𝖆 OPEN ACCESS

Radiological Sciences

Assessment of Umbilical Artery Doppler Indices and Adverse Outcome in 33-46 Weeks Gestational Age Using Doppler

Eiman Hassan Kamal[1,2*], Mohammed Elfadil[2], Awadia Gareeballah Suliman[1], Rihab Ali Yousif[1], Ragaa Ahmed Aburaida[1]

[1]Faculty of Radiological Sciences and Medical Imaging, Alzaiem Alazhari University, Khartoum, Sudan
[2]Faculty of Medical Radiological Sciences Sudan University of Science and Technology, Khartoum, Sudan

***Corresponding author:** Eiman Hassan Kamal

| **Abstract** | | **Original Research Article** |

This was prospective study carried out in -Khartoum state –Sudan, Khartoum Bahri Teaching hospital in the period from august 2016 to December 2018. The main aim of the study was to assess umbilical arteries and outcome in 33-46 weeks GA using Doppler ultrasound. The study was done in 197 pregnant women with normal singleton pregnancy with mean age 28 years, with gestational age by Last Menstrual period (GA LMP) 33-46 weeks, classified into three group (Group one in GA ranged 33-38 weeks 6 days, Group two in age group 39 weeks -40 weeks (term) and Group three 40 weeks 1day to 46 weeks GA LMP (post-term) , no maternal medical condition that may affect pregnancy outcome such as diabetic and hypertension. The data was collected by data collection sheet designed especially for this study and including all variables; then analyzed by statistical package for social sciences (SPSS). The study found that most of them were nulliparous 78.8%. Significant difference in Doppler indices of UA were noted in these three group of gestational age (p < 0.05) except for PSV and EDV which had no significant difference in these three group of GA (p>0.05), the study found that there was weak significant negative correlation between UA PI,RI ,S\D ratio and GA LMP (p <0.05),the study clarified that as GA increased Doppler indices of UA decreased RI, PI, S\D ratio. There is significant relation between GA and adverse outcome as prevalence of oligohydramnios, macrosomia and cesarean section c\s increased in post-term pregnancy (p<0.01). The study confirmed that no significant differences in all these Doppler indices in patients post term with adverse versus post term with normal outcome.

Keywords: Doppler Ultrasound (DU), UA (Umbilical Artery), post term, LMP.

INTRODUCTION

Foetal neonatal and maternal complications associated with Late-Term and Post-term Pregnancies have always been underestimated. It is not well understood why some women become post-term although in obesity, hormonal and genetic factors have been implicated [1].

Late-term gestation is defined as one occurring between 41 0/7 and 41 6/7 weeks, while a pregnancy that lasts more than 42 0/7 weeks and beyond (294 days since the first day of the last menstrual period) is considered post-term gestations, other terms often used for this include prolonged pregnancy, post-dates pregnancy and post-maturity, Post-term pregnancy is associated with longer labours and operative delivery. In contrast, preterm pregnancies are less than 37 0/7 weeks' gestation, early term gestations are between 37 0/7 weeks

and 38 6/7 weeks, and full term occurs between 39 0/7 weeks and 40 6/7 weeks [2].

Post term pregnancy is associated with an increased risk of foetal and neonatal mortality and morbidity as well as an increased maternal morbidity. Antepartum stillbirth at and beyond term (37-43 weeks gestation) is a major public health problem accounting for a greater contribution to perinatal mortality than either deaths from complications of prematurity or the sudden infant death syndrome [1].

Maternal and foetal several test are often performed for a post-term pregnancy to monitor the outcome, like Foetal movement counting, Non-stress testing, Biophysical profile, ultrasound and Doppler ultrasound studies.

Doppler ultrasonography (DU) of fetal and uterine vessels is a well-established method for antenatal

monitoring. DU was successfully introduced in obstetric imaging and fetal monitoring way back in 1977 Fitzgerald *et al.*, were the first to report noninvasive demonstration of the umbilical cord (UC) blood flow pattern and suggested that the umbilical artery (UA) waveforms could be abnormal in fetuses with intrauterine growth-restriction (IUGR). This breakthrough concept of studying waveforms also resulted in several important clinical applications. Doppler assessment of the UA has now become standard of care in antenatal surveillance. Among all vessels studied in DU, the UA and MCA are relatively easier to access and evaluate and are more used [3].

Several studies have examined the potential value of Doppler assessment in the prediction of adverse outcome (usually defined as fetal distress in labor) in post-term pregnancies and provided conflicting results, the impedance to flow in the umbilical arteries of pregnancies with adverse outcomes was normal in five studies, increased in three studies [4-6] and decreased in one study [7].

OBJECTIVES

To assess the Umbilical Arteries Doppler Indices and Outcome in 33-46 weeks Gestational Age LMP using Doppler Ultrasound.

METHODOLOGY

197 patients were enrolled in the study, the S/D ratio, pulsatility index(PI) and resistance index (RI) of the umbilical artery in 33-46 GA LMP were taken, the including criteria was normal singleton pregnancy in third trimester pregnancies from 33 weeks to 46 weeks by GA LMP (calssified to three group ((Group one in GA ranged 33-38 weeks 6 days, Group two in age group 39 weeks - 40 weeks and Group three 40weeks 1day to 46 weeks GA LMP), any pregnant women with fetal anomaly before

recruitment, multi-fetal pregnancy, history of maternal smoking, known complications in the current pregnancy before recruitment, history of any pre-existing maternal medical condition (such as hypertension, diabetes mellitus, renal disease) likely to affect the fetus, and inability to obtain perinatal data were excluded, ethical approval is taken from department in area of study and verbal consent from each pregnant women was also taken.

UA was identified in each case using color Doppler. Spectral trace was obtained with a sample volume of 4 mm from the free loop of the UC. In case of difficulty in obtaining the free loop of the UC, the placental insertion of the cord was tracked along to help localizing the free loop. Angle of insonation was maintained between 0 and 60°. PI and RI were measured both manually and in auto mode over three consecutive cardiac cycles. The measurements were repeated and two successive readings showing same results were finally noted for the study, the pregnancy outcome and complication evaluate pre and postanataly.

The data collected by data collection sheet then analyzed using SPSS version 16, frequency and percentage were taken then corrlation to determine asoossciation between doppler indicies and other variables were done and significant if p value <0.05 consider significant, regression analysis was done to assess relation between doppler indicies and GA.

RESULTS & DISCUSSION

The age of pregnant women ranged 17-45 years, 46% of them in age ranged 24-30 years and 23.9% of them in age group 17-23 years as shown in table and Figure-1, mean age 28.07 ± 6.07 years, most of them were nulliparous 78.7%, (as shown in Table 1 & 2, Figure-1).

Table-1: Frequency distribution of age \years

Age\years	Frequency	Percen	Valid Percen	Cumulative Percen
17-23	47	23.9	23.9	23.9
24-30	91	46.2	46.2	70.1
31-37	43	21.8	21.8	91.9
38-45	16	8.1	8.1	100.0
Total	197	100.0	100.0	
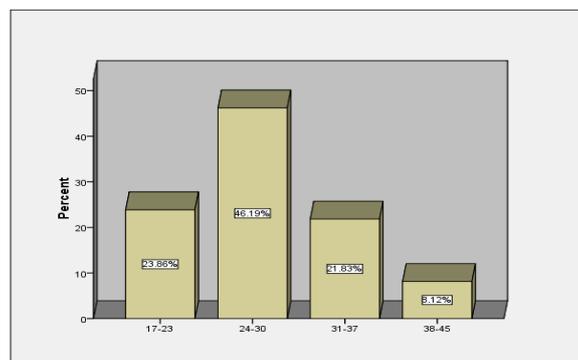
Fig-1: Frequency distribution of age \year

Table-2: Frequency distribution of parity

Parity	Frequency	Percent	Valid Percent	Cumulative Percent
Nulliparous	155	78.7	78.7	78.7
Multiparous	42	21.3	21.3	100.0
Total	197	100.0	100.0	

The study clarified that the mean Doppler indices for UA were $0.46 \pm .18, 0.80 \pm 0$, 29.44 ± 8.88, 16.18 ± 5.28, 1.88 ± 0.46 for RI,PI, PSV, EDV, S\D ratio respectively (as shown in Table-3)

Table-3: descriptive statistic for age and measurements of GA, Doppler indices of UA (minimum, maximum, mean ± Std. Deviation)

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age of women	197	17	45	28.07	6.076
GA LMP	197	33.43	46.43	39.0753	2.27973
GA FL	197	29.00	41.71	37.6214	2.09028
GA BPD	197	29.00	41.71	37.2923	2.15982
GA AC	197	29.00	42.00	37.5158	2.52691
UA PSV	197	12.7	65.2	29.449	8.8804
UA EDV	197	5.0	43.4	16.184	5.2817
RI UA	197	0.10	1.82	0.46	0.18
PI UA	197	0.15	3.96	0.80	0.46
S\D UA	197	1.11	5.08	1.8817	0.46835
Valid N (listwise)	197				

The study found that 51.3 % of these cases had normal outcome, while 48.7% had adverse outcome. 34.5% delivered by CS, 3.5% had oligohydramnios, 5% had macrosomia, 0.5 % prenatal mortality (as shown in Table-4).

Table-4: Frequency distribution of outcome

Adverse outcome	Frequency	Percent	Valid Percent	Cumulative Percent
C\S	68	34.5	34.5	34.5
polyhydramnios	4	2.0	2.0	36.5
oligohydramnios	5	2.5	2.5	39.1
macrosomia	3	1.5	1.5	40.6
macrosomia and C\S	5	2.5	2.5	43.1
C\S and polyhydramnios	6	3.0	3.0	46.2
normal outcome	101	51.3	51.3	97.5
oligo and C\S	2	1.0	1.0	98.5
macrosomia, C\S and polyhydramnios	2	1.0	1.0	99.5
prenatal mortality	1	.5	.5	100.0
Total	197	100.0	100.0	

The study found that there was no significant difference in Doppler indices of UA in these three group of gestational age ($p > 0.05$), except for S\d ratio and PI which shows significant difference in different age group ($p < 0.05$) ,the mean Doppler indices for each were $29.95 \pm 9.73, 15.8 \pm 6.01, 0.48 \pm 0.19$, 0.81 ± 0.32, $1.97 \pm .53$ for PSV ,EDV , RI, PI , S\D ratio respectively for 34-38 w6d , 29.04 ± 7.94, 17.05 ± 5.0, 0.45 ± 0.25, 0.94 ± 0.84, 1.75 ± 0.31 PSV ,EDV , RI, PI , S\D ratio respectively for 39-40 weeks and 28.9 ± 8.02, 16.15 ± 4.12, 0.42 ± 0.11, 0.71 ± 0.27, 1.82 ± 0.40 PSV ,EDV , RI, PI , S\D ratio respectively for postdate respectively.

Table-5: compare mean Doppler indices of UA in different range of GA by LMP

GA		PSV UA	EDV UA	S\D UA	PI UA	RI UA
33-38w6d	Mean	29.9505	15.8920	1.9681	.8067	.4840
	N	98	98	98	98	98
	Std. Deviation	9.73928	6.01346	.53298	.32869	.19228
term (39-40 weeks)	Mean	29.0446	17.0506	1.7580	.9423	.4594
	N	35	35	35	35	35
	Std. Deviation	7.94979	5.00615	.31973	.84138	.25625
post date (more than 40 weeks)	Mean	28.9027	16.1586	1.8277	.7095	.4269
	N	64	64	64	64	64
	Std. Deviation	8.02546	4.12757	.40849	.27904	.11837
Total	Mean	29.4491	16.1845	1.8851	.7992	.4611
	N	197	197	197	197	197
	Std. Deviation	8.88037	5.28175	.46835	.45564	.18665
P value		0.733	0.530	0.03	0.05	0.163

The study demonstrate that as GA increased Doppler indices of UD decreased RI, PI, S\D ratio (as shown in Figure 2 & 3).
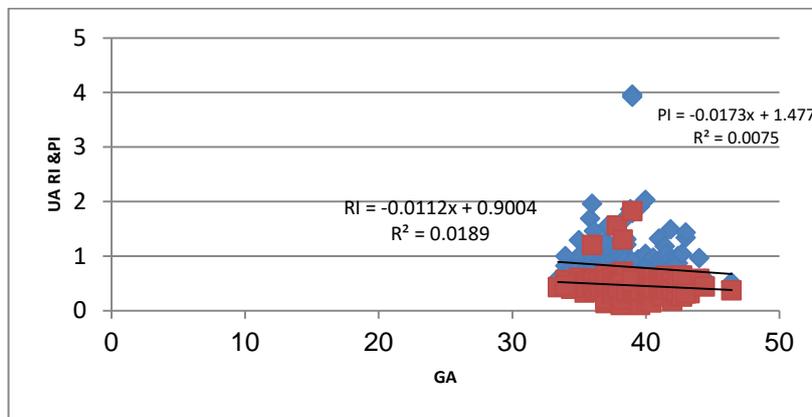
Fig-2: Scatterplot shows inverse linear relation between GA LMP and RI, PI UA
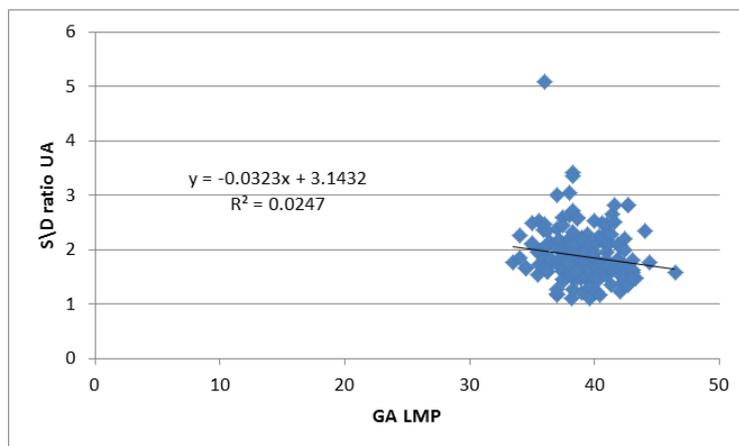
Fig-3: Scatterplot shows inverse linear relation between GA LMP and S\D ratio of UA

There is significant relation between GA and adverse outcome P=.007 as prevalence of oligohydramnios, macrosomia a, prenatal mortality and cesarean section c\s increased in postdate, this results go online with Battaglia *et al.*, [8]. Post-Term pregnancies were associated with an increased incidence of oligohydramnios (as shown in Table-6).

Table-6: Cross tabulation adverse outcome and GA

Outcome	GA			Total
	33-38w6d	Term (39-40 weeks)	postdate (>40 weeks)	
C\S	31	11	26\64 (40.6%)	68
polyhydramnios	4	0	0\ 64 (0%)	4
oligohydramnios	2	1	2\64 (3.12%)	5
macrosomia	0	0	3\64 (4.69%)	3
macrosomia and C\S	0	1	4\64 (6.25%)	5
C\S and polyhydramnios	3	0	3\64 (4.69%)	6
normal outcome	58	22	21\64 (32.8%)	101
oligo and C\S	0	0	2\ 64 (3.12%)	2
macrosomia, C\S and polyhydramnios	0	0	2\64 (3.12%)	2
prenatal mortality	0	0	1\64 (1.56%)	1
	98	5	64	197
P =0.007				

Concerning Doppler indices and outcome in postdate pregnancy the study clarified that no significant difference in Doppler indices in normal versus adverse outcome p >0.05, slightly increased in PSV and EDV were noted in post term with adverse outcome (Table-7). (Table-8) compare the present study Doppler indices in post term pregnancy with adverse and normal outcome correlate to other studies performed in different countries

Table-7: Compares mean Doppler indices of UA and outcome in post term

	Adverse outcome	N	Mean	Std. Deviation	Std. Error Mean	P
UA PSV	no	21	26.52	5.82	1.27	
	yes	43	30.06	8.73	1.3 3	
UA EDV	no	21	15.02	3.54	.77	
	yes	43	16.71	4.31	.65	>0.05
UA S\D ratio	no	21	1.81	.387	.084	
	yes	43	1.84	.42	.06	
UA PI	no	21	.75	.29	.06	
	yes	43	.69	.27	.041	
UA RI	no	21	.42	.11	.025	
	yes	43	.42	.12	.018	

Table-8: Compare the present study Doppler indices in post term pregnancy with adverse and normal outcome correlate to other studies performed in different countries

Author	n	Impedance to flow	Adverse outcome	P value
Rightmire & Campbell, 1987 [4]	35	umbilical artery	increased	
Fischer *et al.*, 1991 [5]	75	umbilical artery	increased	
Anteby *et al.*, 1994 [6]	78	umbilical artery	increased	
Olofsson *et al.*, 1997 [7]	44	umbilical artery	decreased	
Farmakides *et al.*, 1988 [9]	149	umbilical and uterine arteries	normal	
Brar *et al.*, 1989 [10]	45	umbilical and uterine arteries	normal	Not significant >0.05
Stokes *et al.*, 1991 [11]	70	umbilical and uterine arteries	normal	
Bar-Hava *et al.*, 1995 [12]	57	umbilical and middle cerebral arteries	normal	
Zimmermann *et al.*, 1995 [13]	153	umbilical, uterine & middle cerebral arteries	normal	
Present study, 2019	64	PI	decreased	
		RI	unchanged	
		PSV , EDV, S\D ratio	slightly increased	

Image-1: Shows color Doppler umbilical artery waveform at 41 weeks
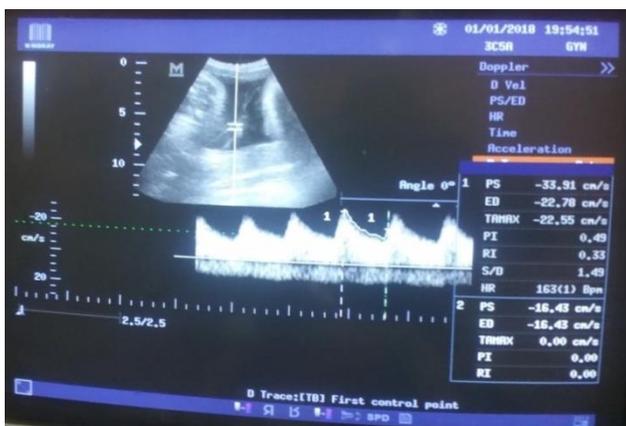
Image-2: Shows color Doppler umbilical artery waveform at 38 weeks

CONCLUSION

The study concluded that there was inverse linear relationship between Doppler indices and GA, there was significant difference in adverse outcome with GA as caesarian section, oligohydramnios, prenatal mortality, macrosomia all of them was more in post term than in preterm and term pregnancy, the UA PSV and EDV were increased in patients with adverse outcome than in normal and no significant difference in all Doppler indices of UA in patients post term with adverse versus normal outcome.

REFERENCES

1. Galal M, Symonds I, Murray H, Petraglia F, Smith R. Postterm pregnancy. Facts, views & vision in ObGyn. 2012;4(3):175-187.
2. American College of Obstetricians and Gynecologists. Practice bulletin no. 146: Management of late-term and postterm pregnancies. Obstetrics and gynecology. 2014 Aug;124(2 Pt 1):390-396.
3. Fitzgerald DE, Drumm JE. Non-invasive measurement of human fetal circulation using ultrasound: a new method. Br Med J. 1977 Dec 3;2(6100):1450-1.
4. Rightmire DA, Campbell ST. Fetal and maternal Doppler blood flow parameters in postterm pregnancies. Obstetrics and gynecology. 1987 Jun;69(6):891-4.
5. Fischer RL, Kuhlman KA, Depp R, Wapner RJ. Doppler evaluation of umbilical and uterine-arcuate arteries in the postdates pregnancy. Obstetrics and gynecology. 1991 Sep;78(3 Pt 1):363-8.
6. Anteby EY, Tadmor O, Revel A, Yagel S. Post-term pregnancies with normal cardiotocographs and amniotic fluid columns: the role of Doppler evaluation in predicting perinatal outcome. European Journal of Obstetrics & Gynecology and Reproductive Biology. 1994 Apr 1;54(2):93-8.
7. Olofsson P, Saldeen P, Marsál K. Association between a low umbilical artery pulsatility index and fetal distress in labor in very prolonged pregnancies. European Journal of Obstetrics & Gynecology and Reproductive Biology. 1997 May 1;73(1):23-9.
8. Battaglia C, Artini PG, Ballestri M, Bonucchi D, Galli PA, Bencini S, Genazzani AP. Hemodynamic, hematological and hemorrheological evaluation of post-term pregnancy. Acta obstetricia et gynecologica Scandinavica. 1995 May;74(5):336-40.
9. Farmakides G, Schulman H, Ducey J, Guzman E, Saladana L, Penny B, Winter D. Uterine and umbilical artery Doppler velocimetry in postterm pregnancy. The Journal of reproductive medicine. 1988 Mar;33(3):259-61.
10. Brar HS, Horenstein J, Medearis AL, Platt LD, Phelan JP, Paul RH. Cerebral, umbilical, and uterine resistance using Doppler velocimetry in postterm pregnancy. Journal of Ultrasound in Medicine. 1989 Apr;8(4):187-91.
11. Stokes HJ, Roberts RV, Newnham JP. Doppler flow velocity waveform analysis in postdate pregnancies. Australian and New Zealand journal of obstetrics and gynaecology. 1991 Feb;31(1):27-30.
12. Bar-Hava I, Divon MY, Sardo M, Barnhard Y. Is oligohydramnios is postterm pregnancy associated with redistribution of fetal blood flow?. American journal of obstetrics and gynecology. 1995 Aug 1;173(2):519-22.
13. Zimmermann P, Albäck T, Koskinen J, Vaalamo P, Tuimala R, Ranta T. Doppler flow velocimetry of the umbilical artery, uteroplacental arteries and fetal middle cerebral artery in prolonged pregnancy. Ultrasound in Obstetrics and Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology. 1995 Mar 1;5(3):189-97.