low APGAR score. When comes to neonatal complications, no significant differences reported in respiratory depression between each group. However, several studies reported that increase incidence of respiratory distress with low AFI which is evaluate at low gestational age [25] [26] Fact that no significant difference in mean gestational age of delivery and no significant difference in maternal medical complications particularly gestational diabetes in this population, it is the prematurity rather AFI level which leads to developing respiratory distress in SGA fetuses. However, over all neonatal complications including neonatal hypoglycemia and jaundice more reported in neonates with low AFI.

From finding of this study reinforced adverse perinatal outcomes in term SGA fetuses with low AFI. Therefore, monitoring AFI in term SGA fetuses will be helped physician to plan time of delivery and setting of delivery to achieve safe perinatal outcome without undue delay. When comes to limitations, measuring of AFI is operator depend which might affect delivery decision and fetal outcomes. Study sample also is a limiting factor, especially 62 of SGA with low AFI. So further studies with prospective observation are required.

5. Conclusion

This study implies that AFI in term SGA fetuses has predictive value of adverse perinatal outcomes. However, further studies are required in this area. Due to

lack of good evidence in managing term SGA fetuses, antepartum or intrapartum surveillance of AFI in term SGA fetuses will be important to triage high risk pregnancies and plan their deliveries.

Conflicts of Interest

Authors have no conflict of interest.

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