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Research Article

The Feasibility and Potential Benefits of a Two-Dimensional Amniotic Fluid Index (Afi2) In the Clinical Management of Pregnancy

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ABSTRACT

This study investigates the feasibility and potential advantages of a novel two-dimensional amniotic fluid assessment method, termed AFI2, in the clinical management of pregnancy. The conventional amniotic fluid index (AFI) relies on one-dimensional measurements, potentially limiting accuracy. A total of 195 sonographic examinations were conducted on 66 unselected patients, yielding paired AFI and AFI^2 measurements from 28 to 39 weeks 6 days of gestation. Results showed a modest correlation (rs=0.482, p=0.112) between AFI^2 and AFI, and a limited correlation with gestational age (rs=-0.279, p=0.37 NS for AFI; rs=-0.118, p=0.712 NS for AFI^2). The AFI^2 may be particularly relevant in extreme AFV values, offering a potentially improved estimate of the AFV. Further prospective randomized studies are recommended to establish norms of AFI^2 in uncomplicated singleton pregnancies during the second half of gestation. This method could enhance ultrasonographic assessment of amniotic fluid volume, approaching an ideal three-dimensional estimate.

Keywords

One-dimensional AFI, Two dimensional AFI (AFI2), Pregnancy, Amniotic fluid.

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Introduction

The amniotic fluid volume (AFV) is influenced by maternal and fetal health and plays a major role in maintaining fetal well-being [1]. The AFV is known to increase progressively through the second and third trimesters to a maximum followed by a slow decline towards the term of gestation [2,3]. Many of the fetal vital organs depend on the AFV's homeostasis for their normal development, and the reverse is also true: significant changes in the amniotic fluid volume often indicate anatomic or physiologic abnormalities within the fetus or the placenta. The quantitative methods of compound dilution during amniocentesis or direct measurements at the time of cesarean section are not clinically usable and qualitative or semiquantitative sonographic assessment are considered standard clinical practice.

One of the applications of the amniotic fluid assessment is its contribution to the biophysical profile (BPP) through the amniotic fluid index (AFI) [4]. However, the AFI only uses the sum of the deepest vertical diameters of the four quadrants of a gravid uterus, essentially one dimension of a three-dimension space to assess the volume of its content [3]. In a comparative study of the dye-dilution technique and the ultrasonographic method, Dildy reported differences in measurement error between the two approaches and concluded: "A major source of error in ultrasonographic amniotic fluid volume assessment is that one-dimensional measurements are used to estimate the volume of a complex, three-dimensional object" [5]. While this method of evaluating the AFV has been an asset in our clinical armamentarium for decades [6], we undertook a clinical improvement project to determine the feasibility of a two-

dimensional assessment of the AFV, named AFI^2, using the same four fluid pockets of the AFI. A comparison of the conventional AFI to this new two-dimensional AFI^2 is presented in this quality improvement project.

Materials and Methods

At the Maternal Fetal Medicine Unit of Wyckoff Heights Medical Center in Brooklyn, we undertook to determine the feasibility of a two-dimension AFI (AFI^2) by adding the largest transverse measurement of each of the four pockets of the conventional AFI during the interpretation of ultrasonographic studies in an unselected population of patients from July 1 to August 30th, 2023. The product of the deepest vertical measurement of each amniotic fluid pocket with its corresponding widest transverse diameter yields a new parameter expressed in cm^2 and their sum of the four values designated as the AFI^2. These sonographic fetal assessments were performed from 28 weeks 0 day through 39 weeks 6 days of gestation yielding an AFI and an AFI^2 measurements at each visit (figure 1). The additional transverse diameters and the resulting AFI^2 were not reported to the managing clinicians and therefore not used in the patient's clinical management. The AFI-square expressed in square centimeters is the sum of the products of the two diameters of each pocket in the same manner that the AFI is the sum of the deepest vertical diameters of these same four fluid pockets. The range of AFI^2 measurements mirroring the AFI in this unselected population were recorded and the correlation between these two variables as well as their correlation to gestational age were presented for analysis using the Spearman correlation coefficient as the relationship of the amniotic fluid volume measurements to the gestational age is not simply linear, and a p value <.05 was considered significant.

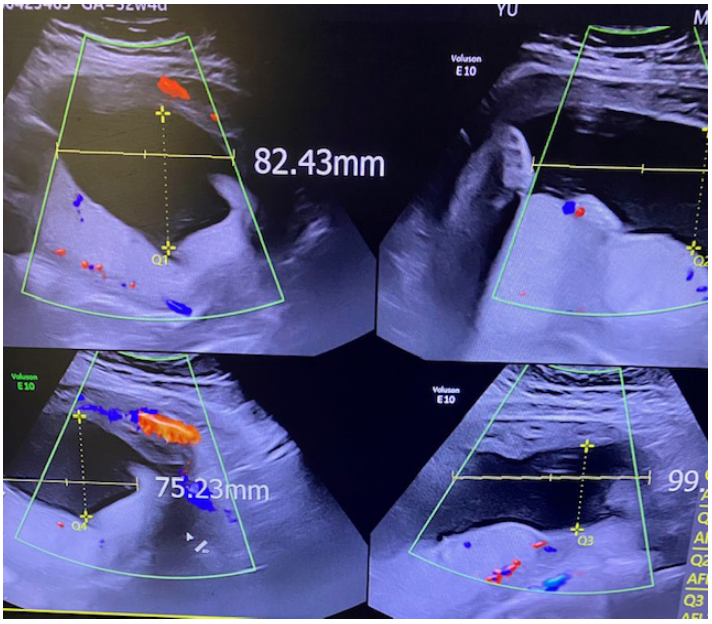

Figure 1: Sonographic representation of the 4 quadrants of the uterine cavity used to compute the AFI and the AFI^2.

Results

195 sonographic examinations were performed either for routine fetal growth or biophysical profile assessment of the fetus on 66 patients undergoing prenatal evaluation. From 28 to 39 6/7 weeks of gestation, 195 pairs of AFI/AFI^2 measurements were obtained as indicated in table 1. The mean AFI and AFI^2 are represented for each gestational age in this patient population with the AFI measurements varying from 3.13 to 33.2 cm and the AFI^2 values from 5.92 to 426.4 cm^2. The Spearman correlation coefficient between the AFI^2 and the AFI was rs=0.482, p= 0.112, non-significant (NS). The Spearman correlation coefficient of AFI and AFI^2 to the gestational age were rs=-0.279 with p=0.37 NS and -0.118 with p= 0.712 NS, respectively.

Table 1: AFI and AFI^2 from 28 0/7 to 39 6/7 weeks of gestation.

Gestational age (weeks)	Number	AFI (cm)	AFI^2 (CM2)
28	15	18.85	151.93
29	7	15.4	91.91
30	12	22.1	97.3
31	15	18.87	162.23
32	25	16.9	120.89
33	16	15.73	124.57
34	17	17.18	123.75
35	31	16.16	128.54
36	23	15.94	117.98
37	15	18.8	172.87
38	10	15.01	73.94
39	9	17.84	117.88

Discussion and Conclusion

The ideal method of amniotic fluid assessment should enable the clinician to use a volumetric technique. This would correspond to a tri-dimensional imaging measurement. This two-dimensional AFI or AFI^2 offers an additional AFV estimate that is available on the same images used to determine the conventional AFI and therefore without significant additional time commitment. The poor correlation between the AFI^2 and the AFI is understandable, as one does not necessarily affect the other. The correlation coefficients between the AFI and the AFI^2 and the gestational age are also poor although one may argue that the rs of the AFI^2 to gestational age is closer to a positive value than the corresponding correlation of the AFI with the gestational age.

These observations enable us to obtain a wide range of a two-dimensional AFI^2 in comparison to its corresponding conventional AFI values in a diverse population of gravida at an inner-city community hospital and underscore the feasibility of a two-dimensional AFI^2 as a method of likely improving our assessment of the amniotic fluid volume. This may be more relevant at the extremes of amniotic fluid volume such as in oligohydramnios and polyhydramnios. A prospective study of uncomplicated singleton pregnancies preferably from 20 to 40 weeks of gestation with determination of the mean values of AFI^2 for each gestational age would help establish the norms for this new measurement during

the second half of the pregnancy. This potential new and improved amniotic fluid volume estimate would be available without added equipment or imaging technique. A two-dimensional amniotic fluid volume estimate is likely to advance this ultra-sonographic tool closer to the ideal three-dimensional estimation of the amniotic fluid volume.

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