The Role of Amniotic Fluid Assessment in Indicated Preterm Delivery

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Measuring amniotic fluid pockets with ultrasound is an efficient and reasonably reliable method of evaluating amniotic fluid volume and categorizing relative risk of perinatal morbidity. The most commonly used ultrasound criteria for oligohydramnios, SDP <2 cm and AFI <5 cm, assign approximately 2%-3% and 4%-5% of late preterm pregnancies into the “low amniotic fluid” category. The AFI offers somewhat greater sensitivity and greater precision but has less specificity for predicting perinatal morbidity than does the SDP. Thus, before 34 weeks, use of the AFI <5 cm as a criterion for intensive fetal monitoring, but not as sole criteria for delivery, is recommended. In pregnancies beyond 34 weeks, use of either AFI or SDP to diagnose oligohydramnios can be expected to reliably identify fetuses at risk for compromised perinatal outcome especially if replicate measurements are confirmatory. In such cases, care must be taken to identify comorbid conditions that, together with oligohydramnios, may place the fetus at significant risk. In such cases, delivery is the recommended intervention.

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Antenatal fetal biophysical testing has become a mainstay in achieving good perinatal outcomes. Before the advent of ultrasound, antenatal fetal surveillance protocols limited evaluation to the fetal heart rate alone (nonstress test, NST) or fetal heart rate responses to induced uterine contractions (contraction stress test, CST). Current data indicate that fetal mortality rates ranging from 1 to 2 per 1000-7 per 1000 were achieved with these approaches.1

When the ability to evaluate the fetus with ultrasound, at the bedside or in an antepartum testing center, became widespread in the 1980s, the evaluation of amniotic fluid volume was incorporated into fetal testing regimes. Studies demonstrating that excessive or extremely low-appearing amniotic fluid volume (AFV) were associated with significantly an increased risk of fetal death, even after a normal CST or NST,2-4 spurred the inclusion of AFV assessment into fetal testing protocols. However, the optimal method for sonographic screening of AFV remains to be determined. A variety of approaches (single deepest pocket [SDP], amniotic fluid index [AFI], 3-dimensional, subjective estimation) to estimate amniotic fluid volume have been proposed and have been shown to be moderately effective, but rigorous comparative and clinical efficacy studies continue to be lacking.

At term (37 weeks and beyond), nonreassuring fetal testing is frequently used as an indication for labor induction or cesarean delivery. Usually these interventions are associated with limited fetal/neonatal morbidity. However, even in the setting of suspicious findings on antenatal testing, late preterm birth carries its own significant fetal risks that are often difficult to compare with the hazards associated with continued life in utero. The risk of excess morbidity to the fetus or mother upon recommending labor induction because of the findings of low amniotic fluid at term is probably low, but at earlier gestations, such decisions must be taken with caution.

Normal Amniotic Fluid Volume

Figure 1 is a plot of amniotic fluid in normal human pregnancy derived from direct observations and estimations by the use of dye dilution techniques.5 There is a gradual increase in volume with advancing gestation until approximately 31-33 weeks, followed by a significant decrease toward and beyond the estimated date of confinement. At term, the average AFV is approximately 750 mL, but volume de-
creases rapidly after 40 weeks. By 42 weeks, AFV averages only 400 mL.

The range of “normal” AFV as well as cutoffs for higher (polyhydramnios) and lower (oligohydramnios) volumes vary significantly across gestation. As shown in Table 1, the range of volumes between the 5th (200 mL) and 50th (400 mL) percentiles at 20 weeks is 200 mL, whereas at 33 weeks, the range from 5th to 50th percentile spans 400 mL. Importantly, after 40 weeks, the range from 5th to 50th percentiles is compressed (250-550 mL, only 300 mL). Thus, discriminating various gradations of “low amniotic fluid” is challenging, with a 20 percentile difference comprising only 150 mL.

### Measuring Amniotic Fluid Pockets with Ultrasound

Amniotic fluid, as seen on an ultrasound image, appears as black spaces between and around the folded fetal frame and head. Proper measurement of amniotic fluid pocket depth requires discipline and consistency if results are to be applied to a clinical situation reliably. The ultrasound transducer beam is oriented perpendicular to the patient’s coronal plane and aligned in sagittal plane. The transducer is not tilted to make the amniotic fluid pocket deeper. One should measure the deepest echo-free amniotic fluid pocket identified in the sagittal and coronal planes, excluding “gray areas,” which may include portions of fetal extremity or umbilical cord. One also should avoid measuring pockets <1 cm in width. The inclusion of narrow ribbons of fluid increases inaccuracy.

### Normal Values and Predictive Ability of the SDP

In the earliest attempts to correlate AFV and fetal well-being, in 1984 Chamberlain et al. identified and measured the SDP of amniotic fluid visible in the uterus with ultrasound. By using a qualitative scale, they categorized amniotic fluid volume as “normal” if the SDP was ≥2 and ≤8 cm (94% of cases), “marginal” if the visible pocket measured <2 cm but ≥1 cm (2% of cases), and “decreased” if the pocket was <1 cm (1% of cases; Table 2). In their series of 7582 cases, they reported perinatal mortality in structurally normal fetuses of 1.97 of 1000 patients with normal AFV, which increased to 109.4 in 1000 and 187.5 in 1000 if AFV was marginal (SDP <2 cm) or decreased (SDP <1 cm). They also reported that SDP <1 cm was more efficient at identifying fetuses with...
Normal Values and Predictive Ability of the AFI

On the basis of the premise that measurement of a single deepest pocket of amniotic fluid may not reflect actual amniotic fluid volume, Rutherford et al. proposed in 1987 summing the SDPs identified in 4 quadrants of the uterus. By using a cohort of high risk pregnancies, they defined oligohydramnios as an AFI <5 cm and polyhydramnios as an AFI >24 cm. The percentiles reflected by these limits were not initially established from a low-risk population. Rutherford et al. did, however, report a strong correlation between an AFI <5 cm and abnormal fetal heart rate, meconium in labor, and cesarean delivery, as shown in Fig. 2.

More recently, Magann and colleagues conducted a secondary analysis of a prospective longitudinal study of the intrapartum outcomes of pregnancies with normal and “abnormal” AFI obtained during antenatal testing. “Abnormal” was defined as AFI > 97.5th percentile (polyhydramnios) or < 2.5th percentile (AFI = 5 cm). Pregnancies with oligohydramnios had a greater risk of labor induction (18% vs 9% P = 0.001), IUGR (25% vs 9%, P < 0.001), and preterm birth (29% vs 17%, P = 0.01). The authors concluded that the use of a 5-cm cutoff of AFI identified a substantial portion of pregnancies with suboptimal intrapartum outcomes.

Although the 5-cm cutoff for AFI definition of oligohydramnios had strong enough clinical correlations to support its use, AFI values across gestation were not rigorously established. Therefore, Moore and Cayle performed a cross-sectional study of AFI across gestation in normal pregnancies and showed that the mean AFI was 12-14 cm throughout most of pregnancy, but decreased after 33 weeks. The average AFI at 40 weeks was 12 cm, with the 95th percentile (polyhydramnios) equal to 20 cm and the fifth percentile (oligohydramnios) equal to 7 cm.

A decade later, Magann and associates repeated Moore’s study by using more advanced ultrasound equipment. As shown in Fig. 3, the shape of Magann’s AFI curve closely resembles that of Fig. 1, which was derived from direct amniotic fluid measurements. Note that AFI values from Magann’s data set are 1-2 cm less than Moore and Cayle’s, with the fifth percentile approximately 5 cm at term (vs 7 cm for Moore and Cayle) and the 50th percentile 9.5 cm (vs 12 cm).

By using the data from that study, which reported the 95% confidence limits for both the SDP and AFI in normal pregnancy, in Table 3 we tabulate these limits from 34 weeks onward with additionally calculated values for the 2.5th percentile. It can be seen in Table 3 that the “2-cm” cutoff for SDP corresponds to the third percentile near term in normal pregnancy, whereas the third percentile for AFI is approximately 3 cm. Thus, the customary use of a “5-cm” cutoff for AFI to define oligohydramnios, which is the 7th percentile near-term, will define approximately twice as many pregnancies to have oligohydramnios vs a 2-cm limit for SDP.

Comparative Effectiveness of SDP Versus AFI for Predicting Perinatal Morbidity

Despite the widespread use of both AFI and SDP to assess amniotic fluid, data directly comparing the predictive value of the single deepest pocket and AFI have been conflicting. A large prospective, blinded observational trial compared the...
predictive values of the SDP and AFI techniques in pregnancies undergoing antenatal testing at or beyond 40 weeks of gestation. By using an AFI cutoff of 5 cm and an SDP cutoff of 2 cm, the authors diagnosed oligohydramnios in 7.9% by using AFI but in only 1.4% with maximum vertical pocket (MVP) (SDP; \( P < 0.001 \)). The AFI technique identified cesarean delivery for fetal distress, neonatal intensive care unit admission, asphyxia, and meconium aspiration more efficiently than SDP (28% vs 0%, \( P < 0.001 \)). However, this benefit was achieved at a cost of an increased false-positive rate (8%) compared with the MVP technique (1%).

A recent systematic review of the 5 randomized trials currently available comparing AFI and SDP was performed by Nabhan and Abdelmoula. In most of these trials, as in most existing clinical practices, oligohydramnios (using cutoffs of SDP \( < 2 \) cm or AFI \( < 5 \) cm) was considered an indication for immediate delivery in pregnancies beyond 33 weeks and for delivery 48 hours after initiation of steroid treatment for those \( < 34 \) weeks. They found that an oligohydramnios cutoff of AFI \( < 5 \) cm approximately doubled the rate of labor inductions compared with an SDP \( < 2 \) cm. Although the use of AFI \( < 5 \) cm enabled researchers to identify more cases of cesarean delivery for fetal distress, the AFI criterion was not associated with less frequent umbilical cord blood acidosis or NICU admissions (Table 4).

The findings of the Nabhan review have led to calls to abandon the AFI in antepartum testing because of increased pregnancy interventions without obvious benefits. However, Haws et al recently performed an extensive meta-analysis of various methods of monitoring fetal well being before and during labor. They noted that very low AFI values (eg, third percentile) are frequently associated with poor pregnancy outcomes, and in these cases a reassuring NST loses its usual predictive value. They further concluded that while the association between oligohydramnios and suboptimal perinatal outcome is clear, evidence demonstrating that interventions in response to the finding of oligohydramnios can improve outcomes is lacking. Further research is needed to determine the correlations between intervention and perinatal morbidity and mortality using various sonographic cutoffs for oligohydramnios.

**Management of Oligohydramnios**

Because oligohydramnios portends significant potential fetal jeopardy, a systematic approach to evaluation and choice of management intervention, if any, is recommended.

**Be Precise in the Sonographic Diagnosis of Oligohydramnios**

As noted in Table 2, in the low ranges of amniotic fluid, small absolute differences may result in large variations in percentile. For example, when diagnosing oligohydramnios at 35

<table>
<thead>
<tr>
<th>AFI vs SDP</th>
<th>Relative Risk</th>
<th>95% CI</th>
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<tbody>
<tr>
<td>NICU admission</td>
<td>1.04</td>
<td>0.85-1.26</td>
</tr>
<tr>
<td>Umbilical artery pH (&lt;7.1)</td>
<td>1.1</td>
<td>0.74-1.65</td>
</tr>
<tr>
<td>Diagnosis of oligohydramnios</td>
<td>2.39</td>
<td>1.73-3.28</td>
</tr>
<tr>
<td>Induction of labor</td>
<td>1.92</td>
<td>1.5-2.46</td>
</tr>
<tr>
<td>Cesarean delivery</td>
<td>1.09</td>
<td>0.92-1.29</td>
</tr>
<tr>
<td>Cesarean delivery for fetal distress</td>
<td>1.46</td>
<td>1.08-1.96</td>
</tr>
</tbody>
</table>

From Nabhan and Abdelmoula. AFI, amniotic fluid index; CI, confidence interval; NICU, neonatal intensive care unit; SDP, single deepest pocket.
weeks, an SDP of 2 cm is below the 2.5th percentile whereas a pocket just 1 cm larger—3 cm—is at the 10th percentile. When AFI is used, 5 cm correlates with the 2.5th percentile but the 10th percentile is 7 cm, possibly allowing AFI greater precision in discriminating gradations of reduced AFV.

Furthermore, there is substantial intraobserver variation in SDP and AFI measurements. Moore and Cayle found intraobserver and interobserver errors to average between 0.5 and 1.0 cm, respectively. This amounts to 3%-7% of the typical AFI measurement (12-14 cm) overall, but the error can be as high as ±30% for AFI measurements below 7 cm. Williams et al evaluated the intraobserver agreement of AFV assessment by using AFI and SDP and noted that the SDP technique showed poor intraobserver agreement (kappa = 0.33), whereas the kappa for AFI (0.72) was significantly better, suggesting that the SDP technique has relatively poor reproducibility especially with oligohydramnios. Thus, measurements of AFV in the setting of reduced amniotic fluid should be approached with caution, particularly if labor induction is under consideration. The practitioner should pay meticulous attention to obtaining reproducible, clear images and consider performing at least 3 replicates of measurements to increase reliability.

Either the SDP or AFI can be used to diagnose oligohydramnios in the preterm period. Although the SDP has greater specificity, it has a lower sensitivity and reproducibility. For the significantly preterm fetus (<34 weeks) that would benefit from prolongation of pregnancy under hospital observation, AFI less than 5 cm is a reasonable cutpoint. Waiting to hospitalize for intensive fetal monitoring until the SDP decreases to <2 cm may lead to increased morbidity.

**Exclude Rupture of Membranes**

In the preterm pregnancy with oligohydramnios, diagnosis of premature rupture of membranes (PROM) may be difficult. The customary vaginal assessments for pooling, pH changes, and a ferning pattern on a microscope slide of dried vaginal secretions should be performed, but a repeat evaluation after maternal recumbency for 30 or more minutes may help increase the likelihood of successful diagnosis. Use of the vaginal placental alpha microglobulin-1 (PAMG-1; Amnisure®; Aren Medikal, Istanbul, Turkey) test may be helpful.

**Evaluate Urinary Tract Anomalies**

Because amniotic fluid is largely the product of fetal urination, fetal genitourinary anatomy should be evaluated. Detailed sonographic imaging may reveal renal and bladder anomalies because these are the most common causes of severe second trimester oligohydramnios. Bilateral renal agenesis, multicystic, or polycystic kidneys are other causes.

**Assess Placental Function**

In the absence of PROM and urinary tract anomalies, uteroplacental insufficiency is a common cause of oligohydramnios. This is often associated with conditions such as uncontrolled maternal hypertension, renal disease, chronic placental abruption, systemic lupus, and the antiphospholipid syndrome. Underperfusion of the placenta reduces nutrient and water delivery to the fetus and secondarily diminishes fetal urine output. IUGR typically precedes the oligohydramnios, resulting from placental insufficiency and accounts for up to 20% of all cases of oligohydramnios. Abnormal umbilical and middle cerebral artery Doppler studies help corroborate the diagnosis of oligohydramnios attributable to poor placental function.

**Management Options for Oligohydramnios from 34 to 36 Weeks**

**Isolated Oligohydramnios**

Beyond 34 weeks, the risks associated with preterm birth are diminished but in individual cases may be significant. In this group, an AFI <5 cm or SDP <2 cm should not be used as the sole indication for delivery. In a normally grown fetus, the patient should be evaluated for maternal dehydration before proceeding to delivery procedures.

**Maternal Hydration**

The interrelationship between low amniotic fluid volume and reduced maternal intravascular volume has been demonstrated experimentally and clinically. In women with low AFI associated with chronic hypertension or maternal dehydration arising from illness, fever, or low oral fluid intake, oral or intravenous hydration can result in increased fetal urine output and a consequent rise in AFI. A systematic review of randomized trials of maternal hydration for oligohydramnios performed by Hofmeyr and Gülmezoglu noted that the AFI increased significantly in women with oligohydramnios undergoing repeat AFV assessment 2 or more hours after hydration with oral fluids (mean difference 2.01 cm, 95% CI 1.43-2.60). Intravenous isotonic infusion was less effective than oral hydration. Thus, when MVP <2 or AFI <5 cm is encountered but no comorbidities are evident (eg, placental insufficiency), a repeat amniotic fluid assessment should be performed 2-12 hours after a trial of maternal oral or IV hydration with 1-2 L.

**Oligohydramnios with Comorbid Conditions**

In pregnancies beyond 34 weeks complicated by maternal hypertension, reduced fetal growth or documented placental disease (eg, chronic abruption), the finding of oligohydramnios is usually an indication to evaluate for delivery. Either the MVP <2 cm, or AFI <5 cm, can be used for diagnosis of oligohydramnios.

**Management Options for Oligohydramnios at 37 Weeks or Greater**

At 37 weeks gestation or beyond, the potential risks of morbidity associated with isolated or comorbid oligohydramnios are greater than those associated with preterm delivery. As-
summing biophysical status is reassuring on fetal heart rate testing and oligohydramnios is an isolated finding, maternal dehydration should be considered and repeat testing performed after oral or intravenous hydration.

Conclusions

Measuring amniotic fluid pockets with ultrasound is an efficient and reasonably reliable method of evaluating amniotic fluid volume and categorizing relative risk of perinatal morbidity. The most commonly used ultrasound criteria for oligohydramnios, SDP <2 cm and AFI <5 cm, assign approximately 2%-3% and 4%-5% of late preterm pregnancies into the “low amniotic fluid” category. The AFI offers somewhat greater sensitivity and greater precision but has less specificity for predicting perinatal morbidity than does the SDP. Thus, before 34 weeks, use of the AFI <5 cm as a criterion for intensive fetal monitoring, but not as sole criteria for delivery, is recommended.

In pregnancies beyond 34 weeks, use of either AFI or SDP to diagnose oligohydramnios can be expected to reliably identify fetuses at risk for compromised perinatal outcome especially if replicate measurements are confirmatory. In such cases, care must be taken to identify comorbid conditions that, together with oligohydramnios, may place the fetus at significant risk. In such cases, delivery is the recommended intervention.

Otherwise, isolated oligohydramnios in the late preterm infant can be evaluated with a trial of maternal hydration which, if associated with a return to normal AFV, places the fetus in a much lower risk category. Isolated but persistent oligohydramnios in the late preterm pregnancy should be managed with intensive surveillance and delivery when fetal biophysical status becomes concerning or the patient reaches term.

References