Sonographic Assessment of Normal Amniotic Fluid Volume in Pregnant Nigerian Women

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Abstract
Objective: To re-investigate the relationship between amniotic fluid volume (AFV) and gestational age (GA) and produce a normogram for the locality. This study will in addition establish borderline values of AFV as a guide in the determination of abnormal values of amniotic fluid (AF).
Methods: The AFV was measured sonographically in a prospective study of 500 women who had singleton, uncomplicated pregnancies and no maternal diabetes mellitus or co-existing intrauterine mass.
Measurements were taken from 16 weeks to 40 weeks of GA and converted to percentile values. Mean values at 50th percentile were compared with Caucasian values using one tailed t-test for any differences.
Results: Amniotic fluid volume increases from 16weeks to 27 weeks with AFI values of 6.2cm 21. 4 cm. Maximum values of AFI were achieved at 29 weeks (12.3cm 21.4cm). Thereafter from 31 weeks 40 weeks AFI values declined from 21-3cm 8.5cm. The relationship between AFI and GA is described by a parabolic equation: AFI = -258.99 + 29. 68GA 0.50GA. Borderline values of AFI established are 6.0cm 7.62cm at the lower limit and 21.4cm 21. 8cm at the upper limit
Conclusion: A normogram of AFV across the GAs has been produced for this locality and the values are lower than those for the Caucasians. The borderline values of AFI for the lower limit are 6.0cm 7.6cm while the upper limit of normal range is from 21.4cm 21.8cm. Critical values of AFI have been set by this study; below 6.0cm denoting oligohydraminous and above 21.8cm denoting polyhyraminous
Key Words: Sonography, Amniotic Fluid Volume, Gestational Age

Introduction
Ante partum assessment of AF is a vital biophysical parameter for evaluating foetal well-being. The amount of fluid within the pregnant uterus varies with the rate at which amniotic fluid is produced and removed. What may be normal for one stage of pregnancy may be abnormal for another stage[1].

Certain foetal anomalies present with abnormal volumes of AF. These abnormalities may manifest as increased or decreased amounts of AFV. Correlating the accurate volume of AFV with menstrual age is important in evaluating these abnormalities and assessing foetal well-being.Literature is however not quite clear on the relationship between AFV and GA[2]

Presently, normograms used for the assessment of adequacy or otherwise of AFV in the locality is based on Caucasian values and there is no normogram specific to the locality. This study therefore is aimed at re-investigating the relationship between AFV and GA and produce a normogram specific to a Nigerian population.

Patients and Methods
The AFI was measured sonographically in a prospective study of 500 pregnant women drawn from a total of 1258 patients who were referred for obstetric scan at Bishop Shanaham Hospital, Nsukka, between July 2004 to December, 2005.

Subjects were excluded if

gestational age was less than 16 weeks or greater than 40 weeks.

patients had conditions such as pre-eclampsia, maternal diabetes mellitus or complications of pregnancy

there is multiple gestation, co-existing mass or bulky placenta

there is a subjective impression of polyhydraminos or oligohydraminos or

ultrasound estimated GA differs by more than two weeks from menstrual age

there is any sonographically detectable foetal abnormality

AFV was obtained from antero-posterior measurements of AF in the quadrants of the uterus. With the subject in a supine position and adopting a longitudinal scan, the uterus is divided into four quadrants using the linear niagra and a horizontal line at the level of the maternal umbilicus. The largest presence of clear fluid, free of umbilical cord and foetal parts in each of the four quadrants of the uterus were identified and measured in the antero-posterior dimension according to Phelan et al[3]. The values were

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added to give the AFI. The AFI was thus used as a measure of AFI. The GA of the foetus was determined using the standard obstetric menu charts of biparietal diameter (BPD) and femoral length (FL) according to Hardlock et al[4] and Warda et al[5] respectively.

A minimum of 9 subjects and a maximum of 18 subjects were enlisted for each GA.

AFI values were transformed to 3rd, 5th, 50th, 95th and 97th percentiles according to Nwabuokei[6] method and graphs of AFI plotted against GA. The mean for each GA was calculated at the 50th percentile. The borderline values were established as the values between 3rd and 5th percentile for the lower limit and 95th and 97th percentiles for the upper limit. One tailed t-test compared any difference between the mean values of AFI of our results and corresponding values for Caucasians.

Results

Table 1 presents the mean values of normal AFI across the GA and corresponding Caucasian values. The percentile transformation of the AFI values including the borderline values are shown in Table 2. The results show that AFV increases from 16 weeks - 27 weeks with AFI values of 6.2cm 21.5cm. Maximum values of AFI are achieved at 29 weeks with values of 21.5cm 21.8cm and thereafter AFI values decline from 31 weeks 40 weeks with values of 21.3cm 8.5cm. The relationship between AFI and GA from the study is described by a parabolic equation AFI = -258.99 + 29.68GA 0.50GA^2 at the 50th percentile. The borderline values in the lower limit increases from 6.0cm 6.1cm at 16 weeks to 11.9cm 12.2cm at 29 weeks and decreases from 12.1cm 11.8cm at 30 weeks to 8.4cm 8.2 cm at 40 weeks.

In the upper limit, these values increase from 11.6cm - 11.7cm at 16 weeks to 21.5cm 21. 8cm at 29 weeks and thereafter decrease from 21.5cm 21.4 at 31 weeks to 15.6 cm 15.3cm at 40 weeks. Fig 1 shows the graphical representation of AFI percentiles plotted against GA.

Discussion

Normal AFV in pregnancy is one of the parameters used as an indicator of foetal well-being[7]. The availability of quantitative normal values of AFV is beneficial in eliminating the error of subjectivity in documenting AFV as normal, reduced or increased. By quantitatively stating AFV, deviations from normal values can easily be identified and serve as a guide in selecting pregnancies that require amnioninfusion for severe oligohydramious[8] or amnioreduction for severe polyhydraminos[9]

The results of this study show that AFI varies from one trimester to another increasing from 16 weeks 27 weeks, reaches maximum values at 29 weeks and thereafter declines from 31 weeks 40 weeks. This pattern is in agreement with previous studies[10,11,12]. In the second and third trimesters of pregnancy, urine production constitutes greater part of the AF and Kurjak et al[13]; Brace and Wolf[14,] demonstrated a steady increase in foetal urine production throughout the later half of gestation with a tendency to decrease after 40 weeks. The result of this present study is consistent with the trend documented for the normal biological and physiological processes during pregnancy. Our study shows that the ranges of normal AFV for the locality are 6.2 cm - 21.4 cm from 16 weeks 27 weeks and 12.3cm 21. 4cm at 29 weeks. From 31 weeks 40 weeks, being the values bound by 5th 95th percentiles the range is from 21.3cm -8.5cm. The mean AFI calculated at the 50th percentile range from 7.6cm - 17.4cm at 16 weeks 29 weeks and 17.1 cm 11.5cm at 30 weeks 40 weeks. Our results compared with 9.9cm 19cm at 16-30 weeks and 18.9 14. cm at 31 weeks 40weeks for the Caucasian population by Nwosu et al[11], are significantly lower ($p< 0.05$). The values of AFI from this study also differ from those of Moore and Cayle[10], who had 12.1 14.7cm at 16 weeks 27weeks and 14.6cm 12.3 cm at 2 weeks 40 weeks. Seeds[15] demonstrated that the production and regulation of AF is a dynamic process involving the foetus and the mother. The effect of climatic differences on the production of urine[16] may account for the differences observed in the different population groups. The findings of Sciscione et al[17,] on the effect of ambient temperature on AFI apparently corroborate our result. However, the effect of the non-serial scan of the subjects as adopted in this study on the results, different from the serial scan used by Nwosu et al[11] needs to be ascertained. The use of non-serial scan is however justified because the practice of regular sonographic monitor of pregnancy is yet to be adopted in the locality due to cost and other logistics.

The values obtained from this study can serve as a preliminary normogram for quantitatively assessing AFV across the GA in this locality. However, it is important to recognize that due to the number of subjects scanned for each GA (16-29 subjects)that is considered small, slight variations may occur at higher frequencies. It may be necessary to investigate whether these values would change if the number of subjects is increased for each GA. The use of the nomogram produced from this study in the assessment of AFI across the gestation ages would give more reliable results than would be obtained with the Caucasian based values currently in use.

This study has produced values of borderline AFI for the lower and upper limit across the GA using 3rd 5th and 95th 97th percentiles respectively. The chart would be useful in identifying cases of oligohydraminos and

polyhydraminos in the locality. For example AFI values between 21.4cm 21.8cm at 27 weeks 31 weeks are in the upper limit of normal and thus values greater than 21.8cm would obviously cases of poly hydraminos

A preliminary normogram of AFV throughout the gestational period in a Nigerian population has been provided by this study. The values are significantly lower than those for Caucasians, possibly, due to climatic factors. The borderline values obtained for the lower limit are 6.0cm 7.6cm and for the upper limit of normal are from 21. 4cm 21.8cm. These will serve as guide for identification of abnormal values of AFV in the locality.

Table 1 Comparative Values of Afi of Nigerian Women and those of Caucasian

G A (Weeks)	No. of Patients	Range of AFI values (cm)		Mean AFI values (cm) at 50 th Per centile	Caucasian Values (cm) Nwosu et al,10)
16	28	6.0	11.8	7.6	9.9
17	16	6.8	11.5	9.7	11.1
18	16	7.6	17.3	11.2	12.3
19	16	8.4	15.4	12.5	13.3
20	16	8.4	15.7	13.4	14.3
21	20	8.8	18.7	14.3	15.2
22	20	9.2	18.7	15.1	16.0
23	20	10.5	18.8	15.8	16.4
24	18	10.3	20.0	16.3	17.3
25	20	11.2	20.7	16.7	17.8
26	21	11.0	19.5	17.0	18.2
27	19	11.4	20.1	17.1	18.5
28	18	11.1	24.0	17.2	18.7
29	28	11.5	17.8	17.4	18.9
30	28	11.0	18.5	17.1	19.0
31	26	12.2	18.0	17.1	18.9
32	19	10.9	20.0	16.9	18.8
33	29	11.1	18.6	16.6	18.6
34	20	10.6	18.6	16.3	18.2
35	16	10.7	19.6	15.8	17.8
36	16	9.7	19.2	15.2	17.3
37	16	9.5	18.6	14.4	16.8
38	16	8.9	18.4	13.6	16.1
39	16	8.4	13.8	12.6	15.3
40	16	8.0	13.1	11.5	14.5

Table 2: Range of Normal and Borderline Values of AFI

GA (Weeks)	Oligo - hydramnios (cm)	Range of borderline lower limit 3rd 5th%	Range of normal 5 th 95th%	Range of Borderline Upper Limit 95th 97th%	Polyhydramnios
16	<6.0	6.0-6.1	6.2-11.5	11.6-11.7	>11.7
17	<7.0	7.0-7.1	7.2-13.1	13.2-13.4	>13.4
18	<7.8	7.8-8.0	8.1-14.4	14.5-14.8	>14.8
19	<8.6	8.6-9.8	9.0-15.9	16.0-16.2	>16.2
20	<9.2	9.2-9.6	9.7-17.0	17.1-16.2	>16.2
21	<9.8	9.8-10.2	10.3-18.1	18.2-17.4	>17.4.
22	<10.3	10.3-10.7	10.8-18.9	19.0	>19.0
23	<10.8	10.8-11.1	11.2-19.5	19.6-19.8	>19.8
24	<11.1	11.1-11.4	11.5-20.0	20.1-20.3	>20.3
25	<11.5	11.5-11.6	11.7-20.5	20.6-20.8	>20.8
26	<11.7	11.7-11.9	12.0-20.9	21.0-21.2	>21.2
27	<11.8	11.8-12.0	12.1-21.1	21.2-21.5	>21.5
28	<12.0	12.012.2	12.3-21.3	21.4-21.7	>21.7
29	<11.9	11.9-12.2	12.3-21.4	21.5-21.8	>21.8
30	<11.8	11.8-12.1	12.2-21.4	21.5-21.8	>21.8
31	<11.7	11.7-12.0	12.1-21.3	21.4-21.5	>21.5
32	<11.4	11.4-11.8	11.9-21.0	21.1-21.3	>21.3
33	<11.2	11.2-11.4	11.5-20.8	20.9-21.0	>21.0
34	<10.8	10.8-11.0	11.1-20.3	20.4-20.6	>20.6
35	<10.4	10.4-10.7	10.8-19.7	19.8-20.0	>20.0
36	<10.0	10.0-10.2	10.3-19.0	19.1-19.2	>19.2
37	<9.6	9.6-9.8	9.9-18.2	18.3-18.6	>18.6
38	<9.1	9.1-9.3	9.4-17.4	17.5-17.6	>17.6
39	<8.7	8.7-8.9	9.0-16.3	16.4-16.7	>16.7
40	<8 2	8 2-8 4	8.5-15.2	15.3-15.6	>15.9

Table 2: Range of Normal and Borderline Values of Afi

GA (Weeks)	Oligo - hydramnios (cm)	Range of borderline lower limit 3rd 5th%	Range of normal 5 th 95th%	Range of Borderline Upper Limit 95th 97th%	Polyhydramnios
16	<6.0	6.0-6.1	6.2-11.5	11.6-11.7	>11.7
17	<7.0	7.0-7.1	7.2-13.1	13.2-13.4	>13.4
18	<7.8	7.8-8.0	8.1-14.4	14.5-14.8	>14.8
19	<8.6	8.6-9.8	9.0-15.9	16.0-16.2	>16.2
20	<9.2	9.2-9.6	9.7-17.0	17.1-16.2	>16.2
21	<9.8	9.8-10.2	10.3-18.1	18.2-17.4	>17.4.
22	<10.3	10.3-10.7	10.8-18.9	19.0	>19.0
23	<10.8	10.8-11.1	11.2-19.5	19.6-19.8	>19.8
24	<11.1	11.1-11.4	11.5-20.0	20.1-20.3	>20.3
25	<11.5	11.5-11.6	11.7-20.5	20.6-20.8	>20.8
26	<11.7	11.7-11.9	12.0-20.9	21.0-21.2	>21.2
27	<11.8	11.8-12.0	12.1-21.1	21.2-21.5	>21.5
28	<12.0	12.012.2	12.3-21.3	21.4-21.7	>21.7
29	<11.9	11.9-12.2	12.3-21.4	21.5-21.8	>21.8
30	<11.8	11.8-12.1	12.2-21.4	21.5-21.8	>21.8
31	<11.7	11.7-12.0	12.1-21.3	21.4-21.5	>21.5
32	<11.4	11.4-11.8	11.9-21.0	21.1-21.3	>21.3
33	<11.2	11.2-11.4	11.5-20.8	20.9-21.0	>21.0
34	<10.8	10.8-11.0	11.1-20.3	20.4-20.6	>20.6
35	<10.4	10.4-10.7	10.8-19.7	19.8-20.0	>20.0
36	<10.0	10.0-10.2	10.3-19.0	19.1-19.2	>19.2
37	<9.6	9.6-9.8	9.9-18.2	18.3-18.6	>18.6
38	<9.1	9.1-9.3	9.4-17.4	17.5-17.6	>17.6
39	<8.7	8.7-8.9	9.0-16.3	16.4-16.7	>16.7
40	<8 2	8 2-8 4	8.5-15.2	15.3-15.6	>15.9

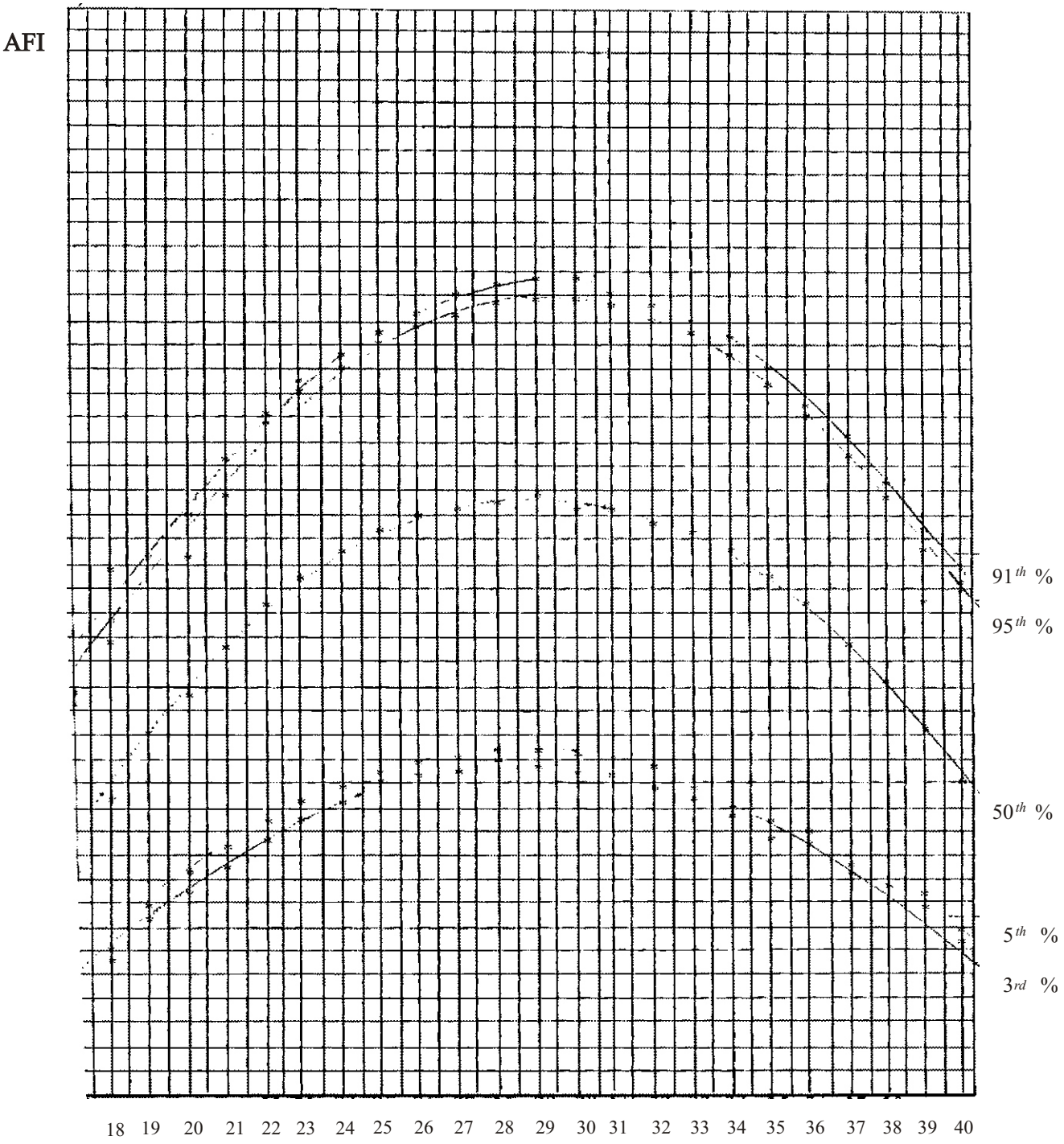

Figure 1: Graphical Representation of AFI Percentiles

References

1. Brace RA Physiology of amniotic fluid regulation. *Clin Obstet Gynecol,* 1997; 40: 280-289
2. Chauhan SP, Roberts WE, Martins JN *et al*.Amnioticfluid index in normal pregnancy; a longitudinal study. *J Miss State Med Assoc*, 1999; 402: 43 46
3. Phelan JP, Smith CV, Broussard P *et al*. Amniotic fluid volume assessment with the four-quadrant technique at 36-42 weeks gestation. *J Reprod Med*. 1987; 32: 540 542.
4. Hadlock FP, Deter RL, Harrist RB. Foetal biparietal diameter: A critical re-evaluation of the relationship to menstrual age by means of real time ultrasound. *J Ultrasound Med,* 1982; 1: 97 104.
5. Warda AH, Deter RL, Rossavik IK *et al*. Foetal femur length: a critical evaluation of the relationship to menstrual age. *Am J Obstet Gynecol,* 1985; 66: 69 75.
6. Nwabuokei PO. *Fundamentals of Statistics* Revised Edition, Enugu, Nigeria, Koruna Book Publishers 2001:88-94
7. Mahony BS. The genitourinary system in: Caller PW: *Ultrasonography in Obstetrics and Gynaecology* 2nd Edition, Philadelphia, W.B Samders 1984: 254 255
8. Strong T. Amnioinfusion with preterm premature rupture of membranes *Clin Anat* 1992; 1: 19 21
9. Denbow ML, Sepulveda W, Ridout D *et al*. Relationship between change in amniotic fluid index and volume of fluid removed at amnio reduction. *Obstet Gynecol*, 1997; 90: 529 - 532
10. Moore TR, Cayle JE. The amniotic fluid index in normal human pregnancy. *Am J Obstet Gynecol* 1990; 162: 1168 1173
11. Nwosu EC, Welch CR, Manasse PR, Walkinshaw SA *et al*. Longitudinal Assessment of Amniotic Fluid Index. *Br J Obstet Gynaecol*. 1993; 100: 816 819.
12. Khaidar AM. The amniotic volume in uncomplicated singleton pregnancies: the ultrasonic study techniques. *Akush Ginekol* (Sofia) 1997; 36 (3): 13 16.
13. Kurijak An ultrasonic assessment of foetal kidney function in normal and complicated pregnancies *Am J Obstet Gynecol*, 1981; 141: 266 270
14. Brace R A and Wolf E J. Normal amniotic fluid volume changes throughout pregnancy *Am J Obstet Gynecol,* 1989; 161: 382 388
15. Seeds AE. Current concepts of amniotic fluid dynamics. *Am J Obstet Gynecol,* 1984 ; 138: 575 580
16. Onuigbo MAC. Comparative biochemical indices of renal function in Health and Disease. An M.Sc. thesis submitted to the College of Medicine University of Nigeria. 1988.
17. Sciscione AC, Costigan KA, Johnson TR. Increase in ambient temperature may explain decrease in amniotic fluid index. *Am J Perinatol,* 1997; 14 : 249 251.