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Sonography Assessment of Amniotic Fluid Volume as a Predictor of Fetal Outcome in Low-Risk Pregnancy

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ABSTRACT

Background: An essential component of the amniotic sac, amniotic fluid (AF) aids in the growth of the developing fetus. The volume of amniotic fluid (AFV) can be measured using a variety of methods. **Objective**: To determine which is better in assessment of amniotic fluid volume, amniotic fluid index technique (AFI) or single deepest vertical pocket technique (SDVP) for prediction of fetal outcome in low-risk pregnancies.

Patients and Methods: This work is a randomized comparative trial done at Zagazig University Hospitals on 240 pregnant women. Group (A): (Amniotic fluid index group); 120 women. Group (B): (Single deepest pocket group); 120 women. Ultrasound was used to measure amniotic fluid either by AFI or SDP methods. Cardiotocography (CTG) was used to observe fetus intrapartum and Apgar score was used to assess infant post-partum.

Results: mean AFI was 8.8 cm in group A, mean SDP was 3.8 in group B. There was high statistically significant difference between study groups in amniotic fluid assessment. A group had significantly more oligohydramnios than B group. There was high statistically significant difference between study groups in CTG assessment of oligohydramnios cases. Oligohydramnios cases in A group had significantly more reassuring CTG than oligohydramnios cases in B group. In the A group, the difference between normal and abnormal AF was highly statistically significant.

Conclusion: Oligohydramnios and labour inductions for oligohydramnios were increased by using the AFI method, however perinatal outcomes did not improve. Therefore, the SDP approach is the best way for determining amniotic fluid volume.

Keywords: Amniotic Fluid Volume, Low risk pregnancy, Ultrasonography.

INTRODUCTION

An essential component of the amniotic sac, AF aids in the growth of the developing fetus. The development of the fetal musculoskeletal system and the growth and development of the gastrointestinal tract (GIT) are both aided by the consumption of amniotic fluid, which also serves as a vital source of nutrients for the developing baby. Bacteriostatic characteristics keep the body temperature stable and protect the fetus from harm. It reduces fluid loss from the lungs and aids in the development of the pulmonary system [(1)].

During the second and third trimesters of pregnancy, the volume of amniotic fluid (AFV) grows to 700-850 ml, which equates to an AFI of 14-15 cm[(1)].

Fetal growth may be impeded by irregularities in fluid volume, which may be an indication of an underlying illness, such as fetal hypoxia or neural tube defects. **Sultana *et al.*** first identified oligohydramnios as a condition in which the amniotic fluid index (AFI) is less than or equal to 5 cm[(1)].

According to numerous research findings, oligohydramnios is linked to a number of unfavorable pregnancy outcomes, such as fetal discomfort and an increased risk of caesarean section and low birth weight. Fetal health assessment is a crucial aspect of prenatal and postpartum treatment since it leads to the most appropriate intra and postpartum care[(1)]. Monitoring a pregnant woman's health includes determining the amount of amniotic fluid in her womb. Fetal growth limitation, meconium-stained amniotic fluid, fetal deformity, and stillbirth are all associated with oligohydramnios (a decrease in amniotic fluid) [(2)].

It is possible to measure amniotic fluid using a variety of ways. Biophysical profiles testing uses the amniotic fluid index (AFI) and the single deepest pocket (SDP) approach. Aside from that, there is also a two-pocket approach and a subjective assessment, which are less precise. To assess the health of the fetus, these amniotic fluid volume measurements were made[(2)].

There are a variety of ways to calculate AFV. To diagnose oligohydramnios (a lack of amniotic fluid), the maximum vertical pocket (MVP) method was developed. The deepest amniotic fluid void of cords and limbs is used for this purpose. Oligohydramnios is usually diagnosed if the amniotic sac is less than 2 cm in diameter. The amniotic fluid index (AFI) is calculated by summing the amniotic fluid in each of the four quadrants of the uterus[(3)].

SDP equals or more than 8 cm and AFI equals or more than 25 cm, both of which surpass the 95th percentile of their respective gestational age dependent reference ranges, or the extremely subjective feeling of a polyhydramnios might be used to describe it[(4)].

Since the use of AFI leads to an increase in oligohydramnios diagnoses and a rise in labour induction rates, it appears that the single deepest vertical pocket (SDVP) measurement is a superior alternative for assessing AFV during fetal surveillance. The diagnostic accuracy of both approaches in identifying decreasing amniotic fluid has to be studied in a systematic manner. The use of AFI raises the number of pregnancies treated, although there is no discernible benefit in the outcomes of

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the pregnancy. When it comes to measuring AFV during fetal surveillance, the SDVP measurement appears to be the best option. The recommendation that only one method be utilized for fetal evaluation testing is also rational[3].

The amniotic fluid can be assessed quickly using the SDVP or MVP approach because it is less time intensive. For numerous pregnancies, especially dizygotic ones, it is also the sole quantitative approach available. In comparison to AFI, the AFV assessment by SDP is more accurate and results in fewer caesarean section deliveries, with no increase in morbidity or mortality, according to a large study[3].

It was the goal of this study to determine which is better in assessment of amniotic fluid volume, amniotic fluid index technique (AFI) or single deepest vertical pocket technique (SDVP) for prediction of fetal outcome in low-risk pregnancies.

PATIENTS AND METHODS

At Obstetrics and Gynecology Department of Zagazig University Hospitals, 240 singleton pregnant females in labour (from 37 to 42 weeks) were studied in randomized comparative trials.

They were divided into 2 groups according to the method of assessment of amniotic fluid volume by Randomized Comparative Trial (RCT), cross sectional study. Each group consisted of 120 participants

Ethical considerations:

Zagazig University Hospitals Research Ethics Committee approved the study (ZU-IRB #6045) as long as all participants provided informed consent forms. Ethics guidelines for human experimentation were adhered to by the World Medical Association's Helsinki Declaration.

Inclusion criteria:

- Singleton term pregnancy (GA 37-42 weeks by ultrasonography).
- In active phase of labour, which is characterized by cervical dilatation >3 cm onward with regular uterine contractions with effacement>50% and formation of bag of forewater[5].
- Living fetus.
- Intact membrane (By no history of leakage and proved by no vaginal pooling on insertion of speculum).
- Cephalic presentation.
- No fetal anomalies.

Exclusion criteria:

- Chronic hypertension.
- Diabetes.
- Preterm labour.
- Premature rupture of membranes.
- Preeclampsia.
- Multifetal gestation.
- Umbilical cord prolapsed.
- Antepartum hemorrhage.
- Fetal anomalies.

This is what all of the participants in this research had to go through:

1. **A thorough review of the patient's medical history**, menstrual, obstetric and contraceptive history were taken
2. **Complete general examination.**
3. **Gynecological Examination:**
   Including abdomen, pelvic examination (external genitalia, vagina, cervix, bimanual examination. And abdominal examination: to detect fundal level and was it correlated to gestational age or not, to detect presence of hepatosplenomegaly or not.

Ultrasound assessment: The screening test was applied by using Voluson pro 730 ultrasound machine; its abdominal transducer is 3.75 Mega Hertz with a field of vision 70 degrees.

4. **Biometry of the fetus defined and calculated as follow:**

Biparietal diameter (BPD): Fetal skull cross-section acquired at the level of the thalami. This scanning plane should not include the cerebellum, orbits, or ears. To avoid acynclitism, the falx was placed horizontally and equidistant from both parietal bones (head tilted to one side). Both hemispheres should appear symmetrical to the operator. Anterior to the cavum septum pellucidum, a break in the continuous midline echo represented the falx (CSP). The third ventricle was seen in the middle of the falx through a tiny slit.

At its largest diameter, the falx was measured perpendicularly to the axis of the BPD, which was taken from its outer to inner skull bone.

Fetal length (FL): It is important to prevent any echogenic expansions while measuring the femur horizontally across its osseous diaphysis, which runs through the middle of the bone (seldom seen before the third trimester). Image was captured horizontally (perpendicular to ultrasound beam) so that bone was seen in its entirety and foreshortening was avoided.

Abdominal circumference (AC):

The abdominal circumference was measured along the entire circumference of the skin. To reduce measurement error, it was critical that this section was collected accurately. Sections were checked for correctness by looking at a variety of factors. No visible kidneys, spinal cord insertion, or "J"-shaped portion of the slice were extended anteriorly to the skin line. The section was round, not oval (umbilical vein should not be visible to out to the skin line). The section might be oblique, and the AC might be exaggerated if these properties were incorrect.

Head circumference (HC): As an ellipse around the outside of the skull bones, the HC was measured in the BPD axis. Aside from that, ultrasonography was used to rule out any of the things listed in the exclusion criteria, e.g. pregnancy with multiple fetuses.

5. **AFV of every participant was assessed by two methods, AFI and SDP methods.**

Amniotic fluid Index (AFI) method, (The 4-quadrant method):

An amniotic pocket was measured vertically in each of the four quadrants and the data were summed together. The linea nigra divided the uterus vertically into two equal parts. The top and lower halves of the uterus were separated by an imagined horizontal line through the umbilicus. The transducer was held at a right angle to the patient's abdomen during the measurement. A proper angle was maintained between the transducer and the mother's abdomen. The umbilical cord and the unborn extremities were free from the amniotic fluid pockets being measured. Each quadrant's readings were combined to calculate the amniotic fluid index.

Single deepest vertical pocket (SDP) Method:

First attempted by Chamberlain:

For this type of measurement the uterus was divided into four quadrants. The amniotic fluid volume was measured vertically in the deepest amniotic fluid pocket. Values below 2 cm indicated oligohydramnios and values over 8 cm indicated polyhydramnios. The advantage of this method is its simplicity, making it the most commonly used method in practice. It is also the method of choice in multiple gestation. In cases with multiple gestation, a range of 2–8 cm was defined as normal. With this method, polyhydramnios was classified as mild, moderate or severe. Mild polyhydramnios was characterized by a value of 8–11 cm, moderate polyhydramnios by a value between 12–15 cm and severe polyhydramnios by values above 16 cm [(6)].

6. **D: Intrapartum monitoring by CTG:** CTG was done and any case suffered from fetal distress was undergoing immediate delivery.

Assessment of the newborn after delivery by Apgar score at 1 and 5 minutes was done and poor fetal outcome was defined.

Statistical analysis:

In order to analyze the data acquired, Statistical Package for the Social Sciences (SPSS) version 20 was used to execute it on a computer. The quantitative data were presented in the form of the mean, standard deviation (SD), and range. The qualitative data were presented as frequency and percentage. The student's t test was used to assess the data while dealing with quantitative independent variables. Pearson Chi-Square (X^2) or Fisher's exact test was used to assess qualitatively independent data. The significance of a P value of 0.05 or less was determined.

RESULTS

Table 1: shows that study participants' baseline characteristics did not show any statistically significant differences between study groups. A group refers to AFI group; B group refers to SDP group.

Table (1): Characteristics of the studied patients

Variables	A group (n = 120)	B group (n = 120)	p
Age (years):			
▪ **Mean ± SD**	28.0 ± 5.3	29.0 ± 6.4	0.1
▪ **Range**	18.0 – 39.0	20.0 – 40.0	
Gestational age (weeks):			
▪ **Mean ± SD**	38.5 ± 1.3	38.0 ± 3.4	0.1
▪ **Range**	36.0 – 41.0	36.0 – 41.0	
Gravidity: ***No (%)***			
▪ **Primigravida**	27 (22.5%)	30 (25.0%)	0.6
▪ **Multigravida**	93 (77.5%)	90 (75.0%)	
For Multigravida only	**(n=93)**	**(n=90)**	
Parity: ***No (%)***			
▪ **Nullipara**	17 (18.3%)	16 (17.8%)	1
▪ **Primipara**	16 (17.2%)	15 (16.7%)	
▪ **Multipara**	60 (64.2%)	59 (65.5%)	
Previous abortion: ***No (%)***			
▪ **Yes**	17 (18.3%)	16 (17.8%)	0.9
▪ **No**	76 (81.7%)	74 (82.2%)	

In the measurement of amniotic fluid, there was a marked statistically significant difference between the study groups. In comparison to the B group, the A group had considerably higher oligohydramnios's **(Table 2).**

Table (2): Amniotic fluid assessment of study participants

Amniotic fluid	A group (n = 120)		B group (n = 120)		p
	No.	%	No.	%	
Normal	55	45.8	89	74.2	**>0.001**
Oligohydramnios	63	52.8	31	25.8	
Polyhydramnios	2	1.7	0	0.0	

In the CTG evaluation of oligohydramnios patients, there was a substantial statistical difference between the research groups. Oligohydramnios cases in A group had significantly more reassuring CTG than oligohydramnios cases in B group (**Table 3).**

Table (3): CTG assessment of oligohydramnios cases

CTG	A group (n = 63)		B group (n = 31)		p
	No.	%	No.	%	
Reassuring	42	66.7	2	6.4	**<0.001**
Non-reassuring	21	33.3	29	93.6	

There was high statistical significant difference between normal and abnormal AF in A group. Abnormal AF was associated with non-reassuring CTG, CS, Apgar 5, 7 minutes and fetal incubation. **(Table: 4).**

Table (4): Comparison between normal and abnormal AF in A group

Variables	A group				P
	Normal AF (N=55)		Oligohydramnios (N=63)		
	No.	%	No.	%	
CTG:					
▪ **Reassuring** ▪ **Non-reassuring**	49 6	88.3 11.7	37 26	58.7 41.3	**<0.001**
Mod of delivery:					
▪ **NVD** ▪ **CS**	54 1	98.8 1.2	44 19	69.8 30.2	**<0.001**
▪ **Apgar 1 min < 7**	28	50.9	32	50.8	**0.99**
▪ **Apgar 5 min < 7**	5	3.6	21	38.1	**0.001**
Fetal incubation:					
▪ **Yes** ▪ **No**	5 50	3.6 98.2	21 42	29.2 70.8	**<0.001**

There was high statistical significant difference between normal and abnormal AF in B group. Abnormal AF was associated with non-reassuring CTG, CS and fetal incubation **(Table 5).**

Table (5): Comparison between normal and abnormal AF in B group

Variables	B group				P
	Normal AF (n=89)		Oligohydramnios (n=31)		
	No.	%	No.	%	
CTG:					
▪ **Reassuring**	77	86.3	2	6.4	**<0.001**
▪ **Non-reassuring**	12	13.7	29	93.6	
Mod of delivery:					
▪ **NVD**	83	93.3	6	38.7	**<0.001**
▪ **CS**	6	6.7	25	61.3	
▪ **Apgar 1 min< 7**	51	57.3	20	64.5	0.5
▪ **Apgar 5 min < 7**	21	23.6	15	48.4	**0.009**
Fetal incubation:					
▪ **Yes**	15	16.9	11	35.5	**0.03**
▪ **No**	74	83.1	20	64.5	

There were statistical significant differences between A group and B group in Oligohydramnios case. Oligohydramnios in B group was associated with Non-reassuring CTG and CS **(Table 6)**

Table (6): Comparison between A group and B group in oligohydramnios cases

Variables	Oligohydramnios				P
	A group (N=63)		B group (N=31)		
	No.	%	No.	%	
CTG:					
▪ **Reassuring**	42	66.7	2	6.4	**<0.001**
▪ **Non-reassuring**	21	33.3	29	93.6	
Mod of delivery:					
▪ **NVD**	50	69.8	6	38.7	**<0.001**
▪ **CS**	13	30.2	25	61.3	
▪ **Apgar 1 min < 7**	32	50.8	20	64.5	0.2
▪ **Apgar 5 min < 7**	10	18.2	15	48.4	**<0.001**
Fetal incubation:					
▪ **Yes**	10	18.2	11	35.5	0.03
▪ **No**	53	72.8	20	64.5	

There were no statistical significant differences between A group and B group in normal AF **(Table 7)**.

Table (7): Comparison between A group and B group in normal AF

Variables	Normal AF				P
	A group (N=55)		B group (N=89)		
	No.	%	No.	%	
CTG:					
▪ **Reassuring**	49	91.3	77	86.3	0. 83
▪ **Non-reassuring**	6	8.7	12	13.7	
Mod of delivery:					
▪ **NVD**	54	98.8	83	93.3	0.31
▪ **CS**	1	1.2	6	6.7	
▪ **Apgar 1 min < 7**	28	50.9	51	57.3	0.5
▪ **Apgar 5 min < 7**	5	3.6	21	23.6	**0.03**
Fetal incubation:					
▪ **Yes**	5	3.6	15	16.9	**0.19**
▪ **No**	50	96.4	74	83.1	

DISCUSSION

There are a variety of ways to calculate AFV. To diagnose oligohydramnios (a lack of amniotic fluid), the maximum vertical pocket (MVP) method was developed. The deepest amniotic fluid void of cords and limbs is used for this purpose. Oligohydramnios is usually diagnosed if the amniotic sac is less than 2 cm in diameter. It is also possible to use the amniotic fluid Index (AFI), the four quadrant analysis, which totals the amniotic fluid in each of the four quadrants to determine AFV[3]. Amniotic fluid index equals or lower than 5 cm means oligohydramnios [1]**.** An amniotic fluid volume measurement approach based on dye is not appropriate to evaluate whether the AFI or SDP is superior [7]**.**

The current study showed that the two groups were matched regarding maternal age (18-39 y) with the mean age 28.0 ± 5.3 in A group and (20-40 y) with the mean age 29.0 ± 6.4 in B group with no statistically significant difference between both groups. The mean of gestational age was 38.5 ± 1.3 weeks for A group and 38.0 ± 3.4 in B group with no statistically significant difference between both groups. Regarding past abortion and previous pregnancies, there was no statistically significant difference between the research groups.

This agrees with **Ezem *et al.*** [8]**,** who studied oligohydramnios incidence using the amniotic fluid index (AFI) vs the deepest pocket (DDP) (SDP). According to the findings, 400 pregnant women ranging in age from 16 to 42 were scanned, with a mean age of 27.97 years. Their average gestational age was 29.25 weeks, but the gestational ages in our study ranged from 14 to 41 weeks.

The present study showed that mean AFI in A group was 8.8 cm and the mean SDP in B group was 3.8. The incidence of oligohydramnios in A group was 52.8 and in B group was 25.8. There was high statistical significant difference between study groups regarding amniotic fluid assessment. A group had significantly more oligohydramnios than B group.

This agrees with **Ezem *et al.*** [8]**,** who found that 17 of the women studied had an AFI 5 (oligohydramnios), but only five had SDP 2 cm, an incidence of 1.3 percent. Oligohydramnios was more common in the third trimester, with all 17 cases of AFI less than 5 and all 5 cases of SDP less than 2 cm occurring in this time period (P=0.001). Additionally, the AFI approach detected significantly more incidences of oligohydramnios (63) than the SDP method (31) ($p < 0.001$). To put it another way, in comparison to the SDP, the AFI labelled 3.3% more women as having oligohydramnios than SDP. More interventions, labour inductions, and caesarean sections may arise from this differential in the prevalence of oligohydramnios between AFI and SDP. This may lead to an increase in maternal morbidity without any improvement for the neonatal outcome of the baby.

Induction of labour was performed in 47 women due to a decrease in amniotic fluid volume, in 51 women due to a post-term pregnancy, in nine women due to a non-reassuring fetal cardiotocography, and in two women due to other reasons. Variability in fetal cardiotocography decreased in the context of chronic severe varied and/or late decelerations, indicating non-reassuring cardiotocography [8]**.**

The study of **Nabhan and Abdelmoula** [9]**,** found that MVP measurement in the evaluation of AFV appears to be the best method for monitoring fetal development, which is in accordance with this study. That the AFI approach increases AFV abnormality identification and labour induction frequency without improving peripartum outcomes was their belief. Pregnancy interventions are more common in women who use the AFI method than those who use the MVP approach, which is why many clinicians have advocated to eliminate the AFI method in antenatal testing because it leads to greater rates of pregnancy interventions without any evident advantages[10].

Our results agreed with a study done by **Shah** [11] as one hundred and fifty-four (154) oligohydramnios patients were analysed using SDVP and AFI techniques. A total of (154) oligohydramnios cases that satisfied the inclusion criteria were collected over the course of the three-month study period. Oligohydramnios was 10.4 percent by SDVP method and 18.2 percent by AFI method, respectively. Only 23 patients (29.9 percent) of those in the B group and 25 patients (32.5%) of those in the A group experienced induction of labour each (P-value = 0 .728).

Regarding Apgar score, this study showed also high statistical significant difference between study groups in Apgar assessment of oligohydramnios cases. Oligohydramnios cases in A group had significantly better Apgar scoring (18.2% < 7) than oligohydramnios cases in B group (48.4% < 7). There was high statistical significant difference between study groups in fetal outcome assessment of oligohydramnios cases. Oligohydramnios cases in A group had significantly better outcome (18.2% incubation) than oligohydramnios cases in B group (35.5% incubation). Meanwhile there was no statistical significant difference between study groups in CTG, Apgar score and incubation assessment of normal cases.

In contrast to our study, a study done by **Kehl *et al.*** [12] using the single deepest vertical pocket or amniotic fluid index test for predicting unfavorable pregnancy outcomes. The A group was more likely than the B group to have an abnormal

CTG. (32.3% (*n* = 161) *vs* 26.2% (*n* = 132) (RR, 1.23 (95% CI, 1.02–1.50); *P* = 0.03). Only in high-risk pregnancies did the AFI group have a lower arterial pH than the SDP group (7.25} 0.08 *vs* 7.28} 0.07; *P* = 0.01). There was no difference between the A and B groups in terms of the major end measure, postpartum admission to the NICU (*P* = 0.86). The vast majority of the study's results were unaffected by either of these two variables. Nonetheless, the method of measurement had an impact on a few people: oligohydramnios (*P* < 0.01) and oligohydramnios induction of labour (*P* < 0.01) with higher rate in group A high-risk pregnancies were more likely to necessitate a labour induction than low-risk ones (*P* < 0.01). These results differs from our results may be due to large sample and it was done in multicenters.

CONCLUSION

There isn't a single way to consistently gauge AFV across different applications. Oligohydramnios diagnosis and labour induction were raised by the use of the AFI method, however the perinatal outcomes did not improve. Amniotic fluid volume can be estimated using the SDP method. Clinics employ the MVP technique while others use the AFI method to treat patients. Based on the facts presented above, it appears that the MVP method is the best way to evaluate AFV.

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