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A Comparison of Amniotic Fluid Index versus Single Deepest Vertical Pocket Measurement at Term as a Predictor of Adverse Perinatal Outcome

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Abstract

Introduction: Oligohydramnios is an important sign of fetal jeopardy and amniotic fluid index (AFI) and single deepest vertical pocket (SDVP) have been used to detect it. **Objective**: To compare AFI vs. SDVP at term as a predictor of adverse perinatal outcomes. **Methods**: A prospective observational study was conducted in Teaching Hospital Kandy, Sri Lanka for eight months from July 2015 to March 2016. 448 Singleton pregnancies admitted after 37 completed weeks were included. AFI ≤ 5 cm and SDVP < 2 cm were the exposure variables, which were related to outcome variables. **Results**: Mean AFI was 11.35 cm (SD = 5.15) and Mean SDVP was 4.07 cm (SD = 1.88). AFI and SDVP values showed a significant positive correlation ($r = 0.954$; $p < 0.001$). A significant percentage with low AFI needed induction of labour (RR 2.14, 95% CI 1.85 - 2.49). Low AFI was also a significant risk factor for not having an uneventful birth outcome (RR 2.682, 95% CI 1.082 - 6.642). Low SDVP was a significant risk factor for induction of labour (RR 1.83, 95% CI 1.434 - 2.334), operative delivery (RR 1.714, 95% CI 1.292 - 2.280), meconium-stained liquor (RR 2.67, 95% CI 1.342 - 5.308), and Apgar < 7 (RR 17.74, 95% CI 7.96 - 40.924). SDVP had better predictability than AFI for adverse perinatal outcomes. **Conclusion**: AFI better predicted oligohydramnios and subsequent labour induction than SDVP. Low SDVP was a risk factor for adverse perinatal outcomes (such as induction of labour, meconium-stained liquor, operative delivery, 5-minute Apgar less < 7, admission to special care baby units or perinatal deaths). In predicting adverse perinatal events, a higher potential was noted in SDVP method than AFI method. To determine the most predictive cut-off values of SDVP and AFI for each perinatal outcome, an in-depth experimental analysis is required in future research.

Keywords

Perinatal Outcomes, Amniotic Fluid, Predictability, AFI, SDVP

1. Introduction

Prevention of maternal as well as fetal mortality and morbidity is the ultimate goal of a good obstetrician. Antepartum fetal surveillance during pregnancy with prompt and timely interventions is crucial in the prevention of an adverse pregnancy outcome.

Oligohydramnios is associated with increased fetal and neonatal morbidity and mortality complicating 0.5% - 4% of all pregnancies, emphasizing the significance of precise antenatal assessment of amniotic fluid volume [1]. A low amniotic fluid volume is thought to reflect inadequate uteroplacental perfusion preserving the blood flow to the fetal brain, heart and adrenal glands leading to renal hypo perfusion and reduced fetal urinary output. A reduced liquor volume has also been identified as a sign of potential fetal compromise as well as a fetal response to chronic stress [2] [3].

Several methods are used to assess the amniotic fluid volume. Semi-quantitative estimates of amniotic fluid volume can be yielded by ultrasonography using the measurements of single deepest vertical pocket (SDVP), amniotic fluid index (AFI) and amniotic fluid distribution, the former two being the most practiced methods. In the late gestational age, magnetic resonance imaging (MRI) shows comparable results in predicting oligohydramnios [4].

The use of SDVP technique to assess amniotic fluid volume was introduced by Manning in 1980, defining it as "fluid evident throughout the uterine cavity as well as the largest pocket of fluid measuring more than 1 cm in the vertical dimension", which was later modified to "a pocket of fluid that measured at least 1 cm in two perpendicular planes" (1 × 1 pocket) [5] [6]. In 1984, Chamberlain *et al.* proposed that SDVP less than 1 cm was too stringent and recommended considering SDVP less than 2 cm as having oligohydramnios [7]. In 1987, Phelan *et al.* described measuring AFI as a better method to estimate liquor volume instead of SDVP [8]. This inference was reinforced by subsequent studies conducted by Rutherford *et al.* and Sarno *et al.*, which reported an increased rate of caesarian delivery for a non-reassuring fetal heart rate tracing and a low Apgar score in association with a reduced AFI value [9] [10].

In the current practice, oligohydramnios is defined as a SDVP of less than 2 cm or an AFI of 5 cm or less while polyhydramnios is defined as a SDVP of more than 8 cm or AFI of at least 25 cm or more [11]. Royal College of Obstetricians and Gynaecologists (RCOG) recommends that interpretation of amniotic fluid volume should be based on a single deepest vertical pocket [12]. The American College of Obstetricians and Gynecologists (ACOG) also advocates the use of a single deepest vertical pocket in antepartum fetal surveillance [13]. An USA based survey among members of Society of Maternal Fetal Medicine

(SMFM) has reflected the variations in the method of evaluating amniotic fluid in the practice of clinicians [14].

Although the impact of amniotic fluid volume mostly considering AFI on the fetal well-being as well as perinatal outcome has been investigated to a greater extent, only a few studies provide data directly comparing the impact of AFI and SDVP measurements on pregnancy outcome. Despite some similar observations, most conclusions of such comparisons were contradictory. AFI has been identified as a superior method to SDVP in several studies in predicting adverse perinatal outcomes [15] [16] [17]. In contrast, SDVP was recognized as a better predictor of perinatal outcomes in some published literature [18] [19] [20]. This inconclusiveness of available literature makes it a difficult task to apply the existing knowledge to practice in an evidence-based manner. Modifications of cut-off values have also been proposed in some studies with more predictive accuracy [15] [21]. This points out the probability of calculating unique cut-off values, which could be more precisely applicable, particularly to the local population. Such data would also facilitate consensual agreement of obstetric care policymakers and will be of value in provision of recommendations on amniotic fluid volume assessment in future guidelines.

Objectives

- To determine the association between the amniotic fluid index (AFI) value at period of gestation of 37 + 0 weeks to 40 + 0 weeks and adverse perinatal outcomes (abnormal fetal heart rate tracing, presence of meconium-stained liquor, caesarean delivery/operative vaginal delivery due to fetal distress, an Apgar score of less than seven at five minutes, admission to a special care baby unit, perinatal death).
- To determine the association between the single deepest vertical pocket (SDVP) value at period of gestation of 37 + 0 weeks to 40 + 0 weeks and selected adverse perinatal outcomes.
- To compare the predictive ability of amniotic fluid index and single deepest vertical pocket measurement at period of gestation of 37 + 0 weeks to 40 + 0 weeks with respect to selected adverse perinatal outcomes.

2. Materials and Methods

2.1. Study Design

This was a hospital based prospective observational study. Pregnant women receiving antenatal care at obstetrics unit of ward 05 Teaching Hospital Kandy, Sri Lanka during the period of eight months from July 2015 to March 2016 were the study population of this study.

2.2. Method

2.2.1. Inclusion Criteria

- Singleton pregnancy.

- Period of gestation from 37 + 0 weeks to 40 + 4 weeks.
- Intact membranes without rupture on admission.
- Delivery occurring within seven days of the last amniotic fluid volume assessment performed between 37 + 0 weeks and 40 + 0 weeks of gestation.
- Confirmed period of gestation by an ultrasound scan performed from 11 + 0 weeks to 14 + 0 weeks of gestation.

2.2.2. Exclusion Criteria

- Pregnancies complicated with maternal complications such as diabetes and hypertension.
- Pregnancies complicated with fetal complications such as fetal growth restriction and congenital malformations. These issues were identified by mid-trimester morphology USS, serial growth surveillance and other relevant antenatal assessments.

2.2.3. Data Collection Strategy

Study participants were recruited after obtaining informed written consent and in adherence with the selection criteria during their ward stay. Routine history taking was done and they were subjected to general, systemic, obstetric and pelvic examinations. Routine baseline investigations including CTG were done. Relevant history, examination and investigation findings were entered in a pre-designed data collection sheet by the investigators with emphasis on demographical data, past and present obstetric details, ultrasonography results and selected perinatal outcome measures.

Ultrasound scan measurements—Amniotic fluid volume evaluation was performed by trans-abdominal scanning with the use of Samsung Medison Sonoace R7 ultrasound machine. Both AFI and SDVP values were measured simultaneously in each research participant only by the principal investigator in order to avoid inter-observer variability following adequate prior training on ultrasound measurement by the supervisor before the stage of data collection. The amniotic fluid measurement that was used for this study was the last value measured before the delivery of the baby from 37 + 0 weeks to 40 + 0 weeks of gestation.

The deepest pocket of amniotic fluid free of umbilical cord was detected with the ultrasound probe held perpendicular to the maternal abdominal wall and vertical and transverse diameters of this pocket were measured. The deepest vertical diameter of the pocket which had a transverse diameter of at least 1 cm was considered as SDVP value [11]. A cord-free measurement was obtained by the identification of umbilical cord using colour flow Doppler.

Considering the umbilicus as the reference point, the uterus was divided into an upper and lower half. Subsequent division of uterus into right and left halves resulted in four uterine quadrants. The ultrasound transducer was placed in each quadrant with the probe held in the longitudinal axis of the mother at a right angle to the floor. In each quadrant the deepest vertical pool-depth was recorded

by the above technique. The sum of these four quadrant values in centimeters was regarded as the AFI value.

Within the scope of this study, presence of one or more of the following was stipulated as having an adverse perinatal outcome.

- Abnormal fetal heart rate tracing (non-reassuring or pathological CTG).
- Presence of meconium-stained liquor.
- Caesarean delivery due to fetal distress.
- Operative vaginal delivery due to fetal distress.
- An Apgar score of less than seven at five minutes.
- Admission to a special care baby unit (SCBU).
- Perinatal death.

All efforts were made to assess subjective outcomes such as Apgar score and fetal heart rate tracing by the chief investigator as much as possible.

2.3. Sample Size and Sampling Techniques

Sample size was calculated by using the specificity values reported by Fisher *et al.* being 87.9% and 89.1% for SDVP and AFI respectively [21]. Following formula for paired comparisons was used to yield minimum and maximum sample sizes for the study [22].

$$n = \frac{\left(SLF \times ¥^{1/2} + PF \times \left(¥ - £^2\right)^{1/2}\right)^2}{£^2}$$

n = sample size

¥ = probability of disagreement between the techniques

£ = P1 − P2: P1 = sensitivity (specificity) of the technique; P2 = sensitivity (specificity) of the contender

SLF = significance level factor

PF = power factor

Online calculation was done using the web-based application; https://www.statstodo.com/SSizSenSpc_Tab.php, which was based on the above formula. The minimum sample size was 122 and maximum sample size was 542. 448 participants were recruited for this study.

Convenience sampling technique was used to select the study participants. One to three patients from daily ward admissions, who had given consent and who fulfilled the selection criteria were recruited daily until the desired sample size was reached.

2.4. Outcome Measures

Outcome of this study was measured by thematic analysis of data collected from study participants. Following outcome measures were used to report the results to arrive at the conclusion of this study.

- Rate of diagnosis of oligohydramnios
- Rate of induction of labour

- Rate of caesarean delivery
- Rate of caesarean delivery for fetal distress
- Rate of operative vaginal delivery for fetal distress
- Number of abnormal fetal heart rate tracing
- Rate of Apgar score being less than 7 in 5 minutes
- Rate of presence of meconium-stained liquor
- Rate of admission to special care baby unit
- Number of perinatal deaths

2.5. Statistical Analysis and Presentation of Results

The data were entered in a secured data base and were analyzed by using Statistical Package for the Social Sciences (SPSS) version 23.

Categorical variables were described by percentages and frequencies. Numerical variables were described by measures of central tendency. The probability of the diagnostic test accuracy was compared by calculated likelihood ratios. Probability cut-off value was 0.05 and, 95% confidence interval was used for statistical significance.

2.6. Ethical Considerations

Only the participants, who had given their informed written consent, were recruited for the study. The participant consent form carried personal identification details only for the purpose of future correspondence if necessary. Participants' identification data were not recorded during data collection stage of the study. Instead, the gathered data were entered in relevant databases only under unique identification numbers with the motive of protecting the confidentiality and anonymity of the study participants. The collected data were utilized exclusively for this study. All the data would be kept for two years and destroyed thereafter preventing access by unauthorized persons. All paper-based data were kept under lock and key in secured filing cabinet with access only for the investigators and all electronic data were stored in a dedicated computer for this study secured with a password. Since ultrasound scanning during pregnancy is not associated with maternal or fetal morbidity, this study had no harmful effect on the participants. The ethical clearance for conducting this study was obtained from Ethics Review Committee of the Faculty of Medicine, University of Peradeniya, Sri Lanka.

3. Results

The study population consisted of 448 participants. Table 1 describes the distribution of population characteristics in the study sample.

Age of the participants ranged from 18 years to 40 years (Mean 29.09, SD 6.02). The majority were in the 25 to 36 years age group (n = 244, 54.5%) and presenting in their first pregnancy (n = 180, 40.2%). Gestational age at delivery ranged from 261 days to 284 days (Mean 267.98, SD 7.18). Gestational age at

Table 1. Distribution of characteristics of the participants.

Parameter	Mean	SD	Minimum	Maximum
Age (y)	29.09	6.02	18	40
POG-Delivery (days)	276.98	7.18	261	284
POG-USS (days)	274.04	5.97	260	280
Birth weight (g)	2908.25	329.72	2620	4150
Parameter	**Frequency (n)**	**Percentage**	**X^2**	**p value**
Education				
Up to O/L	247	55.1	138.56	<0.05
Completed A/L	157	35.0	df = 2	
Graduated	44	9.8		
Employment				
Employed	138	30.8	66.03	<0.05
Unemployed	310	69.2	df = 1	
Parity				
1	180	40.2	251.64	<0.05
2	158	35.3	df = 4	
3	66	14.7		
4	22	4.9		
5	22	4.9		

(y) = years, (g) = grams, POG = period of gestation, USS = ultrasound scan, SD = standard deviation, X^2 = chi square, df = degrees of freedom, O/L = ordinary Level examination, A/L = Advanced Level examination.

USS for calculation of AFI and SDVP values ranged from 260 days to 280 days (Mean 274.04, SD 5.9). Newborn birth weight varied from 2650 g to 4150 g (Mean 2908, SD = 329.72) and none of them were in the low birth weight (<2500 g) category.

Perinatal outcomes were evaluated initially, and favorable outcomes were significantly higher than their adverse counterparts in a majority (Table 2). 205 deliveries (45.8%) were performed by LSCS (41.1%) or OVD (4.7%). 19 (4.2%) newborns required SCBU admission, and the main indications were respiratory distress, meconium aspiration, fever, convulsions and jaundice. Majority were due to respiratory distress (n = 8).

The mean AFI was 11.35 cm (SD 5.15) and mean SDVP was 4.07 cm (SD 1.88) in the study population (Table 3). AFI of 5 - 10 cm (n = 173, 38.6%) and SDVP of 2 - 4 cm (n = 191, 42.6%) were the most frequent amniotic fluid volumes. AFI and SDVP values showed significant positive correlation with each other (r = 0.954; $p < 0.001$). Both AFI and SDVP values positively correlated with

Table 2. Distribution of perinatal outcomes among participants.

Outcome variable	Frequency (n)	Percentage (%)	X^2	p value
Labour onset				
Spontaneous	240	53.6	2.28	0.131
Induced	208	46.4		
Cardiotocography				
Normal	316	70.5	75.57	<0.05
Abnormal	132	39.5		
Meconium-stained liquor				
Present	63	14.1	231.43	<0.05
Absent	385	85.9		
Mode of delivery				
NVD	243	54.2		
OVD	21	4.7	177.08	<0.05
LSCS	184	41.1		
Apgar score				
<7	17	3.8	382.5	<0.05
≥7	431	96.2		
Birth outcome				
Uncomplicated	421	94.0	474.09	<0.05
SCBU admission	19	4.2		
Perinatal Death	8	1.8		

NVD = Normal Vaginal Delivery, OVD = Operative Vaginal Delivery, LSCS = Lower Segment Caesarean Section, SCBU = Special Care Baby Unit, X^2 = chi square.

Table 3. Distribution of AFI and SDVP values among participants.

Parameter	Mean (cm)	SD	Minimum	Maximum
AFI	11.35	5.15	2.4	26.2
SDVP	4.07	1.88	1.2	9.4
AFI category (cm)	**Number (n)**	**Percentage (%)**		
≤5	35	7.8		
>5 - 10	173	38.6	X^2 = 194.34	
10 - 15	140	31.3	df = 4	
15 - 20	80	17.9	p < 0.001	
>20	20	4.5		

Continued

SDVP category (cm)	Number (n)	Percentage (%)	
<2	17	3.8	
2 - 4	191	42.6	$X^2 = 364.308$
4 - 6	180	40.2	df = 4
6 - 8	40	8.9	$p < 0.001$
>8	20	4.5	

Correlations	Pearson's r	p value
AFI & SDVP	0.954	0.001
AFI & POG at delivery	0.074	0.116
SDVP & POG at delivery	0.043	0.364
AFI & birth weight	0.101	0.033
SDVP & birth weight	0.050	0.290

Pearson's r = Pearson's correlation coefficient, POG = Period Of Gestation, AFI = Amniotic Fluid Index, SDVP = Single Deepest Vertical Pocket.

gestational age at delivery. Birth weight positively correlated with SDVP value (r = 0.05; $p = 0.29$) and showed a significant positive correlation with AFI value (r = 0.101; $p = 0.033$).

An AFI value equal to or less than 5 cm was considered a low AFI value (Table 4). Relative risk was calculated using the low AFI value as the exposure variable. A low AFI value indicated a non-significant risk to have an abnormal intrapartum CTG (RR 1.18, 95% CI 0.728-1.912). A significant percentage of low AFI cases needed labour induction (RR 2.14, 95% CI 1.85 - 2.49). Risk of undergoing an operative delivery (LSCS or OVD) was not significant in the exposure group (RR 1.205, 95% CI 0.873 - 1.664). Low AFI value was not a significant risk factor for meconium - stained liquor in labour (RR 1.017, 95% CI 0.437 - 2.370) or Apgar score less than 7 (RR 1.573, 95% CI 0.375 - 6.604). However, low AFI was a significant risk factor for deviating from an uneventful birth outcome (RR 2.682, 95% CI 1.082 - 6.642).

A SDVP less than 2 was considered as a low SDVP value (Table 5). Relative risk was calculated using the low SDVP value as the exposure variable. A low SDVP value was also a non - significant risk factor for abnormal intrapartum CTG (RR 1.636, 95% CI 0.967 - 2.767). A significant proportion of participants with a low SDVP required induction of labour (RR 1.83, 95% CI 1.434 - 2.334). A significant risk of undergoing an operative delivery was observed in the exposure group (RR 1.714, 95% CI 1.292 - 2.280). Low SDVP was also a significant risk factor for meconium-stained liquor (RR 2.67, 95% CI 1.342 - 5.308) and Apgar score less than 7 (RR17.74, 95% CI 7.96 - 40.924). Low SDVP value was identified as a significant risk factor for not having an uneventful birth outcome (RR 5.76, 95% CI 2.484 - 13.366).

Table 4. Association between perinatal outcomes and the AFI value.

Parameter		AFI category		RR	95% CI
		≤5 cm	>5 cm		
Cardiotocography	Abnormal	12	120	1.18	0.728 - 1.912
	Normal	23	293		
Labour onset	Induction	32	176	2.14	1.85 - 2.49
	Spontaneous	3	237		
Mode of delivery	LSCS/OVD	19	186	1.205	0.873 - 1.664
	NVD	16	227		
Meconium liquor	Yes	5	58	1.017	0.437 - 2.370
	No	30	355		
APGAR score	<7	2	15	1.573	0.375 - 6.604
	≥7	33	398		
Birth outcome	SCBU/Death*	5	22	2.682	1.082 - 6.647
	Uneventful	30	391		

*All perinatal deaths (still births and early neonatal deaths), RR = Relative Risk, CI = Confidence Interval.

Table 5. Association between perinatal outcome and the SDVP value.

Parameter		SDVP category		RR	95% CI
		<2 cm	≥2 cm		
Cardiotocography	Abnormal	8	124	1.636	0.967 - 2.767
	Normal	9	307		
Labour onset	Induction	14	194	1.83	1.434 - 2.334
	Spontaneous	3	237		
Mode of delivery	LSCS/OVD	13	192	1.717	1.292 - 2.280
	NVD	4	239		
Meconium liquor	Yes	6	57	2.67	1.342 - 5.308
	No	11	374		
APGAR score	<7	7	10	17.74	7.96 - 40.924
	≥7	10	421		
Birth outcome	SCBU/Death*	5	22	5.76	2.484 - 3.366
	Uneventful	12	409		

*All perinatal deaths (still births and early neonatal deaths), RR = Relative Risk, CI = Confidence Interval.

The predictive ability of low AFI and SDVP values for adverse perinatal outcomes was evaluated by calculating the likelihood ratios for both techniques (Table 6). Low SDVP value was more favorable than a low AFI value to predict

Table 6. Comparison of likelihood ratios of AFI & SDVP.

Perinatal outcome	Low AFI		Low SDVP	
	LR	p value	LR	p value
CTG abnormality	0.414	0.52	2.47	0.119
Induction of labour	34.8	<0.05	9.73	0.002
Meconium stained liquor	0.002	0.968	5.05	0.025
Operative delivery*	1.107	0.293	6.92	0.008
Apgar score < 7	0.338	0.561	26.51	<0.01
SCBU/Perinatal death	3.428	0.293	9.66	0.002

*Delivery by an operative vaginal delivery or caesarean section, LR = Likelihood Ratio.

intrapartum CTG abnormalities (LR-SDVP > LR-AFI). But both techniques were not predictive to a significant level ($p > 0.05$). However, labour induction could be successfully predicted by both tools ($p < 0.05$) and AFI was more predictive (LR-AFI > LR-SDVP). A low SDVP showed a better predictive ability for meconium-stained liquor and low 5-minute Apgar score (LR-SDVP > LR-AFI; $p < 0.05$). It was also more predictive of requiring operative deliveries and a complicated birth outcome with SCBU admission or perinatal death than a low AFI (LR-SDVP > LR-AFI; $p < 0.05$).

4. Discussion

4.1. Summary of Study Findings

The study population consisted of 448 participants and their mean age was 29.09 years (SD 6.02) and majority was in the 25 to 36 years age group. Mean gestational age at delivery was 267.98 days (SD 7.18). They underwent the USS for calculating AFI and SDVP at a mean gestation of 274.04 days. 46.4% of the population required induction of labour.

Favorable perinatal outcomes were significantly higher than their adverse counterparts in most outcome variables. Intrapartum CTG abnormalities and meconium-stained liquor were noted in 39.5% and 14.1% of the population respectively. 205 (45.8%) Operative deliveries included LSCS (41.1%) and OVD (4.7%) and 54.2% had uncomplicated vaginal deliveries. Mean newborn birth weight was 2908g and them were in the low birth weight (<2500 g) category. A 5-minute Apgar score less than 7 was noted only in 3.8%. 19 (4.2%) newborns needed SCBU admission. 8 (1.8%) perinatal deaths occurred in the study population consisted of 4 still births and 4 neonatal deaths.

The mean AFI was 11.35 cm (SD 5.15) and mean SDVP was 4.07 cm (SD 1.88) in this study. AFI of 5 - 10 cm and SDVP of 2 - 4 cm were the most frequent amniotic fluid volume categories. AFI and SDVP values showed significant positive correlation with each other. Both AFI and SDVP values positively correlated with gestational age at delivery and birth weight. However, AFI value showed

significant positive correlation with the birth weight.

An AFI value equal to or less than 5 cm was considered a low AFI value. The risk to have CTG abnormalities, meconium-stained liquor, operative delivery and Apgar score less than 7 was not significant in the low AFI category. But a significant percentage of low AFI mothers needed labour induction. A low AFI was also a significant risk factor for deviating from an uneventful birth outcome with more risk of SCBU admission and perinatal death.

A SDVP less than 2 was considered as a low SDVP. A low SDVP was also not a significant risk factor for abnormal intrapartum CTG while a significant proportion with a low SDVP required induction of labour and these two observations were comparable with low AFI findings. In contrast, a significant risk of meconium-stained liquor, operative delivery and Apgar score less than 7 was observed in the Low SDVP category. It was also identified as a significant risk factor for a birth outcome complicated by SCBU admission and perinatal death.

The predictive ability of low AFI and SDVP values for the selected adverse perinatal outcomes in this study was evaluated by calculating and comparing the likelihood ratios for both techniques. Although both techniques were not significantly predictive of CTG abnormalities, SDVP was superior to AFI with its higher likelihood ratio. AFI was more predictive of labour induction than SDVP despite both being a significant risk factor for it. However, meconium-stained liquor, operative delivery, low 5-minute Apgar score and a complicated birth outcome with SCBU admission and perinatal death were better predicted by a low SDVP than a low AFI.

4.2. Comparison of Study Findings with Other Studies

7.8% and 3.8% of the pregnancies were identified as having oligohydramnios in this study by AFI and SDVP methods respectively. This was consistent with the systemic review which concluded that significantly more cases of oligohydramnios were identified by AFI [23]. The same finding was applauded by two RCTs as well [18] [24].

Recent RCT in 2016 found that induction of labour was higher in the AFI group which was confirmed in this study as well [24]. This could be attributed to the higher rate of oligohydramnios identified by AFI method. A low SDVP indicated a significant risk for meconium-stained liquor, operative delivery and Apgar score less than 7 and complicated birth outcome with SCBU admission and perinatal death, in this research. These findings were in contrary to those of a RCT in 2004 which failed to identify significant predictability for adverse events or difference in outcomes of AFI and SDVP groups [19]. However, the superiority of SDVP for predicting adverse outcome noted in this study was consistent with the findings of Fisher RL who identified a greater value in SDVP for abnormal perinatal outcomes [21]. But that was conducted through a continuous variable analysis using a ROC curve based alternate cut-off of 2.7 cm.

Most of the recent studies concluded that the SDVP is the preferred option for amniotic fluid volume measurement during fetal surveillance as AFI only in-

creased the diagnosis of oligohydramnios and subsequent inductions without improving perinatal outcome [22] [24]. It was also endorsed by the findings of this study that identified a better predictive ability of SDVP for individual as well as composite perinatal outcomes.

4.3. Implications of the Findings of Study

If adverse perinatal outcomes can be predicted in advance, those pregnant mothers can be promptly directed for specialized care. It helps to minimize the use of infrastructure such as specialized baby care units and operation theatres, conserving a significant amount of human and physical resources. In Sri Lanka, as a country with free health care model, it is vital to utilize resources with proper management and cost-effective strategies. In addition, prior planning can alleviate the psychosocial and economic burden on the patient and the family.

AFI and SDVP measurements can be calculated by a trained operator and is not an invasive or time-consuming procedure. Therefore, feasibility of using this technology is high. USS facilities are available in most hospitals in Sri Lanka where 97% of the child births take place. Therefore, measuring amniotic fluid volume seems a feasible method of predicting adverse perinatal outcomes systematically and cost effectively utilizing available resources.

The paucity of data on the best method of amniotic fluid assessment particularly in local context has been addressed by this study and SDVP technique is superior as a predictor for adverse perinatal outcome than AFI. These findings can be utilized for relevant guidelines and clinical recommendations.

4.4. Suggestions for Further Studies

Both AFI and SDVP values, independent variables used in this study are ratio scale data. They were divided into low and normal categories based on available literature and predictability was assessed by calculating likelihood ratios. These cut-off values should be adjusted to Sri Lankan population accordingly. It is appropriate to calculate the most suitable value having the highest sensitivity and specificity by ROC curve enhancing the validity of the value calculated in future studies.

A more representative study sample may improve the validity of future studies. If a study can be conducted at multicenter, a higher external validity can be anticipated. There are many possible confounding factors which can affect AFI and SDVP value such as parity, maternal age, anatomy and anthropometry. Therefore, methodology should be designed to compare each parameter individually.

Characteristics and correlates of AFI and SDVP values should be studied individually as the study findings strongly depend on them minimizing the effect created by other factors on the study findings. An expert in obstetric ultrasonography should be recruited to measure ultrasound parameters. Measurement bias can be minimized by using the average value of several measurements taken from a single patient by several experts.

5. Limitations

5.1. Factors Affecting the Internal Validity of the Study

In this study, mothers having a gestational age from 37 + 0 weeks to 40 + 4 weeks who underwent USS between 37 + 0 weeks and 40 + 0 weeks were analyzed. It was not practicable to adhere into the concept of taking measurements at a fixed time period before the delivery. Therefore, it was not possible to implement a measurement of uniformity within the study design.

The USS measurements of exposure variables were taken by the principal investigator himself generating the possibility of a measurement bias. There was a possibility of selection bias as well because the principal investigator also got involved in the in-patient clinical management of the participants.

As the ultrasound measurements were taken by the principal investigator who is a postgraduate trainee in Obstetrics and Gynaecology, measurement inaccuracies might be possible. However, training and evaluation of the principal investigator's USS skills was carried out by his supervisor who is a senior Obstetrician prior to data collection stage, which could minimize measurement errors to some extent. In contrast there was no inter-observer measurement variability as the USS was performed by a single operator with a chance of equal distribution of measurement discrepancies.

5.2. Factors Affecting the External Validity of the Study

Representativeness of the study sample is low. Study participants represented several age groups. Although only singleton pregnancies were selected, their parity was different. Restriction or categorization of study participants according to anthropometric differences such as height, weight and BMI was not done. There were minimum opportunities in the study design to focus on the confounding factors and their even distribution which can influence the study outcome. Uniformity of the factors related to the exposure variables among the study participants was extremely low. Consequently, the results were submitted with confounding errors which directly reduces the external validity of the study. However, both exposure variables, AFI and SDVP were measured in all the participants. Therefore, it was possible to assume that individual based confounding factors are equally distributed in both parameters.

Although this study was based on the predictability of two USS tools, comparing them with a gold standard test was not possible due to lack of an available gold standard test. Therefore, applying the study findings directly to general population would be questionable when developing well accepted guidelines and recommendations.

6. Conclusions and Recommendations

6.1. Conclusions

- Amniotic fluid volume assessment by AFI method increases the rate of diagnosis of oligohydramnios and subsequent induction of labour compared to

SDVP method.

- Low SDVP value is identified as a significant predictor of meconium-stained liquor, operative delivery by LSCS or OVD and 5-minute Apgar score less than 7.
- When using amniotic fluid volume to predict adverse perinatal outcomes, a higher potential is noted in SDVP method than AFI technique with a more significant likelihood of a complicated birth outcome with special care baby unit admission and perinatal death shown in low SDVP group.
- Birth weight positively correlates with amniotic fluid volume measured close to delivery having a significant correlation with AFI value.

6.2. Recommendations

- SDVP method appears superior to AFI method for predicting adverse perinatal outcomes and a consensus on considering it as the routine technique for amniotic fluid volume measurement in obstetrics practice is required.
- Feasibility of incorporating prediction of adverse perinatal events by using SDVP and AFI values to obstetric management guidelines should be determined.
- To determine the most predictive cut-off values of SDVP and AFI for each perinatal outcome, an in-depth experimental analysis should be performed.
- It is prudent to pay special attention to the delivery of mothers with low amniotic fluid volume determined by SDVP or AFI.

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Conflicts of Interest

The authors declare no conflicts of interest.

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