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Amniotic fluid volume: When and how to take action

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Assessment of amniotic fluid volume (AFV) is an integral part of antenatal ultrasound evaluation during screening exams, targeted anatomy examinations, and in tests assessing fetal well-being.

Abnormal AFV has been associated with an increased risk of perinatal mortality and several adverse perinatal outcomes, including premature rupture of membranes (PROM), fetal abnormalities, abnormal birth weight, and increased risk of obstetric interventions.[1]

A recent systematic review demonstrated associations between oligohydramnios, birthweight <10th percentile, and perinatal mortality, as well as between polyhydramnios, birthweight >90th percentile, and perinatal mortality. The predictive ability of AFV alone, however, was generally poor.[2]

How to assess AFV

Ultrasound (U/S) examination is the only practical method of assessing AFV. A **subjective assessment** of AFV should be performed at every antenatal U/S examination; it has intraobserver and interobserver agreement of 84% and 96%, respectively.[3] However, subjective evaluation does not provide a numerical value that can be used to compare patients and to follow trends in AFV over time. **Objective measures** should be used if the subjective assessment is abnormal in patients at increased perinatal risk (Table 1), and in all patients examined in the late third trimester or post-term.

TABLE 1 Indications for antenatal objective evaluation of AFV

Maternal indications
Hypertensive disorders
Hyperthyroidism
Hemoglobinopathies
Cyanotic heart diseases SLE
Chronic renal disease
Diabetes mellitus
Antiphospholipid syndrome
Pregnancy-related indications
Pregnancy-induced hypertension
Decreased fetal movements

Amniotic fluid index (AFI) and single deepest pocket (SDP) are the most-used semi-quantitative techniques. Color Doppler U/S does not improve the diagnostic accuracy of U/S estimates of AFV.[4] It may be useful, however, in circumstances in which visualization of cord-free pockets of fluid is difficult (eg, obesity).

AFI is calculated by summing the depth in centimeters of 4 different pockets of fluid not containing cord or fetal extremities in 4 abdominal quadrants using the umbilicus as a reference point and with the transducer perpendicular to the floor.

SDP refers to the vertical dimension of the largest pocket of amniotic fluid (with

a horizontal measure of at least 1 cm) not containing umbilical cord or fetal extremities and measured at a right angle to the uterine contour and perpendicular to the floor. SDP is the criterion used in the biophysical profile to document adequacy of AFV.[5]

The most commonly used U/S diagnostic criteria for AFV abnormalities are polyhydramnios: SDP >8 cm or AFI >25 cm, and oligohydramnios: SDP <2 cm or AFI <5 cm.[6]

Ultrasound estimates of AFV correlate poorly with direct measurements of amniotic fluid.[7] Table 2 lists the diagnostic indices of AFV measurement in respect to the actual volume measured with dye dilution (oligohydramnios defined as AFV <500 mL; polyhydramnios defined as > 1500 mL).

Relationship between U/S assessment of AFV abnormalities and actual measurements of AFV in mL

		Sensitivity	Specificity	PPV	NP
mnios	AFI ≥ 20 cm	29%	97%	62%	89
	SDP ≥ 8 cm	29%	94%	45%	89
amnios	AFI ≤ 5 cm	10%	96%	60%	63
	SDP ≤ 2 cm	5%	98%	60%	62

ıs: AFI, amniotic fluid index; SDP, single deepest pocket
m: Magann EF, Chauhan SP, Barrilleaux PS, Whitworth NS, Martin JN. Amniotic flu
ıgle deepest pocket: weak indicators of abnormal amniotic volumes. *Obstet Gyne*
Pt 1):737–740.

The use of percentiles rather than fixed cut-offs does not improve the accuracy of AFI in identification of low or high AFV.[8] Table 3 displays the most common pitfalls in the assessment of AFV.

TABLE 3 Pitfalls in AFV assessment

- Excessive pressure on the maternal abdominal transducer leads to underestimation of AFI and SDP;
- Artifactual echoes (particularly in obese patients) may lead to underestimation of AFI and SDP;
- "Free-floating particles" in the third trimester may lead to under-

Advantages and limits of AFI and SDP

A review comparing AFI and SDP has found that use of AFI results in overdiagnosis of oligohydramnios, leading to unnecessary interventions (eg, labor induction), which often contribute to increased morbidity without an improvement in perinatal outcomes.[9] Thus SDP measurement may be the more appropriate method for assessing AFV during

fetal surveillance in the preterm period, when false-positive diagnoses may lead to iatrogenic preterm delivery.

A recent systematic review reports an improved positive likelihood ratio (LR) of SDP compared with AFI for prediction of adverse perinatal outcome (LR 6.2, 95% CI 2.3–16.9 vs 2.7, 95% CI, 1.3–5.7) but not for birthweight <10th percentile (LR 2.6, 95% CI 1.7–4.0 vs 2.6, 95% CI, 1.9–3.5) in the presence of oligohydramnios.[2]

To improve reliability of findings, it may be helpful to repeat the measurements in the presence of abnormal values. Findings at AFV evaluation should be combined with other clinical and U/S assessments for optimal interpretation of their significance and for management of the pregnancy.

Oligohydramnios

Prevalence and causes

The incidence of reduced AFV varies from 0.5% to 5%, depending on the study population and the definition of oligohydramnios. The etiologies vary according to the severity and the trimester in which oligohydramnios is diagnosed.

In the first trimester, oligohydramnios is a rare finding and is usually associated with a poor outcome. Causes include congenital heart anomalies, chromosomal aneuploidy, fetal demise, and ruptured membranes. At this stage oligohydramnios may also be due to iatrogenic causes (ie, post chorionic villous sampling) or its cause may be unknown.[10,11]

Oligohydramnios is an infrequent finding in the second trimester. Causes at this stage include congenital urinary tract obstruction (51%), preterm PROM (34%), placental abruption, amniochorionic separation (7%), and early and severe FGR (5%). The cause is unknown in 3% of cases.[11,12]

In the third trimester, the incidence of oligohydramnios is 3%–5% in late preterm pregnancy and 5%–11% between 40 weeks and 41.6 weeks of gestation.[13-15] Causes at these stages include PROM, FGR, placental abruption, amniochorionic separation, and fetal anomalies. At this stage oligohydramnios may also be attributable to iatrogenic causes (eg, ACE inhibitors or prostaglandin synthase inhibitors) or unknown causes.[12,15]

Consequences

In the second trimester, longer duration of oligohydramnios increases the risk of pulmonary hypoplasia, abnormal chest wall compliance, and limb deformities and contractures.[1]

At term, oligohydramnios increases the risk of labor induction, the risk of category II fetal heart rate (FHR) tracings during labor, and recourse to cesarean delivery. Its effect on adverse neonatal outcome is less clearly documented.[1,14]

Management

Borderline AFI (5.1 cm–8 cm)

Insufficient evidence exists on which to base a recommendation for any intervention in the presence of borderline AFI (5.1 cm to 8 cm) in the third trimester. Sonographic assessment of fetal biometry may be a consideration because FGR can be associated with decreased AFV.[2]

It is customary to monitor this condition (eg, repeat AFV evaluation twice a week) because it may worsen over time. If a subsequent AFV evaluation is normal, surveillance can be discontinued.

Oligohydramnios (AFI ≤5 cm or SDP <2 cm)

Ruling out fetal urinary anomalies, FGR, and PROM is important and can be done by assessing fetal anatomy (if not done previously), measuring fetal biometry, and performing pertinent tests on vaginal secretions to confirm or rule out PROM (ie, rapid dipstick tests). The type of assessment depends on the gestational age at the time oligohydramnios is diagnosed. For example, visualization of a normal fetal urinary tract with bladder at the time of an anatomy scan at 16–20 weeks' gestation might suggest some other causes for oligohydramnios—such as PROM—if the diagnosis is made after 20 weeks. If visualization of fetal anatomy is hampered by oligohydramnios, transabdominal amnioinfusion can be considered (Table 4).

TABLE 4 Transabdominal amnioinfusion

Indications:

- **Diagnostic**
  - to permit evaluation of fetal anatomy;
  - to rule out or confirm pPROM (with use of indigo carmine).
- **Therapeutic**
  - in early pPROM and midtrimester oligohydramnios or anhydramnios to assist in promotion of lung development and reduce morbidity

Technique:

Amnioinfusion is similar to amniocentesis except that fluid is instilled rather than removed. Protocols vary among institutions and there is no evidence that any one method is superior in terms of safety, efficacy, or rates of complications.

- **Clean the site with antiseptic solution and drape.**
- **Under ultrasound guidance, identify a pocket of fluid. Color Doppler sonography is useful for identifying an area devoid of umbilical cord.**
- **20-g needle insertion**

Oligohydramnios associated with comorbid conditions

In this case, management is dictated by the comorbid condition.[12] In particular:

--**Urinary anomalies:** If the anomalies are incompatible with perinatal survival (eg, bilateral renal agenesis) and the patient elects to continue the pregnancy, fetal monitoring should be avoided. If the condition is compatible with perinatal survival, consultation with a pediatric urologist may shed light on the optimal timing for delivery in relation to fetal size and type of anomaly. However, urinary anomalies typically have no impact on timing of delivery.

--**FGR:** Presence of oligohydramnios is a clinically important predictor of outcome, especially when combined with estimated fetal weight of less than the third percentile ($P = .007$).[16] However, false negatives have been reported with clinical or sonographic assessment of estimated fetal weight. In uncomplicated term pregnancies, risk of birth weight below the 10th percentile has been reported in fetuses with U/S findings appropriate for gestational age and isolated oligohydramnios (AFI < 5 cm).[14] Umbilical artery Doppler has been proposed to identify cases of oligohydramnios destined for a poorer outcome independently of estimated fetal weight.[17,18]

--**PROM**: In the presence of PROM, residual AFV should not influence prenatal management until 34 weeks' gestation, when delivery is usually recommended.[19] A feared complication of PPROM prior to 22 weeks is pulmonary hypoplasia, which is related to early anhydramnios.

Isolated oligohydramnios

If no comorbidities are found in a fetus shown to be growing normally, consider gestational age.

--**Preterm**: As discussed above, SDP rather than AFI should be used in the preterm period. In most cases, an SDP <2 cm should not be used as the sole indication for delivery; prolongation of pregnancy under close surveillance is an option.[13] Complete and persistent anhydramnios is commonly considered an indication for delivery after 32–34 weeks, although studies are not available to guide management.

A trial of maternal hydration can be attempted (Box) and the AFV can be reassessed a few hours later. In the presence of isolated and persistent oligohydramnios, fetal surveillance should be instituted twice weekly; delivery can be expedited for non-reassuring fetal testing or attainment of term pregnancy, when the potential risk associated with oligohydramnios is greater than that associated with delivery.

BOX

Maternal hydration therapy in isolated oligohydramnios

Several uncontrolled and randomized controlled trials show an improvement in the quantity of AF after hydration: after 2 or more hours of hydration with oral fluids, the AFI increases significantly in women with oligohydramnios (mean difference 2.0 cm, 95% CI, 1.4–2.6); intravenous isotonic or hypotonic infusions are less effective than oral hydration.[24]

--**Term and post-term**: Isolated oligohydramnios is not an uncommon finding. Cohort studies have shown an association between oligohydramnios and higher rates of labor induction and cesarean section because of non reassuring FHR tracing,[20] as well as adverse perinatal outcome.[21,14] Trends in AFV within the normal range do not have prognostic significance.[22] Some providers induce labor for oligohydramnios at term to reduce perinatal morbidity and mortality, although the quality of evidence is low and the grade of recommendation is weak.[23]

Indeed, the literature lacks randomized clinical trials to explore whether interventions result in improved perinatal outcome.[15] The finding of reduced AFV should always be combined with other prognostic factors (including cervical Bishop score) to allow more accurate pre- diction of outcome and to inform management.[2]

Polyhydramnios

Prevalence and causes

The prevalence of olyhydramnios ranges from 1% to 2%.[1,25] Table 5 displays the most commonly used cutoffs for AFV in relation to severity of polyhydramnios.[1,25]

Idiopathic polyhydramnios is most commonly mild (55%). Causes of polyhydramnios include uncontrolled maternal diabetes; large-for-gestational-age fetus or birth weight >90th percentile; movement disorders (neuromuscular disorders) that affect fetal amniotic fluid swallowing; and multiple gestations (most commonly in the context of twin-twin transfusion syndrome, associated with oligohydramnios in the co-twin).

TABLE 5 Severity of polyhydramnios in relation to semi-quantitative measurements of AFV

Degree	SDP (cm)	AFI (cm)	Frequency	PNM	Anomalies
Mild	> 8	> 24(a); 25–30(b)	68%	50	≤6%
Moderate	> 11	> 32(a); 30–35(b)	19%	190%	>45%
Severe	> 15	> 44(a); 35.1\(b)	13%	540	>65%

Abbreviation: PNM, perinatal mortality rate (number of perinatal deaths per 1000 births)
Sources: a: Harman CR,[1] b: Pri-Paz, S[25]

Certain fetal anomalies (associated or not with genetic conditions) are more often associated with severe polyhydramnios; the combination of FGR and polyhydramnios is suggestive of chromosomal aneuploidy (ie, Trisomy 18 or 13).[26] Table 6 displays the fetal anomalies described in association with polyhydramnios. Visualization of fetal anatomy can be hampered by the excessive amniotic fluid volume (the fetus may be positioned far from the U/S transducer or fetal movements may be excessive). Placing the mother in lateral decubitus or performing an amnioreduction may facilitate U/S visualization (Table 6).

Rare conditions associated with polyhydramnios include fetal anemia and/or heart failure (eg, polyhydramnios with hydrops), placental tumors (eg, chorioangiomas), and congenital infections. After birth, an abnormality is diagnosed in up to 25% of cases that prenatally had been considered idiopathic.[29]

TABLE 6 Most common fetal malformations associated with polyhydramnios

Central nervous system	Neural tube defects (anencephaly, iniencephaly, encephalocele)
Gastrointestinal tract	Esophageal atresia Diaphragmatic hernia Duodenal stenosis (atresia)
Respiratory tract	Cystic adenomatoid malformation of the lung Chylothorax
Cardiovascular system	Ebstein's anomaly, other anomalies with atrioventricular valve regurgitation Arrhythmias (tachycardias, bradycardias) Twin-to-twin transfusion syndrome
Musculoskeletal system	Skeletal dysplasia (eg, thanatophoric dysplasia) Myotonic dystrophy Pena-Shokeir syndrome Fetal akinesia/hypokinesia syndrome

Consequences

Polyhydramnios is associated with increased risk of adverse pregnancy outcomes (in addition to associated morphologic abnormalities): maternal respiratory compromise, preterm PROM, preterm delivery, preeclampsia ("mirror syndrome"), fetal malpresentation, macrosomia, umbilical cord prolapse, abruption upon rupture of membranes, postpartum uterine atony.

These complications increase the risk of cesarean delivery and neonatal intensive care admission.[2] Overall perinatal mortality in isolated polyhydramnios is increased 2- to 5-fold compared to pregnancies with normal AF.[2] Recently the rate of adverse outcomes has been reported to be lower in presence of an elevated (>8 cm) SDP but normal AFI (<25 cm) than when both measurements are abnormal. This observation suggests that diagnosing polyhydramnios based on the AFI is more accurate.[25]

Management

Initial assessment

Conduct a comprehensive U/S evaluation of fetal biometry, searching for anomalies, signs of fetal infection (eg, splenomegaly, hepatomegaly, liver or intracranial calcifications) or fetal hydrops. Observe fetal movement to rule out neurologic conditions. Obtain peak systolic velocity in the middle cerebral artery to rule out fetal anemia. Examine the placenta with color and power Doppler to rule out placental hemangiomas.

If it has not been done, screen for diabetes mellitus, because a linear relationship has been reported between AFI and birth weight centiles in a poorly controlled diabetic population.[30]

Polyhydramnios associated with comorbid conditions

If congenital anomalies and/or FGR are detected, request fetal chromosome analysis or microarray testing as well as maternal testing to rule out congenital infections (ie, cytomegalovirus, toxoplasmosis, etc.).

If fetal hydrops is detected, request indirect Coombs to rule out an immune etiology as well as maternal testing to rule out congenital infections. Also evaluate for signs of cardiac failure (eg, triscuspid regurgitation, pulsations in umbilical vein). If polyhydramnios is associated with other conditions, management is based on the underlying condition.

Isolated polyhydramnios

Monitor fetal well being Because of the above-mentioned associations between polyhydramnios and adverse obstetric outcome, some experts have suggested institution of fetal testing in the presence of polyhydramnios (eg, NST weekly until delivery).[31] Check AFV at least every 2–3 weeks and fetal biometry every 4 weeks.

A biophysical profile (BPP) may be required if difficulties are encountered in recording FHR. Use caution in interpreting the BPP score in the presence of polyhydramnios, since the 2 points for AFV in these cases are not necessarily reassuring. For example, a BPP can be as high as 8/10 (2 points off for nonreassuring NST) in the presence of a hypoxemic fetus and setting of uncontrolled maternal diabetes.

Treat severe and symptomatic polyhydramnios

In addition to monitoring fetal well being, measures can be implemented to reduce the amount of amniotic fluid, including amnioreduction (Table 7). Before 34 weeks, the procedure can be preceded by prophylactic maternal administration of steroids for fetal lung maturity enhancement (in case the procedure results in preterm labor and delivery or triggers placental abruption).

TABLE 7 Decompression amniocentesis (amnioreduction)

Technique:

- **Clean the site with surgical scrub;**
- **Administer local anesthesia;**
- **Insert an 18-g spinal needle with the tip directed in a caudal direction and the hub of the needle positioned cranially to prevent the needle tip from touching the uterine wall as the uterus becomes smaller with decompression. Hard-walled arterial line tubing with a 3-way stopcock is attached to the needle and connected to a vacuum suction bottle.**

A reasonable practice is to remove the fluid no faster than 1000 mL over 20 minutes and not to remove more than 5 L at one time.

End the procedure when the AFI is normalized (in singletons) or SDP <8 cm (in twin pregnancies). Sometimes the procedure must be terminated early because of patient discomfort, a clogged needle, preterm labor, or membrane separation.

Initiate tocolytic therapy (ideally indocin) either prophylactically or therapeutically (if contractions occur).

On average, 2 procedures are needed to reduce AFV chronically, although some patients require more procedures.

Post procedure:

- **Monitor AFV every 1 to 3 weeks;**
- **Repeat decompression amniocentesis if symptomatic severe polyhydramnios recurs;**
- **Decompression reduces symptoms but there is no evidence that it prolongs gestation.**

Complications:

Complications occur in about 1%–3% of cases and include preterm labor, abruptio placentae, PROM, intraamniotic infection, and hypoproteinemia.[28]

Sources: Elliott JP, Sawyer AT, Radin TG, Strong RE. Large-volume therapeutic amniocentesis in the treatment of hydramnios. *Obstet Gynecol.* 1994;84(6):1025–1027. Leung WC, Jouannic JM, Hyett J, Rodeck C, Jauniaux E. Procedure-related complications

Although fetal lung maturity tests can be assessed at the time of amnioreduction after 34 weeks, their utility is limited because timing of delivery is mostly affected by the coexisting anomalies (with possible need for neonatal corrective surgeries) and maternal symptoms.

Time delivery

For mild to moderate polyhydramnios with reassuring fetal testing, there is no need to change standard obstetric management.

For severe polyhydramnios, care should be taken at the time of membrane rupture to avoid umbilical cord prolapse or abruption. One solution is to perform an amnioreduction in early labor; alternatively the membranes can be needled to allow gradual spillage of fluid, or can be ruptured at early cervical dilation, because prolapse of a loop of cord is more common as cervical dilation increases.

Summary

AFV abnormalities—whether diminished or excessive—should prompt an evaluation for underlying causes. The level of assessment and potential etiologies depend on gestation at the time of diagnosis, associated U/S abnormalities, and maternal condition.

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