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Original Research Article

Amniotic fluid index as indicator for pregnancy outcome in late third trimester

Anamika Majumdar[1], Kallol Mallick[2], Ritwika Majumdar[3], Priyanka Patel[1]*

[1]Department of Obstetrics and Gynaecology, [2]Department of Community Medicine, SMIMER, Surat, Gujarat, India
[3]Department of Medicine, R. G. Kar Medical College, Kolkata, West Bengal, India

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***Correspondence:**
Dr. Priyanka Patel,
E-mail: anamikakallol@yahoo.com

ABSTRACT

Background: Amniotic fluid index is one of the major predictors of pregnancy outcome. Less AFI indicate growth restriction and renal anomalies of fetus, whereas more may indicate fetal GI anomalies, maternal diabetes mellitus, and so forth. Objectives were to establish reference standards for AFI for local population after 34 weeks of pregnancy and to decide an optimal scan interval for AFI estimation in third trimester in low-risk antenatal women.
Methods: A prospective estimation of AFI was done in 83 healthy low risk pregnant women from 34 to 40 weeks at weekly intervals. The trend of amniotic fluid volume was studied with advancing gestational age. Statistical analysis was done using SPSS software (Version 16, Chicago, IL). Percentile curves (5th, 50th, and 95th centiles) were constructed for comparison with other studies. Cohen's d coefficient was used to examine the magnitude of change at different time intervals.
Results: Starting from 34 weeks till 40 weeks, 83 ultrasound measurements were available. The mean (standard deviation) of AFI values (in cms) were 34W:14.59(1.79), 35W: 14.25 (1.57), 36W: 13.17 (1.56), 37W: 12.48 (1.52), 38W: 12.2 (1.7), and 39W: 11.37 (1.71). The5th percentile cut-off was 8.7 cm at 40 weeks. There was a gradual decline of AFI values as the gestational age approached term. Significant drop in AFI was noted at two-week intervals.
Conclusions: Appreciable changes occurred in AFI values as gestation advanced by two weeks. Hence, it is recommended to follow up low risk antenatal women every two weeks after 34 weeks of pregnancy.

Keywords: Amniotic fluid index, Ultrasound image segmentation, Deep learning

INTRODUCTION

Maternal perception of decreased fetal movements is a cause of concern and common reason for visits to the antenatal clinic or delivery room. Several studies have shown that a reduction or cessation of Fetal Movements (FM) may result in poor pregnancy outcome and magnified increased risks of serious perinatal morbidity and mortality. Decreased fetal movement (DFM) is associated with placental pathologies and a range of adverse pregnancy outcomes, including fetal growth restriction and death. If DFM is recognized early and managed appropriately, adverse outcomes may thus be prevented. Due to placental oxygen insufficiency, fetus tries to conserve energy is the reason for decreased fetal movements. Morris et al conducted a prospective observational study to determine the usefulness of ultrasound assessment of amniotic fluid in predicting adverse outcome in prolonged pregnancy and concluded that AFI is superior to a measure of single deepest pocket but routine use is likely to lead to increased obstetric intervention without improvement in perinatal outcomes.[1] Chauhan et al conducted a randomized clinical trial to

determine the superior technique of either of the amniotic fluid index (AFI) versus the Single deepest pocket technique in predicting pregnancy outcome among high-risk patients, and concluded that during antepartum fetal surveillance, use of single deepest pocket compared with AFI is associated with significantly lower rate of suspected oligohydramnios.[2] The goal of antepartum surveillance is to improve perinatal outcome and to decrease intrauterine fetal demise besides prevention of maternal morbidity and mortality.[3,4] Fetus distress is identified at the earliest so that timely delivery will not only salvage the fetus but also prevent long term neurological impairments such as injury to fetal central nervous system.[5] Amniotic fluid assessment by ultrasound is one of the important tools in assessing the fetal health in all risk categories especially beyond the period of viability.[6] Though there are several ways to assess quantity of amniotic fluid ranging from clinical palpation to measurement of single deepest vertical pocket, amniotic fluid index (AFI) by four-quadrant technique as described by Phelan et al in 1987 and among them AFI is popular and reliable method of quantifying amniotic fluid till today.[7-9] AFI is one of the essential components of fetal biophysical profile (BPP) and its values correlate well with adequacy of fetal renal perfusion. Normally it peaks at 32 to 34 weeks of gestation and thereafter there is a gradual reduction in amniotic fluid due to increase in concentrating capacity of fetal kidneys.[10]

However, a drastic reduction in its quantity may indicate underlying placental insufficiency, which has definite implications on growing fetus. The values between 8 and 25 are considered to be normal, 5-8 low normal, and less than 5 oligoamnios.[11] At values less than 5, there is higher incidence of perinatal morbidity and mortality and many a time immediate delivery is the only way out.[12,13] Hence it is very important to scan the patient to note such a trend periodically during antenatal visits. AFI is the fifth parameter in traditional five-point biophysical profile and second parameter in rapid two-point modified BPP (the other one being NST).[14] Though there is no definite said protocol for identifying compromised fetus, many believe that biweekly nonstress test and AFI assessment should be offered to all women at risk.[15]

Aims and objectives

Aim and objectives of current study were to; study the changes in AFI on weekly basis from 34 weeks till delivery; to admit the reference ranges of AFI from 34 to 40 weeks of gestation and to find the time interval by which there is a significant fall in AFI, which will help obstetrician to plan an ideal protocol for antenatal ultrasound examination in the third trimester.

METHODS

This was a prospective observational study conducted at the Department of Obstetrics and Gynaecology, SMIMER Medical College, Surat, from January 2020 to June 2021. Institutional ethical committee approval was obtained prior to study. Inclusion criteria were low risk singleton pregnancy, pregnant women Gestational age more than 34 weeks with complain of decreased fetal movement, women who will give consent for it. Once initial criteria were met, those who were subsequently diagnosed to have abnormalities of liquor volume due to conditions such as hypertensive disorders, gestational diabetes, placental insufficiency pregnancy less than 34 weeks of gestation, diagnosed IUFD, congenital malformation were, women with multiple pregnancies, patients who refuse to give consent excluded from the study, so as to obtain normative data. Only those patients who delivered at 40 weeks were included in the study as we wanted longitudinal data till term. The final study subjects were 83 low risk pregnant women who underwent serial scans at weekly interval starting from 34 weeks till term. The ultrasound examination was carried out after instructing the patient to empty her bladder. The examinations were performed with a convex 3.5 MHz probe ultrasound equipment. The patient was asked to lie down in supine position. Uterus was arbitrarily divided into four quadrants using linea nigra as a vertical line and a transverse line passing through umbilicus, as described by Phelan et al. [9]. The transducer was placed in each of these quadrants in sagittal plane perpendicular to patient's abdomen and maximum depth of amniotic fluid was calculated in centimeters excluding the cord loops and small fetal parts. Caution was exercised to avoid excessive pressure on the transducer as it can alter AFI measurements. The values of all four quadrants were added to obtain the final amniotic fluid index (AFI). Sample Size Estimated using the refrence of Khadilkar et al who conducted a prospective, cross-sectional study in low-risk healthy pregnant subjects to obtain a gestational reference range for AFI among Indian women.[16] They noted that the mean and standard deviation of AFI (cm) at 34 weeks of gestation was 14.2 and 2.4, respectively. We hypothesised that a difference of 1.5 cm in the mean AFI would be significantly different from the normal values and accordingly estimated sample size to show a desired level of power of 90% and level of significance 0.05, by using the formula:

$$N = [(z\alpha + z\beta)\sigma]/(\mu 1 - \mu 0)]^2$$

where $z\alpha$=1.96 (critical value that divides the central 95% of z distribution from 5% in the tails), $z\beta$=1.28 (critical value that separates the lower 10% of distribution from upper 90%), σ=standard deviation, and $\mu 1-\mu 0$=difference of two means. Accordingly, it was estimated that 27 patients are required and we decided to recruit 83 patients to have satisfactory results.

Statistical analysis

Data was analyzed using SPSS version 16 for windows (SPSS Inc., Chicago, IL, USA). Descriptive analysis was performed to obtain mean, standard deviation, and percentile values for AFI from 34 to 40 weeks. Microsoft Excel 2010 was used to plot percentile values (5th, 50th, and 95th) across various gestational ages. A polynomial

regression analysis of 3rd order was used to find the best fit. The decline in AFI value was calculated at weekly interval and the magnitude of change was analyzed by effect size estimation (Cohen d coefficient) [17]. The formula for Cohen's d is given as follows:

$$d = \frac{M_1 - M_2}{\sqrt{(s_1^2 + s_2^2)/2}},$$

Where $M1$ and $M2$ are the means and $s1$ and $s2$ are the standard deviations of two groups.

RESULTS

Out of the 80 (50) patients were recruited for the study and they were between 22 years to 28 years, more than half (51 patients, 64%) were primigravidae and 19 (36%) were multigravida. None of them had any antenatal complications. 25 (32%) patients required caesarean delivery for obstetric indication such as failed induction, cephalopelvic disproportion, and fetal distress in labour. The mean (standard deviation) birth weight of the neonates (measured in kg) was 2.83 (0.34), with 1st minute APGAR score (mean and standard deviation) of 8.48 (1.09) and 5th minute APGAR was 8.72 (1.01).

Table 1: AFI values from 34 to 40 weeks; mean, standard deviation, and percentile values (centimetres).

Gestational age (weeks)	Mean	Standard deviation	5th percentile	50th percentile	95th percentile
34	14.59	1.79	11.7	14.6	17.3
35	14.25	1.57	11.1	14.2	16.4
36	13.17	1.56	10.6	13.2	15.7
37	12.48	1.52	10.1	12.6	15.1
38	12.20	1.70	9.8	12.1	14.7
39	11.37	1.71	8.8	11.4	14.4
40	10.99	1.55	8.7	10.8	13.7

Table 2: Mean change in AFI (cm) values at different intervals.

Intervals (weeks)	35 weeks	36 weeks	37 weeks	38 weeks	39 weeks	40 weeks
34	0.34	1.42	2.12	2.39	3.22	3.61
35	*	1.08	1.77	2.05	2.88	3.26
36	*	*	0.7	0.97	1.8	2.19
37	*	*	*	0.27	1.1	1.49
38	*	*	*	*	0.83	1.22
39	*	*	*	*	*	0.39

Table 3: Cohen d coefficients of effect size at different intervals.

Intervals (weeks)	35 weeks	36 weeks	37 weeks	38 weeks	39 weeks	40 weeks
34	0.21	0.85	1.29	1.38	1.86	2.18
35	*	0.7	1.16	1.27	1.77	2.12
36	*	*	0.46	0.6	1.1	1.42
37	*	*	*	0.17	0.69	0.98
38	*	*	*	*	0.49	0.76
39	*	*	*	*	*	0.24

0.2-0.49 small effect, 0.5-0.8 medium effect, and >0.8 large effect.

As mentioned in methodology, we have excluded those who delivered before term as we required AFI from 34 weeks to 40 weeks of gestation for analysis purpose. The (Table 1) shows the descriptive data for AFI. The AFI values differed through the gestational age and there was a gradual decline in the values as pregnancy advanced. The 5th, 50th, and 95th percentiles ranged from 11.7, 14.6, and 17.3, respectively, at 34 weeks to 8.7, 10.8, and 13.7, respectively, at 40 weeks. The values were within 8 to 25 cm range (which is accepted and established normal range for AFI values worldwide). The maximum value of AFI was 17.6 cm and minimum 8.5 cm in our series of low-risk antenatal pregnant women. If minimum (5th centile) and maximum (95th centile) are considered as normal range, it was noted that the corresponding values too were different at different gestational ages; the more advanced the gestational age, the lesser the values. These changes are graphically represented in (Figure 1). We used difference in mean values of one week to the next week to evaluate the decreasing trend of amniotic fluid from 34 to 40 weeks of gestation (Table2). Dark shaded area indicates cells where the calculations are not required as they are the same weeks or previous weeks. In many cells have the values less than1, but still the difference may be calculated statistically significant if ordinary statistical tests such as paired t test were applied and hence, we have used Cohen's

test which very well detects the magnitude of change. The (Table 3) indicates Cohen's d values for week-to-week comparison can be seen, that not much change was seen in immediate week, but changes became significant when the interval between two scans was more than 2 weeks or more in most of the comparisons. Hence from this table there is substantial evidence that liquor volume decreases significantly over the period of 14 days more in low-risk antenatal women.

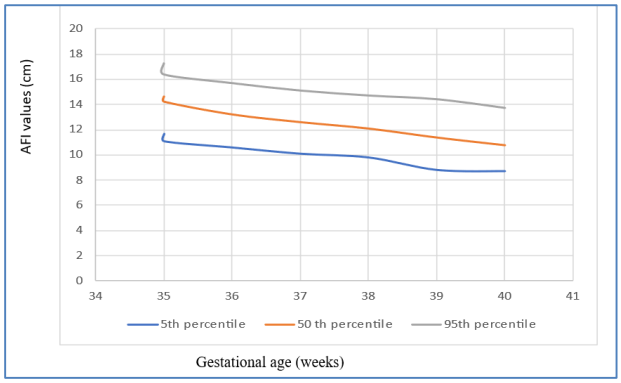

Figure 1: AFI centiles at various gestational ages.

DISCUSSION

Amniotic fluid volume gradually increases still 32-34 weeks of gestation and thereafter a gradual reduction till term.[18,19] The critical AFI range of 8 to 25 cm signifies fetal wellbeing and the deviation from this range is associated with increase in fetal and maternal complications due to oligoamnios and polyhydramnios. The third trimester AFI values are proportionate to fetal urine production and hence in normal range indicate good placental perfusion and fetal nutrient and oxygen transfer. Hence monitoring the AFI has become a standard of antenatal care.[20,21] The majority of the studies agree that from 34 weeks onward there is a gradual fall in AFI values. The two studies are from India, had reported wide range of AFI values.[16,22] This may be because their observations were based upon retrospective cross-sectional data. The AFI reference values published by Singh et al are 2 to 3 cm more than all other series at all gestational ages; this may be because the study was done in Indraprastha Apollo Hospital, New Delhi, where patients were from very high socioeconomic status. Khadilkar et al reported their findings from patients attending antenatal clinic of Grant Medical College, Bombay, and were matched with their data. Hence, it can be opined that AFI standards have to be defined for specific populations in order to eliminate bias resulting from socioeconomic groups, geographical locations, race, and so forth. However, it must be noted that almost all authors have reported a steady decline in AFI values with the advancing gestational age, except Birang et al. from Iran. Their series included retrospective cross-sectional data and the number differed from minimum of 12 observations at 35 weeks to maximum of 68 observations at 39 weeks. This might be the reason for their finding of rapid fall of AFI from 34 to 35 weeks, plateauing between 37 and 39 weeks and once again slow fall at 40 weeks. Such observations indicate weakness of cross-sectional cohort, as the same patients are not followed up sequentially. Amniotic fluid should be observed with approximate turn over time of twenty-four hours. In high-risk pregnancies complicated by chronic placental insufficiency liquor is known to drastically reduce in a shorter time and it has been recommended to perform AFI estimation once in three days or at times even frequently depending upon other fetal well-being. Surveillance tools such as Doppler assessment of fetal circulation. However, there is no universal consensus regarding the frequency of AFI estimation in low-risk antenatal women. Hence, it is important to determine a critical interval at which the fall in AFI becomes clinically significant. In our study 13.28% underwent LSCS for obstetrics indications. In this study we have not used statistical significance test (involving estimation of p value) such as paired t test for comparing AFI values at different gestational ages, as these tests tend to give significant p values even when a minor variation exists in the means of two groups. When sample size is sufficiently large, even the fractional differences are likely to be reported as significant p values, hence giving meaningless interpretations. Instead, we have calculated effect size estimate (Cohen d) to quantify the changes in the AFI over a period of time.

Effect size is a simple measure for quantifying the difference between two groups or the same group over time, on a common scale. There are several methods mentioned in the literature to calculate the effect sizes; Cohen et al, Rosnow et al,' Partial et al and Richard et al and so forth. However, we have used Cohen's d estimate as described by Cohen, to calculate effect sizes as this method is easy, simple to understand and can be applied to any measured out come in scientific study.[20-23] In this study we have found by statistical analysis that there is no much decrease in AFI at interval of one week, but there after the differences become large and significant. When the liquor is within normal range, the chances of fetal jeopardy are unlikely to occur within next week; so, it is safe to repeat the AFI after 2 weeks. Time being of estimation of AFI, one can also perform other tests for foetal well-being such as documentation of gross foetal body movements, foetal tone, and foetal breathing movements to be assured that foetus is not hypoxic. In the absence of any maternal or fetal risk factors, we are of the opinion that AFI estimation once in fortnight is good enough to ensure satisfactory pregnancy outcome.

CONCLUSION

In this study we have established specific normative AFI reference standards for late third trimester (34 to 40 weeks) and also magnitude of change in AFI values at weekly interval by quantitative analysis using effect size statistics. Strength of present study is based on longitudinal data of normal healthy pregnant women and percentile curves obtained can be used to normal range of AFI for low-risk

antenatal patients. Our results are based on required number of patients by sample size determination, larger number of subjects if studied may yield robust reference curves for AFI and identify extreme values to define what constitutes oligo- or polyhy dramnios. The same study can be extended to high-risk pregnancies such as preeclampsia, chronic hypertension, multiple gestation, and intrauterine growth restriction, in order to determine the frequency of liquor testing for these cohorts.

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REFERENCES

1. Morris JM, Thompson K, Smithey J, Gaffney G. The usefulness of ultrasound assessment of amniotic fluid in predicting adverse outcome in prolonged pregnancy. Br J Obst Gynaecol. 2003;110:989-94.
2. Chauhan SP, Doherty DA, Magann F. Amniotic fluid index versus single deepest pocket technique during modified biophysical profile. A randomized clinical trial. Am J Obstet Gynaecol. 2004;191:661-8.
3. Yeo L, Ross MG, Vintzileo AM. Antepartum and intra-partum surveillance of the foetus and the amniotic fluid. Clin Obstet Fetus Mother. 2008;3:586-606.
4. Liston R, Sawchuck D, Young D. Fetal health surveillance: antepartum and intrapartum consensus guideline. J Obstet Gynaecol Canada. 2007;29:56.
5. Baschat AA, Viscardi RM, Hussey GB, Hashmi N, Harman C. Infant neurodevelopment following fetal growth restriction: Relationship with antepartum surveillance parameters. Ultrasound Obstet Gynaecol. 2009;33:44-50.
6. Nash P. Amniotic fluid index. Neonat Net. 2013; 32:46-9.
7. Dubil EA. Amniotic fluid as a vital sign for fetal wellbeing. Austral J Ultrasound Med. 2013;16(2):62-70.
8. Nabhan AF, Abdelmoula YA. Amniotic fluid index versus single deepest vertical pocket as a screening test for preventing adverse pregnancy outcome. Cochrane Database Syst Rev. 2008;3:65-93.
9. Phelan JP, Ahn MO, Smith CV, Rutherford SE, Anderson E. Amniotic fluid index measurements during pregnancy. J Reprod Med. 1987;32(8):601-4.
10. Beall MH, van den Wijngaard JP, van Gemert MJ, Ross MG. Amniotic fluid water dynamics. Placenta. 2007;28(8-9):816-23.
11. Broussard P, Phelan JP, Smith CV, Small M. Amniotic fluid volume assessment with the four-quadrant technique at 36-42 weeks' gestation. J Reprod Med. 1987;32(7):540-2.
12. Iqbal S, Noreen A. Low amniotic fluid index as a predictor of perinatal outcome in low-risk pregnancies at term. Pakistan J Med Health Sci. 2010;4(3):270-1.
13. Voxman EG, Tran S, Wing DA. Low amniotic fluid index as a predictor of adverse perinatal outcome. J Perinatol. 2002;22(4):282-5.
14. Lalor JG, Fawole B, Alfirevic Z, Devane D. Biophysical profile for fetal assessment in high-risk pregnancies. Cochrane Database Syst Rev. 2008.
15. Signore C, Freeman RK, Spong CY. Antenatal testing-a revaluation: executive summary of a Eunice Kennedy Shriver National Institute of Child Health and Human Development workshop. Obstet Gynaecol. 2009; 113(3):687-701.
16. Khadilkar SS, Desai SS, Tayade SM, Purandare CN. Amniotic fluid index in normal pregnancy: an assessment of gestation specific reference values among Indian women. J Obstet Gynaecol Res. 2003; 29(3): 136-41.
17. Cohen J. Statistical Power Analysis for the Behavioural Sciences. USA: Hillsdale; 1988.
18. Brace RA, Wolf EJ. Normal amniotic fluid volume changes throughout pregnancy. Am J Obstet Gynaecol. 1989;161(2):382-8.
19. Moore JT, Cayle RE. The amniotic fluid index in normal human pregnancy. Am J Obstet Gynaecol. 1990;162(5):1168-73.
20. Magann EF, Sandlin AT, Ounpraseuth ST. Amniotic fluid and the clinical relevance of the monographically estimated amniotic fluid volume: oligohydramnios. J Ultrasound Med. 2011;30(11):1573-85.
21. Lee SM, Park SK, Shim SS, Jun JK, Park JS, Syn HC. Measurement of fetal urine production by three-dimensional ultrasonography in normal pregnancy. Ultrasound Obstetr Gynaecol. 2007;30(3):281-6.
22. Singh C, Tayal T, Gupta R, Sharma AP, Khurana D, Kaul A. Amniotic fluid index in healthy pregnancy in an Indian population. Int J Gynaecol Obstet. 2013; 121(2):176-7.
23. Rosenthal R, Rosnow RL. Essentials of Behavioural Research: Methods and Data Analysis. 2nd ed. USA: McGraw Hill; 1991.
24. Richardson JTE. Eta squared and partial eta squared as measures of effect size in educational research. Edu Res Rev. 2011;6(2):135-47.

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