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"Comparison the Amniotic Fluid Index (AFI) Obtained with Gray-Scale Ultrasound and Color Doppler"

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Abstract **Original Research Article**

This cross sectional study was done to find out the correlation between gray scale & color Doppler sonographic finding of amniotic fluid index, in the department of Radiology & Imaging, Mymensingh Medical College & Hospital from July 2012 to June 2014. Total 120 pregnant women ages in between 18-40 yrs with gestational age between 28 to 40 weeks from OPD or indoor patient was purposively selected. Statistical analysis was done by using SPSS version 20 windows & the significant differences were measured by paired t test & Kappa test for evaluation of AFI in both gray scale & color Doppler Ultrasonography findings. The mean AFI in case of gray scale was 12±4.6 cm (mean±SD) varied from 3.7-38 cm & 10.2±4.4 cm (mean±SD) varied from 2.6-35 cm measured by color Doppler. The mean difference was 1.8±1.2 cm varied from 0-10 cm. The mean AFI was significantly higher ($p< 0.05$) in gray scale. The level of agreement in 75.8% and comparison of the results shows significant but reliable difference between two modalities. Also a significant positive correlation ($r=0.915$, $p<0.001$) was found. So color Doppler Ultrasonography also enhances the detection of oligohydramnios and help in the management of high risk pregnancy.

Keywords: Amniotic fluid index; Color Doppler; Gray scale; Ultrasound.

INTRODUCTION

Amniotic fluid has a number of important functions like development of musculoskeletal system by permitting foetal movements, growth and development of gastrointestinal tract by swallowing amniotic fluid and it provides essential nutrients to the color. It protects color from trauma, maintain body temperature and it has a bacteriostatic properties. Its pressure helps in reducing the loss of lung fluid and assist in pulmonary development [1]. There are quantitative and qualitative changes in the amniotic fluid with progression of pregnancy. The amniotic fluid volume reaches peak of about 1000ml at 38 weeks of gestation and decreases of about 800ml at 40 weeks. The reduction of volume continues and the amount of fluid approximately 480ml, 250ml, 160ml at 42, 43 and 44 weeks respectively. An amniotic fluid volume under 400ml at 40 or more weeks of gestation associated with fetal complications [2]. As the pregnancy continues post term, further reduction occurs to the extent of about 200 ml at 43 weeks [3]. The American College of Obstetricians and Gynaecologists states that AFI is a more accurate and reproducible method of determining abnormalities in amniotic fluid volume than are other techniques [4]. Polyhydramnios is defined as amniotic fluid index >24 cm, single deepest pocket >8 cm and two-diameter pocket>50 cm [2, 6]. Polyhydramnios may be associated with anencephaly, esophageal or duodenal atresia, twin pregnancy or maternal diabetes. Oligohydramnios was defined as when AFI < 5 cm. Oligohydramnios may occur due to intrauterine growth retardation (IUGR), hypoplasia of fetal lung, renal agenesis, cystic kidneys or chromosomal abnormality, post maturity, intrauterine death (IUD), leaking membrane [5]. The complete absence of amniotic fluid is a grave sign, particularly in early pregnancy [6]. Estimation of Amniotic fluid

volume is an integral component for antenatal testing for the assessment of foetal health, perinatal health such as foetal distress, meconium passage, operative delivery and foetal death etc [7]. The ultrasonic methods which are used to measure amniotic fluid volume are Amniotic Fluid Index (AFI) [8]. Largest Vertical Pocket (LVP) measurement [9], two diameter pocket measurement [10]. Largest Transverse Pocket (LTP) maximum transverse [9]. The technique is simple, acceptable, reproducible and also readily usable even by people with limited experience of ultrasound technique. Several studies on AFI have demonstrated serial changes of mean AFI values weekly with the threshold for oligohydromnios and polyhydromnios during pregnancy [11-13]. The values described by Moore and Cayle [11]. Are used worldwide. The cut-off values for the AFI commonly used are an AFI of 0–5 cm labelled as low fluid, 5.1 to 8 cm as normal fluid and greater than 8 cm as high fluid value. Rutherford *et al*. [12] and Phelan *et al*. [8] proposed a range of normal AFI of 8 to 18 cm. However as AFI values may be affected by the difference of race and environment. Fluid pockets free of fetal parts or aggregated loops of umbilical cord were measured vertically in each uterine quadrant and the sum of these was the AFI. An increased incidence of non-reactive non-stress tests (NSTs), fetal heart rate (FHR) deceleration, and cesarean deliveries for fetal distress in labor, meconium-stained amniotic fluid and low APGAR scores as the AFI decreased. Cesarean delivery for fetal distress in labor was increased when there was an elevated AFI. The parameters of the amniotic fluid index (AFI) were defined utilizing grayscale ultrasound. The introduction of color flow Doppler made the umbilical cord more evident on many ultrasound scans. Studies evaluating the AFI with color flow Doppler compared to gray-scale ultrasound at > 40 weeks [13] and > 36 weeks [14] have demonstrated a decreased AFI and an increase in the diagnosis of oligohydramnios. The AFI is the current 'gold standard [8-12], non-invasive semi quantitative and clinically useful technique. Croom *et al*. [15] found the AFI to be 84% accurate compared to the actual AFV, and there was a good correlation between the AFI and the largest vertical pocket. This study was done to compare the AFI by gray scale with that of color flow Doppler to determine whether a significant difference existed between the two measurement modalities.

MATERIALS AND METHODS

This cross sectional study was carried out in the department of Radiology and Imaging, Mymensingh Medical College Hospital, Mymensingh, Bangladesh from July 2012 to June 2014. The objectives of the study along with its procedure, alternative diagnostic methods, risks and benefits of this study were explained to the patients in easily understandable local language and then informed consent was taken from each patient. A total of 120 pregnant women ages between 18 to 40 years with gestational age belonged 28 to 40 weeks from OPD and inpatient department purposively selected referred above department for gray scale ultrasound and color Doppler sonography diagnosis to determine the amniotic fluid index. Women with multiple pregnancies and pregnancy with suspected leaking membranes were excluded from the study. Equipment used in this study, TOSHIBA Just Vision 400 for Gray scale, MEDISON Sonoace X8 for Color Doppler Sonography amd Curved array transducer of 3.5 MHz frequencies.

RESULTS

One hundred twenty patients with mean gestational age were 34.3±3.4 weeks (mean± SD) with gestational age range 28–40 weeks.

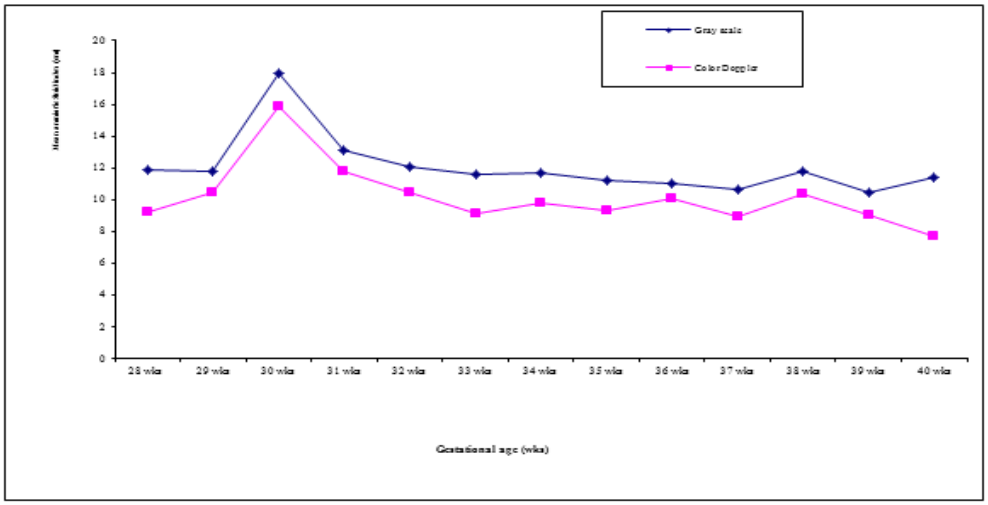

Fig-1: Line diagram showing comparison of the amniotic fluid index between gray scale and Color Doppler in each weeks of gestation of the study subjects.

The mean difference of amniotic fluid index (AFI) of each weeks of gestation evaluated by two modality measured was statistically significant in paired t-test but not significant at 36 weeks of gestation.

Table-1: Measurement of the amniotic fluid index (AFI) with gray scale and Color Doppler **of the study subjects (n=120)**

AFI (cm)	AFI by gray scale						AFI by Color Doppler					
	n	%	Mean	± SD	Range		n	%	Mean	± SD	Range	
< 5	3	2.5	4.2	±0.5	3.7	-4.6	7	5.8	3.7	±0.7	2.6	-4.9
5-10	34	28.3	8.4	±1.4	5	-10	51	42.5	8.0	±1.2	5.1	-10
>10 -20	79	65.8	13	±2.1	10.1	-19	58	48.3	11.6	±1.7	10.1	-17.5
> 20	4	3.3	29.6	±8.6	20.3	-38	4	3.3	28	±6.3	21.3	-35
Total	120	100.0	12	±4.6	3.7-38		120	100.0	10.2	±4.4	2.6-35	

Amniotic fluid index (AFI) of all pregnant women was evaluated by gray scale and Color Doppler in cm, which was divided into four categories. Amniotic fluid index (AFI) was found 3(2.5%) in <5 cm, 34(28.3%) was 5-10 cm, 79(65.8%) was >10-20 cm and 4(3.3%) was >20 cm measured by gray scale. The mean amniotic fluid index (AFI) of the <5 cm subjects were 4.2±0.5 cm (mean±SD) with AFI range 3.7-4.6 cm, 5-10 cm subjects were 8.4±1.4 cm (mean±SD) with AFI range 5-10 cm, >10-20 cm subjects were 13±2.1 cm (mean±SD) with AFI range 10.1-19 cm and >20 cm subjects were 29.6±8.6 cm (mean±SD) with AFI range 20.3-38 cm. The mean amniotic fluid index (AFI) by gray scale of the whole study subject were 12±4.6 cm (mean±SD) with AFI range 3.7-38 cm measured by gray scale. Color Doppler amniotic fluid index (AFI) 7(5.8%) had <5cm, 51(42.5%) had 5-10 cm, 58(48.3%) had >10-20 cm and 4(3.3%) had >20 cm. The mean amniotic fluid index (AFI) of the <5 cm subjects were 3.7±0.7 cm (mean±SD) with AFI range 2.6-4.9 cm, 5-10 cm subjects were 8±1.2 cm (mean±SD) with AFI range 5.1-10 cm, >10-20 cm subjects were 11.6±1.7 cm (mean±SD) with AFI range 10.1-17.5 cm and >20 cm subjects were 28±6.3 cm (mean±SD) with AFI range 21.3-35 cm. The mean amniotic fluid index (AFI) by Color Doppler (cm) of the whole study subject was 10.2±4.4 cm (mean±SD) with AFI range 2.6-35 cm. The distribution of 120 subjects was shown in (Table-1).

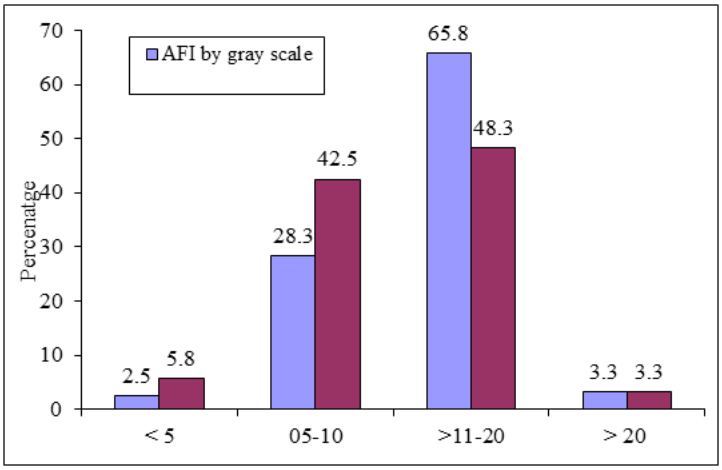

Fig-2: Bar diagram showing comparison of the amniotic fluid index (AFI) between gray scale and Color Doppler of the study subjects.

The level of agreement is 75.8% and the comparison of the results shows good agreement between gray scale and color Doppler; Kappa= 0.568 indicating significant but consistent difference between two modality (Table-2).

Table-2: Distribution of study subjects evaluated by gray scale and Color Doppler according to their amniotic fluid index (n=120)

AFI by color		AFI by Gray scale (cm)				Agreement	kappa
Doppler (cm)	Total	< 5 cm	5-10 cm	>10 -20 cm	>20 cm		
	n	n	n	n	n		
< 5 cm	7	3	4	0	0		
5-10 cm	51	0	29	22	0	75.8	0.568
>10-20 cm	58	0	1	56	1		
> 20 cm	4	0	0	1	3		
Total	120	3	34	79	4		

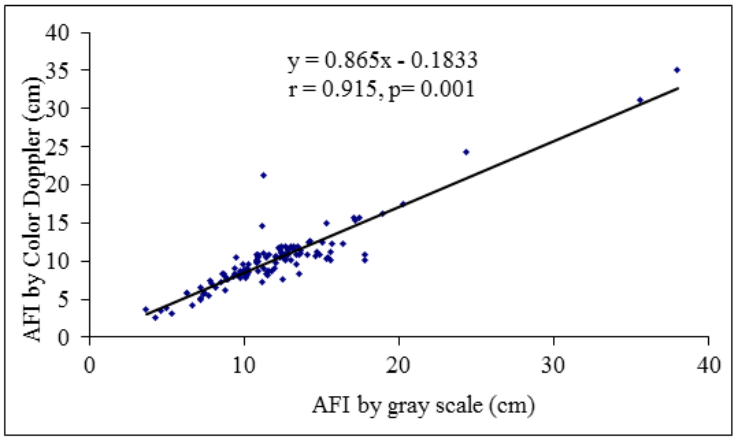

Fig-3: The scatter diagram shows significant relationship (r=0.915 p<0.05**) between amniotic fluid index (AFI) measured by gray scale and Color Doppler.**

DISCUSSION

The introduction of color flow Doppler into AFI determinations has raised questions as to the accuracy of the AFI if one follows the initial guidelines set up by Phelan and colleagues and Rutherford and colleagues, where the fluid pockets must be free of aggregates of cord and fetal parts [16]. If loops of cord are unseen with gray scale and are suddenly evident by the use of color Doppler, then the AFI will be decreased. The mean age of the pregnant women in this present study was 23.5±4.8 years (mean ± SD) varied from 18-40 years and majority (60.8%) of the patients were in the age range of 19-24 years and lowest were 4.2% in the age range >34 years. Similar age range also observed by Ali et al. [17] where they found the age of the patients varied from 18 to 40 years. In another study Bianco *et al.* [14] have shown in their study that mean maternal age was 29±3.7 (± SD) years, which is comparable with the present study. In this present study it was observed that majority (59.2%) of the subjects were in the gestational age range of 28-35 weeks and rest 40.8% in the gestational age range of 36-40 weeks, which is almost identical with Goldkrand *et al.* [16] study. Bianco *et al.* [14] have shown in a prospective study with pregnant women the mean AFI were 11.7±3.7 cm and 9.6±3.7 cm by gray scale and color Doppler respectively, which indicates that the mean AFI was significantly decreased with the addition of color Doppler (P <0.001). In this study the mean amniotic fluid index (AFI) of the subjects was 12±4.6 cm (mean±SD) with AFI range 3.7-38 cm measured by gray scale. In Color Doppler the mean amniotic fluid index (AFI) of the subjects was 10.2±4.4 cm (mean±SD) with AFI range 2.6-35 cm. The mean different of amniotic fluid index (AFI) was 1.8±1.21 cm (mean±SD) with AFI range 0.0-10 cm. The mean amniotic fluid index (AFI) was significantly (p<0.001), decreased in color Doppler measurement. The study findings were strengthened by the Goldkrand *et al.* [16] and Magann *et al.* [18]. All these investigators have observed significant reduction of AFI in color Doppler measurement as compared with gray scale imaging. Goldkrand *et al.* [16] found the mean AFI 9.3±3.3 cm (mean±SD) vs 8.5±3 cm (mean±SD) with gray scale vs color Doppler and significant reduction (p < 0.001) of AFI with color Doppler. Magann *et al.* [18] found the mean AFI 11.6±5 cm (mean±SD) with color Doppler and 9.3±4.9 (mean±SD) cm with gray scale and there was significant reduction (p<0.001) of AFI with the addition of color Doppler. Bianco *et al.* [14] also demonstrated that there were 18 patients with oligohydramnios (AFI <5cm), out of which 17 of these were detected by the AFI with color Doppler and only 2 of the 18 were detected using the gray scale. The detection of oligohydramnios by use of AFI with color Doppler was significantly increased from 11% to 94%

(p<0.05). Similar observation was seen in this study where oligohydramnios (AFI<5cm) was detected in 2.5% with gray scale and 5.8% by color Doppler. In the current series it was observed that the level of agreement is 75.8% and the comparison of the results shows good agreement between gray scale and color Doppler; Kappa= 0.568 indicating significant but reliable difference between two modality (Table II). Goldkrand *et al*. [19], found at gray-scale AFI <5cm, color AFI was basically the same, but at gray-scale AFI 5–10 cm, color AFI was < 5 cm, in 15.2% cases. At gray-scale AFI > 10 cm, no color AFI was < 5 cm. They also showed for each designated AFI (< 5 cm, 5–10 cm, > 10 cm), on average the color Doppler AFI was less than that of the gray scale (p<0.001); Kappa 0.7 indicating significant but consistent differences. In the present study a significant negative correlations (r=-0.223, p<0.014 & r=-0.225, p<0.005) were found between amniotic fluid index (AFI) measured by gray scale with gestational age and amniotic fluid index (AFI) measured Color Doppler with gestational age respectively. Goldkrand *et al.* [19] observed relationship between average gray-scale and color Doppler measurements of amniotic fluid index were r=0.94 and r= 0.93 for two separate examinations, which was consistent with the present study, where the current study found the correlation between two modalities was r=0.915, (p<0.001). Studies done by Moore and Cayle [11], Nwosu *et al*. [19] and Hallak *et al*. [20] on AFI has demonstrated serial changes of mean AFI values weekly with the threshold for oligohydromnios and polyhydromnios during pregnancy. Ali [12] results suggest that could define mild oligohydromnios or alarm points at 40 week when AFI is less than 7 cm. similar findings also described by Moore and Calye [11]. The alarming values is 6 cm in a study done on Indian by Khadilkar *et al*. [21] women while, in Chinese population [22] the lower limit is described as 5.6 cm. This study finding suggests that there is significant difference between measurement of AFI by color Doppler and gray scale and there is significant reduction of AFI with the use of color Doppler. The increased detection of oligohydramnios can potentially reduce perinatal morbidity and mortality if managed appropriately.

CONCLUSION

There was significant difference between measurement of AFI by color Doppler and gray scale sonography and color Doppler resulted in a significantly lower amniotic fluid volume measurement. Therefore it can be concluded that use of color Doppler may enhance the detection of oligohydramnios and help in the management of high risk pregnancy.

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