Journal of Diagnostic Medical Sonography
2017, Vol. 33(4) 280–283

DOI: 10.1177/8756479316687269
journals.sagepub.com/home/jdm
SAGE

Amniotic Fluid Assessment: Amniotic Fluid Index Versus Maximum Vertical Pocket

Jacquelyn Coombe-Patterson, RDMS[1]

Abstract

Amniotic fluid assessment is vital to fetal well-being. Accurately diagnosing an amniotic fluid abnormality can aid in the proper management of a pregnancy at risk for an adverse outcome. Sonography is the most common way to assess amniotic fluid volume throughout a pregnancy; however, the most accurate technique, amniotic fluid index or maximum vertical pocket, is yet to be determined. Dye-dilution techniques are the most accurate way to measure amniotic fluid volume, but they are invasive and can be performed only at the time of a cesarean delivery. Multiple studies have been performed to determine the accuracy of the amniotic fluid index and maximum vertical pocket methods when diagnosing amniotic fluid volume abnormalities. Based on the studies reviewed in this article, neither method stands out as superior to the other when it comes to diagnosing amniotic fluid abnormalities during pregnancy. However, the maximum vertical pocket should also always be considered when an amniotic fluid abnormality is suspected because the amniotic fluid index overdiagnoses amniotic fluid abnormalities, leading to increased rates of pregnancy intervention and the potential for adverse pregnancy outcomes.

Keywords

amniotic fluid, amniotic fluid index, maximum vertical pocket, oligohydramnios, polyhydramnios

Introduction

Amniotic fluid is vital for fetal well-being and pregnancy outcome. It delivers an ideal environment for normal fetal growth and development by providing the fetus with a source of water, protecting the fetus from trauma, allowing for normal movements critical for anatomic development, and contributing to the improvement of fetal lung maturity.[1] The amount of amniotic fluid at any given gestational age is critical to fetal progress and can ultimately affect the end result of a pregnancy. The normal amount of amniotic fluid volume (AFV) across a gestation has not been clearly defined, and consequently, abnormal values are also poorly defined.[1] There are numerous methods that can be used to evaluate AFV during pregnancy; however, the most accurate method is yet to be determined. Amniotic fluid volume assessment is now recognized as an indispensable adjunct to antenatal fetal assessment; therefore, it is crucial that a standard method be determined to prevent fetal morbidity and mortality as well as other adverse pregnancy outcomes when AFV abnormalities are diagnosed.[2] The purpose of this review is to determine an accurate method for determining AFV abnormalities by evaluating several published studies that have compared sonographic methods of assessing AFV during pregnancy.

Sources Affecting AFV

Before classifying AFV as normal or abnormal, it is imperative to understand where amniotic fluid comes from and why it is essential to maintain an ordinary healthy pregnancy. There are many factors, both fetal and maternal, that affect the AFV throughout a gestation. Amniotic fluid is maintained in a dynamic equilibrium; its volume is the sum of fluid (from fetal urine and lung fluid) flowing into and out of the amniotic space.[3] There is an active balance between fetal urine production and fetal swallowing that seems to control the net AFV, unless there is a fetal anomaly affecting those functions. Fetal swallowing can be affected by structural abnormalities such as esophageal atresia; cleft lip and palate; congenital abnormalities including Trisomy 13, 18, and 21; decreased amniotic osmolality; and increased fetal plasma osmolality.[1,2,4] Abnormalities with fetal swallowing often lead to

[1]Southern Illinois University Carbondale, Carbondale, IL, USA

Received July 28, 2016, and accepted for publication November 10, 2016.

Corresponding Author:
Jacquelyn Coombe-Patterson, RDMS
Email: jpatterson2@siu.edu

polyhydramnios, or an abnormal increase in AFV.[4] Other etiologies related to polyhydramnios include maternal conditions such as uncontrolled diabetes and drug exposure as well as fetal causes such as macrosomia; congenital infections; fetal tumors; central nervous system anomalies such as anencephaly and spina bifida; gastrointestinal anomalies; and abnormalities of the respiratory system and genitourinary system.[4,5] Whereas fetal and maternal conditions are seen in nearly half of all cases of polyhydramnios, the remaining half have no apparent cause and the abnormal AFV remains unexplained.[4,5] In idiopathic polyhydramnios, there is a 2- to 5-fold increase in perinatal morbidity and mortality as well as an increased risk of abnormal presentation and cesarean delivery.[4]

Fetal urine production is the principal factor that affects AFV during pregnancy. Fetal urine first enters the amniotic space at 8 to 11 weeks of gestation and is the predominant source of amniotic fluid in the second half of the pregnancy.[1] Lack of fetal urine production often leads to oligohydramnios, or a decreased AFV. Genitourinary abnormalities, such as bladder outlet obstruction, posterior urethral valves, and Potter's syndrome, as well as congenital abnormalities can cause oligohydramnios. Other pathologies related to decreased AFV include premature rupture of membranes, placental dysfunction, intrauterine growth restriction, postdate pregnancy, and uteroplacental insufficiency from maternal or fetal complications such as hypertension, diabetes, and placental abruption.[6,7]

Other factors affecting AFV throughout pregnancy include the secretion of fetal lung fluid and the intramembranous movement of water and solutes into fetal circulation.[1] The intramembranous pathway is a mechanism that the body uses to maintain the balance of AFV as a pregnancy progresses. As gestation advances, fetal urine production increases, as does the amount of lung fluid secreted by the fetus, which can cause a rise in AFV. The intramembranous pathway is the body's natural way of maintaining normal AFV by compensating for the excess fluid that the fetus is producing.[1] Maternal hydration also plays a role in overall AFV at any given point during gestation. The intramembranous pathway likely plays a role in correcting the fluid volume during times of maternal dehydration.[1] Magann et al.[1] performed a study, finding that using 1 liter of intravenous hydration in a dehydrated mother increased the actual and sonographically estimated AFV in the fetus.[1] Kilpatrick et al.[8] confirmed these findings and found that maternal hydration with 2 liters of fluid in a mother with low AFV can increase the human fetal amniotic fluid index (AFI) by up to 31%.[1] In a normal singleton pregnancy, AFV rises progressively until approximately 33 weeks of gestation and then plateaus between 33 and 38 weeks, which is then followed by a decline after 38 weeks.[4]

Methods

Diagnosing any AFV abnormality prenatally is crucial to properly managing a pregnancy in order to decrease the risk of fetal and neonatal morbidity and mortality.[3] There are multiple techniques that can be used to assess AFV during pregnancy. The most accurate, yet most invasive and impractical method for determining AFV is obtaining direct measurements at the time of hysterotomy with the use of dye-dilution techniques.[3,4,8] The problem with this method is that it is intrusive, cumbersome, and time consuming; requires laboratory support; and cannot be used to assess amniotic fluid levels throughout the pregnancy.[3,8] Another limitation is that the direct measurement obtained using the dye-dilution technique reflects AFV only at the time of cesarean delivery.[8] Because of the bounds of the dye-dilution technique, sonography is used to measure AFV at any given point throughout gestation.[3]

The AFI method, first introduced by Phelan et al. in 1987,[10] involves dividing the amniotic cavity into four quadrants and measuring the deepest vertical pocket in each quadrant.[2,7] The measurements are then added to give an estimated total AFV. To obtain an accurate AFI, sonographers must follow several guidelines. The ultrasound transducer should always be oriented perpendicular to the patient's coronal plane, and the deepest, unobstructed pocket of amniotic fluid should be identified.[2] Gray areas on the screen should be avoided when obtaining a measurement, as amniotic fluid is generally near the black end of the gray scale.[2] Measuring narrow spaces between fetal structures and the uterus should also be avoided.[2] A quadrant cannot be measured if one must measure through fetal parts or through a loop of umbilical cord.[2] The use of color Doppler can ensure that parts of the umbilical cord are not included in the measurement. Each pocket should measure at least 2 × 1 cm to be used in the total AFI.[2] The AFI is typically measured after 25 weeks of gestation. A normal AFI measures greater than 5 cm and less than 24 cm.[8] Oligohydramnios is diagnosed if the AFI measures less than or equal to 5 cm, and polyhydramnios is diagnosed if the AFI is greater than 24 cm.[1,2,8] The AFI is the most widely used sonographic method for assessing AFV throughout pregnancy.[2]

The use of the maximum vertical pocket (MVP) technique can be traced back to an article published in 1980 by Manning,[11] where he described a normal AFV as fluid evident throughout the uterine cavity, as well as the largest pocket of fluid measuring more than 1 cm in the vertical dimension.[9] This definition set the standard for the future of the MVP method. The MVP technique can be used to assess AFV as early as the second trimester. By 1990, the definition of an adequate AFV as a component of the biophysical profile was a pocket of fluid measuring

a minimum of 2 cm in the vertical axis and 1 cm horizontally.[9] This threshold of a 2 × 1 cm pocket of fluid is the current ultrasound measurement used to estimate a normal AFV when practicing the MVP method.[1,8,9] When using the MVP technique, oligohydramnios is diagnosed when the MVP is less than 2 cm, and polyhydramnios is diagnosed when the MVP is greater than or equal to 8 cm.[1,7] A MVP of greater than or equal to 2 cm to less than 8 cm is considered normal.

Importance of Accurate Amniotic Fluid Assessment

Amniotic fluid volume is ultimately a gauge of fetal health, and there is no clear consensus on the best method to assess amniotic fluid adequacy.[3] Assessing AFV during a sonographic examination, for fetal anatomy and growth, provides physicians with important information with regard to fetoplacental functions as well as the structural integrity of the fetus.[2] In the late second and third trimesters of pregnancy, the sonographic estimation of AFV is an important part of antenatal testing of a fetus at risk of an adverse pregnancy outcome.[10] Pregnancies with an amplified risk of adverse endings include those affected by intrauterine growth restriction, uncontrolled gestational diabetes, chronic hypertension, obesity, and fetal anomalies and those of mothers with a prior pregnancy with a poor outcome.[1,9,11] It is vital that an accurate assessment is always used in the clinical setting to reduce the risk of morbidity and mortality to the fetus.

Proper measurement of amniotic fluid pocket depth, whether using the AFI or MVP technique, requires discipline and consistency if results are to be applied to a clinical situation reliably.[11] The precise assessment of AFV by sonography can be influenced by an inexperienced sonographer, fetal position, the probability of a transient change, and the different diagnostic criteria of an abnormal volume.[3] A practitioner should pay meticulous attention to obtaining reproducible, high-resolution images and consider performing at least three replicates of measurements to increase reliability if AFV abnormality is suspected.[11] Experienced sonographers become seasoned to subjectively identifying abnormalities with AFV and can greatly influence a physician's outlook for managing the remainder of a pregnancy. Over the years, many studies have been performed to determine which method, AFI or MVP, is the most defined in determining amniotic fluid abnormalities, since dye-determined techniques are not feasible in day-to-day clinic settings.[1,8]

Comparing AFI and MVP

The first attempts to compare AFV and fetal well-being date back to 1984 when Chamberlain et al.[15] used the MVP technique to evaluate overall AFV during pregnancy. Using a qualitative scale, they categorized AFV as normal if the MVP was greater than or equal to 2 cm and less than or equal to 8 cm. The AFV was considered marginal if the MVP measured less than 2 cm but greater than or equal to 1 cm and decreased if the pocket was less than 1 cm.[13] Chamberlain et al.[15] examined 7582 cases and 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 (MVP < 2 cm) or decreased (MVP < 1 cm). The most significant finding from their study was that fetal death risk was increased 10-fold and neonatal death increased by more than 5-fold when the MVP measured less than 1 cm.[14,15] The results of this study emphasize the importance of an accurate fluid assessment and how it can affect the outcome of a pregnancy.

A study performed by Moore[16] evaluated the ability of the MVP technique compared with the AFI method to detect abnormal AFV in 1168 patients.[1] When using the AFI method, 76 women were found to have oligohydramnios compared with only 32 using the MVP technique. Moore concluded that the AFI method was superior to the MVP technique because it identified more women with low AFV.[1,16,17] The limitation to Moore's study was that the two methods were compared only with each other and not directly with measured or dye-determined AFV.[1] Following Moore's study, Magann et al.[17] questioned the findings that the AFI method was superior to the MVP technique in diagnosing abnormal AFV. They then compared the AFI and MVP approaches with dye-determined AFV in 179 singleton pregnancies to conclude if one was superior to the other in detecting AFV abnormalities.[1] Based on their findings, Magann et al.[17] found that both techniques were unreliable in the detection of abnormal AFV and that neither technique was superior to the other.[1,17]

The Cochrane Collaboration provides a review of randomized controlled trials involving women with a singleton pregnancy undergoing assessment of AFV as part of antenatal assessment of fetal well-being that compared the AFI technique and MVP measurement.[3] The goal of this review was to determine if either approach was more accurate in diagnosing AFV abnormality to help reduce the risk of an adverse pregnancy outcome. Five trials met the inclusion criteria, which involved reviews of 3226 women between 1997 and 2004.[3] When using the AFI method, it was found that significantly more cases of oligohydramnios, or an AFI of less than 5 cm, were diagnosed, which led to more inductions of labor and cesarean delivery for fetal distress.[3] Nabhan and Abdelmoula[3] concluded that MVP measurement in the assessment of AFV seems to be a better choice during fetal surveillance. They believe that the AFI method increases the rate of diagnosis of AFV abnormality and the frequency of labor inductions

without improvement in peripartum outcomes. The MVP technique and AFI method are equivalent in their prediction of adverse outcomes and AFV abnormalities; however, based on these findings, many clinicians have pushed to abandon the AFI method in antenatal testing because it leads to higher rates of pregnancy interventions without any noticeable benefits.[9,14]

Conclusion

There is no constant standard for measuring AFV across the board. Some clinics use the AFI method and others use the MVP technique. Based on the above evidence, it would seem that the MVP technique is a better choice when evaluating AFV; however, more research is needed. Studies must be performed to determine if that approach will become the uniform standard of care for assessing AFV. According to Magann et al.,[13] if either of the two techniques is to be acknowledged as superior to the other, it must meet most, if not all, of the following criteria: The technique must accurately identify the actual AFV (analysis by dye-dilution technique or direct measurement at cesarean delivery) as well as minimize the number of patients it considers to have oligohydramnios or hydramnios. The technique must also be a reliable predictor of adverse perinatal complications, and when used in conjunction with other ancillary tests, it improves neonatal outcomes.[9] The ultimate goal of every pregnancy is to have a healthy fetal outcome. Accurate assessment and diagnosis of AFV abnormalities provides physicians with information necessary to properly manage a pregnancy longitudinally, which may improve the overall outcome of the pregnancy.

Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author received no financial support for the research, authorship, and/or publication of this article.

References

1. Magann EF, Sandlin AT, Ounpraseuth ST: Amniotic fluid and the clinical relevance of the sonographically estimated amniotic fluid volume. *J Ultrasound Med* 2011;30: 1573–1585.
2. Moore TR: The role of amniotic fluid assessment in evaluating fetal well-being. *Clin Perinatol* 2011;38(1):33–46.
3. Nabhan A, Abdelmoula Y: Amniotic fluid index versus single deepest vertical pocket as a screening test for preventing adverse pregnancy outcome. *Protocols Cochrane Database of Systematic Reviews* 2007.
4. Karkhanis P, Patni S: Polyhydramnios in singleton pregnancies: perinatal outcomes and management. *Obstet Gynecol* 2014;16(3):207–213.
5. Harlev A, Sheiner E, Friger M, Hershkovitz R: Polyhydramnios and adverse perinatal outcome – what is the actual cutoff?* *J Matern Fetal Neonatal Med* 2014;27(12):1199–1203.
6. Ashwal E, Hiersch L, Melamed N, Aviram A, Wiznitzer A, Yogev Y: The association between isolated oligohydramnios at term and pregnancy outcome. *Arch Gynecol Obstet* 2014;290(5):875–881.
7. Hashimoto K, Kasdaglis T, Jain S, Atkins K, Harman CR, Baschat AA: Isolated low-normal amniotic fluid volume in the early third trimester: association with adverse perinatal outcomesa. *J Perinat Med* 2013;41(4).
8. Kilpatrick SJ, Safford KL, Pomeroy T, Hoedt L, Scheerer L, Laros RK: Maternal Hydration Increase Amniotic Fluid Index. *Am Col Obstet and Gynecol* 1991;78(6):1098–1102.
9. Magann E, Ross MG: Assessment of amniotic fluid volume. UptoDate. www.uptodate.com. Accessed June 20, 2016.
10. Phelan JP, Ahn MO, Smith CV, Rutherford SE, Anderson E: Amniotic fluid index measurements during pregnancy. *Journal Reproduct Med* 1987;32(8):601–604.
11. Manning FA, Platt LD, Sipos L: Antepartum fetal evaluation: Development of a fetal biophysical profile. *Am J Obstet and Gynecol* 1980;136(6):787–795. doi:10.1016/0002-9378(80)90457-3.
12. Moise KJ: Toward consistent terminology: Assessment and reporting of amniotic fluid volume. *Sem Perinat* 2013;37(5):370–374.
13. Magann E, Chauhan S, Doherty D, Magann M, Morrison J: The evidence for abandoning the amniotic fluid index in favor of the single deepest pocket. *Amer J Perinatol* 2007;24(9):549–555
14. Moore T: Physician, the role of amniotic fluid. *Sem Perinatol* 2011;35:286–289.
15. Chamberlain PF, Manning FA, Morrison I, Harman CR, Lange IR: Ultrasound evaluation of amniotic fluid volume: I. The relationship of marginal and decreased amniotic fluid volumes to perinatal outcome. *Am J Obstet and Gynecol* 1984;150(3):245–249. doi:10. 1016/S00029378(84)90359-4.
16. Moore TR: Superiority of the four-quadrant sum over the single-deepest-pocket technique in ultrasonographic identification of abnormal amniotic fluid volumes. *Am J Obstet and Gynecol* 1990;163(3):762–767. doi:10.1016/0002-9378(90)91064-j.
17. Magann E, Chauhan SP, Barrilleaux PS, Whitworth NS, Martin JN: Amniotic fluid index and single deepest pocket: weak indicators of abnormal amniotic volumes*1. *Obstet & Gynecol* 2000;96(5):737–740. doi:10.1016/s0029-7844(00)01020-6.