Amniotic Fluid Index and Single Deepest Pocket: Weak Indicators of Abnormal Amniotic Volumes

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***Objective*: To compare amniotic fluid index (AFI) with the single deepest pocket in the identification of actual abnormal amniotic fluid (AF) volumes.**

***Methods*: One hundred seventy-nine women with singleton pregnancies at the University of Mississippi between March 1994 and June 1999 had ultrasound estimations of AF volume sequentially using the AFI and single deepest pocket techniques. Each woman subsequently had ultrasound-directed amniocentesis with dye-dilution and spectrophotometric calculation of actual AF volume.**

***Results*: Actual AF volumes were low (under 5% by volume for gestational age) in 62 women, normal (5–95%) in 100 women, and high (more than 95%) in 17 women. An AFI up to 5 cm (sensitivity 10%, specificity 96%) and a single deepest pocket up to 2 cm (sensitivity 5%, specificity 98%) were similarly inadequate in identifying dye-determined low AF volumes. Likewise, AFI above 20 (sensitivity 29%, specificity 97%) and a single-deepest pocket above 8 cm (sensitivity 29%, specificity 94%) were poor in identifying dye-determined abnormally high volumes.**

***Conclusion*: There was no difference between AFI and single deepest pocket techniques for identifying truly abnormal AF volumes. Both techniques were unreliable for identifying true AF volumes. (Obstet Gynecol 2000;96:737–40. © 2000 by The American College of Obstetricians and Gynecologists.)**

Amniotic fluid (AF) volume assessment is a valuable adjunct for antenatal assessment of pregnancies at risk for adverse outcomes.[1] A more accurate estimation of actual AF volume can be done with the dye-dilution technique,[2–5] or the volume can be measured directly during cesarean delivery.[6] Dye-dilution is time-consuming, cumbersome, necessarily invasive because of amniocentesis, and dependent on skilled laboratory support. Direct AF volume measurement at cesarean is not useful for assessing gravidas at risk of adverse outcomes because it can be done only at delivery. Those limitations have led to indirect techniques to estimate AF volume measurements using ultrasound. The two most common methods are amniotic fluid index[7] (AFI) and single deepest pocket measurement.[8]

Before 1987, the most common method for evaluating AF volume was the single deepest pocket technique popularized by Chamberlain et al[8] as the 2-cm rule. More recently, AFI has increased in popularity for estimating adequacy or inadequacy of AF volume. Moore[9] posited that using gestational age–specific AFI ranges of normal AF volume allow clinicians to more efficiently recognize abnormal AF volumes than single deepest pocket. His article is widely referenced and appears in the ACOG technical bulletin on antepartum fetal surveillance.[1] However, Moore[9] compared AFI and single deepest pocket only with each other and not with directly measured or dye-determined AF volume. The purpose of the present investigation was to compare AFI and single deepest pocket technique for identifying abnormal AF volumes and to compare both with dye-determined AF volume.

Materials and Methods

Pregnant women who had amniocenteses for evaluation of fetal lung maturity or to detect subclinical chorioamnionitis in preterm labor were eligible. We excluded those who refused amniocentesis or in whom

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Supported in part by the Vicksburg Hospital Medical Foundation, Vicksburg, Mississippi.

0029-7844/00/$20.00

PII S0029-7844(00)01020-6

fetal movement prevented the investigator from completing the procedure to calculate dye-determined AF. None had rupture of membranes. This investigation was approved by the investigational review board of the University of Mississippi Medical Center.

Ultrasonography on all patients was done with Ultramark-9 or HDI-5000 devices (Advanced Technology Laboratories, Bothell, WA) by the same author (EFM), and his intraobserver variability for AFI and single deepest pocket was 3–4%, consistent with other reports. Sonographic measurements included AFI and single deepest pocket. For the single deepest pocket technique, we measured the depth of the largest pocket of AF horizontally at least 1 cm at a right angle to the uterine contour.[8] A depth of 0–2 cm was classified as oligohydramnios, 2–8 cm as normal, and more than 8 cm as hydramnios. The AFI was calculated by dividing the uterus into four quadrants by the linea nigra into right and left quadrants and the umbilicus into upper and lower quadrants.[7] The maximum vertical diameter of AF in each quadrant, without an aggregate of cord or fetal extremities, was measured in centimeters and summed. Color-flow Doppler was not used for these measurements. A depth of 0–5 cm was defined as oligohydramnios, 5–20 cm as normal, and greater than 20 cm as hydramnios.

Ultrasound-directed amniocentesis was done, and AF volume was confirmed by a dye-dilution spectrophotometric technique.[10] After AF was collected for clinical studies, 2 mL of a 20% aqueous solution of aminohippurate sodium (400 mg, Merck Pharmaceuticals, Inc., West Point, PA) was injected into each amniotic cavity. The needle remained in place for the next 20 minutes with continuous ultrasonic monitoring of needle placement and fetal position. Three milliliters of the aminohippurate sodium and AF mixture were withdrawn at 20 minutes. Samples were frozen and stored at −20C until assayed for aminohippurate sodium concentrations and calculation of AF volume within 90 days of collection. Five separate assays were used to test the entire group. Internal control samples of known aminohippurate sodium concentration previously stored like patient specimens were tested with each assay. Concentration of the control samples was 99.2 ± 1.8% of the expected value. The intra- and interassay percentage coefficient of variation ± standard error of the mean (SEM) was 1.8% ± 0.7% and 3.6%, respectively. The volumetric criteria for oligohydramnios (defined as less than 5%), normal (5–95%), and hydramnios greater than 95% were defined by published values by gestational age for singleton pregnancies.[11,12]

The current dye-dilution technique for calculating AF volume has been evaluated in our laboratory by placing known amounts of AF and determining the volume.[4,5] In vitro this is accurate for measuring AF volume. We acknowledge that this is an indirect method and that the only way to actually measure AF volume is by collecting fluid and measuring it.

Table 1. Maternal Demographics

	n	Range
Maternal age (y)*	24.2 ± 6.2	11–41
Race		
White	50	
Black	124	
Native American	5	
Gravidity		
1	66	
2	46	
≥3	57	
Parity		
0	76	
1	50	
≥2	53	
Gestational age (wk)*	29.5 ± 7.4	15–40

* Mean ± standard deviation.

A sample calculation was done before the investigation commenced. Assuming the largest vertical pocket can detect 20% of abnormal AF volumes, 35 women with excessive or inadequate AF were required to determine whether AFI was 2.5 times more likely to detect those aberrant conditions.

For AFI up to 5 cm compared with more than 5 cm, or single deepest pocket less than or equal to 2 cm versus more than 2 cm to detect oligohydramnios, sensitivity, specificity, positive and negative predictive values, and likelihood ratios were calculated. Likelihood ratio is sensitivity (1.0 − specificity) and it tells how many times more likely a woman is to have an abnormal condition for a given positive test. Likelihood ratios greater than 10 or less than 0.1 are considered conclusive changes from pretest to posttest probability. Similar calculations were done for AFI up to 20 cm versus more than 20 cm, or single deepest pocket up to 8 cm versus more than 8 cm, to identify patients with hydramnios accurately. Data are presented as percentages, when applicable, with 95% confidence intervals (CIs).

Results

Nine women refused amniocentesis and 14 procedures could not be completed because of fetal movement, which left 197 women with singleton gestations eligible. The participants were primarily black women in their mid-twenties, of low parity with gestational ages of approximately 30 weeks (Table 1). The mean (± standard deviation [SD]) AFI value was 11.8 ± 6.6 (range 2.1–42 cm). The mean (± SD) single deepest pocket was 4.7 ± 1 cm (range 1.3–13.3 cm). The mean dye-

Table 2. Amniotic Fluid Index and Single Deepest Pocket Technique to Identify Abnormal Amniotic Fluid Volumes

Comparison	Sensitivity	Specificity	PPV	NPV	LR
AFI ≤ versus > 5.0 cm to differentiate between low and normal volume	10% (3%, 20%)	96% (90%, 99%)	60% (26%, 87%)	63% (55%, 71%)	2.4
SDP ≤ versus > 2.0 cm to differentiate between low and normal volume	5% (1%, 13%)	98% (93%, 99%)	60% (15%, 95%)	62% (54%, 70%)	2.5
AFI < versus ≥ 20 cm to differentiate between normal and excessive volume	29% (10%, 56%)	97% (91%, 99%)	62% (24%, 91%)	89% (81%, 94%)	9.8
SDP < versus ≥ 8 cm to differentiate between normal and excessive volume	29% (10%, 56%)	94% (87%, 98%)	45% (17%, 77%)	89% (81%, 94%)	4.9

PPV = positive predictive value; NPV = negative predictive value; LR = likelihood ratio; AFI = amniotic fluid index; SDP = single deepest pocket.

Data are presented as % (95% confidence intervals).

determined AF volume was 712.1 ± 74.5 mL (range 60–4318 mL).

Based on comparison of individual gestational age–specific values to the table of normal AF volume ranges developed throughout gestation, dye-dilution determined that 62 pregnancies had low AF volumes, 100 had normal volumes, and 17 had high AF volumes. Table 2 shows sensitivity, specificity, positive predictive value, negative predictive value, and likelihood ratios of AFI up to 5 cm compared with more than 5 cm to differentiate low volume from normal volume. We determined the capability of single deepest pocket up to 2 cm compared with more than 2 cm to differentiate between low and normal AF volume. We also examined the adequacy of an AFI less than 20 compared with up to 20 cm to discriminate between normal and excessive fluid, and the adequacy of the single deepest pocket less than 8 cm compared with up to 8 cm to discriminate between normal and excessive AF volume. Based on those analyses, there was no difference between AFI and single deepest pocket to identify either low or high AF volumes. We acknowledge that the prevalence of hydramnios was only 9.5% (17 of 179), lower than oligohydramnios at 34.6% (62 of 179), which might hamper our determination of the ability of the techniques to detect excessive fluid. The population disproportionately comprised black women, and it is not known whether our results can be generalized to other populations.

Discussion

The purpose of this investigation was not to evaluate the probability of AFI or single deepest pocket to identify normal AF volumes, but abnormal AF volumes, either high or low. Thus, our findings were different from those of Moore[9] because he compared only one ultrasound estimate to another ultrasound estimate, having first concluded that AFI was the volume standard. Using sensitivities, specificities, positive and negative predictive values, and likelihood ratios, we found that there was no difference between the AFI and single deepest pocket in identifying actual low or high AF volumes. Neither technique was superior to the other in the identification of abnormal AF volumes, but both were such poor predictors of abnormal AF volumes they were determined to be unreliable.

We interpret Moore's results to indicate that 791 women were evaluated using AFI and single deepest pocket. Before any measurements, the critical values (fifth and 95th percentiles) for each gestational age had been calculated for both techniques. Amniotic fluid index was used as the volume standard and single deepest pocket measurements were compared with AFI. The rationale for AFI as the volume standard was based on an earlier investigation in six sheep (Moore TR, Brace RA. Amniotic fluid index (AFI) in the term ovine pregnancy: A predictable relationship between AFI and amniotic fluid volume [Abstract No. 286]. Meeting of the Society for Gynecological Investigation, Baltimore, MD, March 17–20, 1988). In that investigation, all of the amniotic and allantoic fluid was drained from the uterus of the sheep, saline was infused in 100-mL increments, and serial AFI measurements were taken. Curve-fitting formulas were used, and a close linear relationship was observed between AFI and the actual AF volume. The volume standard used was the AFI because of that close linear relationship.[1] The AFI identified 76 women with oligohydramnios whereas single deepest pocket only identified 32 with it. The conclusion of that study was that AFI was a better identifier of low fluid based on AFI as the volume standard.

Other investigators had similar findings with direct measurement and dye-dilution techniques when they evaluated the capability of AFI to identify normal AF volumes.[2–6] Our results suggest that identification of abnormal AF volumes using ultrasound measurements

remains poor. Sepulveda et al[14] studied 16 second-trimester pregnancies; they infused normal saline and did serial AFI measurements but found that only 30% of the changes in AFI could be accounted for by the amount of saline infused. Dildy et al[2] observed that AFI overestimated low volumes by as much as 88% and underestimated high volumes by 54%. Magann et al[4,5] observed that sensitivity of AFI for identifying low fluid volumes was only 6–8%. Horsager et al[6] directly measured AF volume at cesarean delivery and found that sensitivity of AFI to detect low AF volumes was only 18%.

The important consideration for the clinician is the relationship between the ultrasound estimate of AF volume and ultimate pregnancy outcome. Many investigators have already questioned whether there is any relationship between identified abnormal ultrasound estimates of AF and pregnancy outcomes.[15–18] For example, an AFI up to 5 cm might not be associated with an adverse pregnancy outcome when compared with an AFI above 5 cm.[19] Moreover, the knowledge that an AFI is not greater than 5 cm might lead clinicians to institute more interventions without improvement in perinatal morbidity or mortality rates.[20,21] In the future, we must find better techniques to correlate ultrasound estimates with actual AF volumes, specifically low and high volumes, determine whether that correlation is important, and whether those relationships are related. Reliable associations between specific ultrasound measurements and predictable pregnancy outcomes must be confirmed.

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Received January 18, 2000.
Received in revised form June 19, 2000.
Accepted July 7, 2000.