IJMA

International Journal of Medical Arts

Volume 6, Issue 1, January 2024

P- ISSN: 2636-4174
E- ISSN: 2682-3780

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main Subject [Gynecology and Obstetrics]

Original Article

Uterine Artery Pulsatility Index Changes in Hypertensive Pregnancies during Antepartum, Immediate Postpartum and Late Postpartum Periods

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Article information

Received: 07-11-2023

Accepted: 05-12-2023

DOI: 10.21608/IJMA.2023.247004.1860.

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Citation: Alharbi SY, Mohamed NM, keshta NH. Uterine Artery Pulsatility Index Changes in Hypertensive Pregnancies during Antepartum, Immediate Postpartum and Late Postpartum Periods. IJMA 2024 January; 6 [1]: 4023-4028. doi: 10.21608/IJMA.2023.247004.1860.

ABSTRACT

Background and Aim of the work: Normal pregnancy placentation causes endovascular trophoblast to penetrate the spiral arteries, which leads to significant artery remodeling. Hence, our study aimed to document alternations in the uterine artery Pulsatility index [UAPI] in antepartum hypertensive pregnancy, early postpartum, and late postpartum periods compared with normal pregnancy. Regarding changes in uterine artery Doppler study, we investigated 50 cases [25 hypertensive and 25 normotensive pregnancies] in antepartum [30 weeks until birth], early postpartum [within 2 days], and late Postpartum [3 weeks].

Patients and Methods: Fifty pregnant women were included in this study; they were separated into two equal groups depending on whether they had hypertension at any point throughout their pregnancy. Women in group [A] have hypertensive diseases throughout pregnancy, including gestational hypertension, preeclampsia, preeclampsia with chronic hypertension and superimposed preeclampsia. Women in group [B] had pregnancies with normotension.

Results: In the antepartum, early postpartum, and late postpartum phases, group A systolic and diastolic blood pressures were considerably greater than group B [P value <0.001]. On the other hand, there was no discernible variation in the amniotic fluid index [AFI] between the two groups. In the antepartum, early postpartum, and late postpartum phases, group A right [Rt] and left [Lt] UAPI, uterine artery resistance index [UARI], and early diastolic notch [EDN] were considerably greater than group B. In the late postpartum phases, there was no discernible difference in the EDN between the two groups.

Conclusion: Rt and Lt UAPI and UARI are substantially elevated in hypertensive women compared to normotensive women during antepartum and postpartum periods.

Keywords: Uterine Artery Pulsatility; Hypertensive pregnancies; Postpartum period.

INTRODUCTION

Normal pregnancy placentation causes endovascular trophoblast to penetrate the spiral arteries, which leads to significant artery remodeling. In turn, this remodeling results in reduced resistance and elevated flow in the uterine artery [UA] Doppler [1]. On the other hand, inadequate tropho-blast penetration in hypertensive pregnant women causes an aberrant UA Doppler, marked by an early diastolic notch [EDN] and an elevated Pulsatility index [PI] [2].

According to previous reports, aberrant Doppler imaging of the UA in hypertensive pregnant women is linked to unfavourable perinatal outcomes, including low birth weight and premature labour [3, 4]. Furthermore, it has been demonstrated that the first trimester elevated uterine artery Pulsatility index [UAPI] may be utilized for predicting hypertension and fetal growth restriction [5, 6].

Since the placenta is eliminated at birth and the mother's hypertension resolves in the post-partum phase, delivery is regarded as the definitive treatment for gestational hypertension. The UA and its branches are affected by uterine involution during the puerperal phase, which causes dynamic alterations in the UA Doppler and the uterine muscles [endometrium] [7]. UA Doppler alterations following childbirth in normal pregnancies have been a focus of various investigations [8]. While some of these investigations were unable to detect any discernible changes, the majority of them showed an increase in UA indices throughout the postpartum period, including the PI and resistance index [RI] [7, 8].

On the other hand, little is known about the postpartum UA Doppler in pregnancies with hypertension. Hypertensive disorders during pregnancy are considered the most prevalent health issues of pregnancy, as they affect 6% to 8% of pregnant women [1, 2]. According to recent research, combining maternal history with the evaluation of multiple clinical markers is a more successful strategy for forecasting the incidence of pregnancy-related hypertension diseases [9].

One of the clinical instruments frequently used in obstetrics is UA Doppler velocimetry, which is a helpful screening test for women who are at a greater risk of preeclampsia [5, 10]. Our study aimed to document changes in UAPI in antepartum hypertensive pregnancy, early post-partum, and late postpartum periods compared with normal pregnancy.

PATIENTS AND METHODS

Fifty pregnant women were included in this prospective case-control and comparative study; they were separated into two equal groups depending on whether they had hypertension at any point throughout their pregnancy. Women in group [A] have hypertensive diseases throughout pregnancy, such as gestational hypertension, preeclampsia, preeclampsia with chronic hypertension and superimposed pre-eclampsia. Women in group [B] had pregnancies with normotension. The research project was carried out with permission from the Al-Azhar University Faculty of Medicine [for girls] Ethical Committee in Cairo, Egypt. Every patient provided written informed approval.

The exclusion criteria involved fetal abnormalities as small for gestational age not related to hypertension, and other disorders, including diabetic disorders, immune-mediated disorders, kidney disorders, uterine abnormalities, pregnant multiple times women requiring blood transfusions, additional surgeries performed during or after vaginal birth as pelvic arterial embolization, those on anticoagulant agents during their pregnancy, and those using any prostaglandins during labor.

Data collection: All patients were subjected to sociodemographic characteristics and complete clinical examination, including blood pressure measurements. Routine investigations, including complete blood count [CBC], urine analysis for proteinuria, liver and kidney function tests, blood group, and Rhesus factor. Ultrasound examination, including biometric measurements of amniotic fluid index and umbilical artery PI and UAPI.

Doppler measurement of the uterine arteries: During pregnancy [30 weeks until birth], women in the study were instructed to evacuate their bladders and were positioned in the dorsal lithotomy position by a transvaginal ultrasound device [GE healthcare versana essential Logiq P7 device with a 7,5 MHz curved transvaginal transducer] Sono ace R3 [Samsung, Seoul, South Korea]. Using a colour Doppler, the UtA was located at the level of the internal cervical os. A pulsed Doppler was then utilized to determine the average value of three successive UAPI and Maximum systolic velocity measurements [11]. The opposite uterine artery

underwent the same follow-up procedure. The main outcome indicator for analysing the data was the average value of both left and right arteries. It was also noted whether early diastolic notches were present or absent [12]. The same procedure was repeated, 2 days and 3 wks. postpartum

Statistical analysis: With SPSS v26 [IBM Inc., Chicago, IL, USA], statistical analysis was carried out. The symmetry of the data distributions was assessed using histograms and the Shapiro-Wilks test. The mean and standard deviation [SD] of quantitative parameters were reported, and the unpaired Student's t-test was used to contrast the two groups of the study. The Mann-Whitney test was used to analyze quantitative non-parametric variables, which were reported as the median and interquartile range [IQR]. The occurrence and percentage [%] of the qualitative variables were reported, and when applicable, the Fisher's exact test or the Chi-square test was applied. Statistical significance was defined as a two-tailed P value less than 0.05.

RESULTS

A total of 50 patients divided into two groups were included in this study. Table 1 shows the patients demographics in which we found no discernible variation in age, parity, or gestational age between the two groups.

Regarding systolic and diastolic blood pressure, group A had significantly higher systolic and diastolic blood pressure than group B throughout the antepartum, early postpartum, and late post-partum phases [P value <0.001] [Table 2].

We found no discernible variation in the amniotic fluid index [AFI] between the two groups. In the antepartum, early postpartum, and late postpartum phases, group A right and left UAPI, UARI, and EDN were considerably greater than group B. In the late postpartum phase, there was no discernible difference in the EDN between the two groups [Table 3].

Table [1]: Demographics of the patients

	Group A [n=25]	Group B [n=25]	P value
Age [years]	31.32 ± 6.22	30.16 ± 4.78	0.463
Parity	0 [0 – 2]	1 [0 – 2]	0.114
Gestational age at measurement [weeks]	35.56 ± 2.12	34.36 ± 2.48	0.072

Table [2]: Systolic and diastolic blood pressure in antepartum, early postpartum and late postpartum period of the studied groups

		Group A [n=25]	Group B [n=25]	P value
Antepartum period	Systolic blood pressure [mmHg]	155.04 ± 6.68	111.24 ± 4.83	**<0.001***
	Diastolic blood pressure [mmHg]	94.44 ± 4.67	76.64 ± 3.19	**<0.001***
Postpartum period [within 2 days]	Systolic blood pressure [mmHg]	143.52 ± 4.32	112.96 ± 3.37	**<0.001***
	Diastolic blood pressure [mmHg]	85 ± 3.7	76.96 ± 4.16	**<0.001***
Late Postpartum [3 weeks]	Systolic blood pressure [mmHg]	143.52 ± 4.32	112.96 ± 3.37	**<0.001***
	Diastolic blood pressure [mmHg]	85 ± 3.7	76.96 ± 4.16	**<0.001***

Table [3]: Amniotic fluid index, UtA PI, UtA RI and early diastolic notch in antepartum, early postpartum and in late postpartum period of the studied groups

		Group A [n=25]	Group B [n=25]	P value
Antepartum period	Amniotic fluid index [cm]	12.88 ± 3.48	12.56 ± 4.19	0.770
	Right UAPI	1.25 ± 0.47	0.7 ± 0.16	**<0.001***
	Left UAPI	1.46 ± 0.52	0.63 ± 0.16	**<0.001***
	Right UARI	0.7 ± 0.12	0.56 ± 0.15	**<0.001***
	Left UARI	0.7 ± 0.11	0.63 ± 0.14	**0.042***
	Early diastolic notch	11 [44%]	2 [8%]	**0.004***
Early postpartum period [within 2 days]	Right UAPI	1.4 ± 0.36	1.12 ± 0.21	**0.002***
	Left UAPI	1.33 ± 0.36	1.13 ± 0.21	**0.023***
	Right UARI	0.72 ± 0.09	0.61 ± 0.13	**<0.001***
	Left UARI	0.68 ± 0.12	0.6 ± 0.11	**0.014***
	Early diastolic notch	21 [84%]	12 [48%]	**0.007***
Late postpartum [3 weeks]	Right UAPI	1.43 ± 0.42	1.15 ± 0.27	**0.007***
	Left UAPI	1.45 ± 0.4	1.23 ± 0.33	**0.04***
	Right UARI	0.75 ± 0.1	0.6 ± 0.12	**<0.001***
	Left UARI	0.72 ± 0.1	0.65 ± 0.13	**0.029***
	Early diastolic notch	16 [64%]	13 [52%]	0.390

DISCUSSION

Endovascular trophoblast invades the spiral arteries during the placentation of healthy pregnancies, which causes significant remodeling of these arteries. In turn, this remodeling results in reduced resistance and elevated flow in the UA Doppler. On the other hand, inadequate trophoblast penetration in hypertensive pregnant women causes an aberrant UA Doppler, marked by an early diastolic notch and an elevated PI [13].

Regarding our results, age, parity, and gestational age were insignificantly different between both groups. These findings agreed with **Guedes-Martins *et al.*** [14], who found no substantial variation between hypertensive and normotensive pregnant mothers regarding age, parity, and gestational age. Also, **Lee *et al.*** [11] were in accordance with our observations as they showed that hypertensive pregnant females had no difference regarding age, parity, and gestational age compared to normotensive females.

Contrary to our results, **Shen *et al.*** [15], had different results as they found that hypertensive pregnant females had significantly increased age and parity as risk factors as compared to normotensive pregnant women.

Our results show that Group A had significantly higher systolic and diastolic blood pressure than group B during the antepartum, early postpartum, and late postpartum phases [P value <0.001]. These results are in accordance with **Martin *et al.*** [16], who exhibited that hypertensive pregnant women had significantly elevated systolic and diastolic blood pressure in comparison to normotensive pregnant women.

Moreover, **Ngene *et al.*** [17] and **Ushida *et al.*** [18], ascertained our findings as they observed high systolic and diastolic blood pressure in hypertensive pregnant mothers differently from normotensive mothers. Based on our statistic, amniotic fluid index was insignificantly different between both groups. Rt and Lt UAPI, UARI, and EDN in the antepartum period were substantially elevated in group A than in group B [P value < 0.05]. **Alchalabi *et al.*** [19] were on the same side of our outcomes as they found no difference regarding amniotic fluid index between hypertensive pregnant women compared to normal pregnant women. Additionally, **Svirsky *et al.*** [20] and **Shahid *et al.*** [21], assured our results as they noted that Rt and Lt UAPI in the antepartum period were substantially elevated in pregnant women with hypertension as opposed to those with normotension. Additionally, **Weintraub *et al.*** [22] and **Mohamed *et al.*** [23], were on the same side of our results as they noticed high right UARI, left UARI, and EDN in the antepartum period in pregnant women with hypertension as opposed to those with normotension.

Endovascular trophoblast invades the spiral arteries during the placentation of healthy pregnancies, which causes significant remodeling of these arteries. In turn, this remodeling results in reduced resistance and elevated flow in the UA Doppler. On the other hand, inadequate trophoblast penetration in hypertensive pregnant women causes an aberrant UA Doppler, marked by an early diastolic notch and an elevated PI [24]. However, **Malhotra and Deka al.** [25] disagreed with our results as they found that the AFI was lower in pregnant women with hypertension as opposed to those with normotension. Regarding our results, systolic and diastolic blood pressure in the early postpartum period were substantially elevated in group A than in group B [P value <0.001].These results matched **de Hass *et al.*** [26] and **Giorgione *et al.*** [27] as they noticed that systolic and diastolic blood pressure were higher in the postpartum period in females who had hypertension-induced pregnancy before compared to normotensive females during pregnancy.

Our work showed that right and left Ut arteries pulsatility indices, right and left Ut RI in the early postpartum period were substantially elevated in group A than in group B [P value < 0.05]. **Oloyede and Iketubosin** [28] agreed with our results as they found that Rt and Lt UAPI and UARI in the early postpartum period were substantially elevated in pregnant women with hypertension as opposed to those with normotension. Moreover, **Wu *et al.*** [29] and **El Nagar *et al.*** [30] had the same results of Rt and Lt UAPI and UARI in the early postpartum period were significantly higher in hypertensive women.

Our work states that systolic and diastolic blood pressure in the late postpartum period were substantially elevated in group A than in group B [P value <0.001]. **Brown al.** [31] exhibited the same outcomes as he stated that systolic and diastolic blood pressure in the late postpartum phase were significantly higher in previous hypertensive females during pregnancy. Also, **Thomas *et al.*** [32], were on the same side

of our outcomes as they found that females who showed hypertension in pregnancy also showed higher blood pressure in the late postpartum period.

Our study observes that Rt and Lt UAPI and UARI in the late postpartum period were substantially elevated in group A than in group B [P value < 0.05]. Early diastolic notch was insignificantly different between both groups. These results are in accordance with **Alves *et al.*** [33], who found high Rt and Lt UAPI and UARI of hypertensive females during pregnancy, even in the late postpartum period. Rt and Lt UAPI and UARI were still high in the late postpartum period [3 weeks] for follow-up.

Additionally, **Lee *et al.*** [11], supported our results as they observed that Early diastolic notch was insignificantly different between hypertensive females compared to normotensive in the late postpartum phase. This is primarily due to the fact that EDN disappears in the late postpartum period in normotensive women, explaining the absence of the difference between hypertensive and normotensive women for this factor. The discovery was that, in normal pregnancies, the percentage of patients with an early diastolic notch rose. The process by which the UA returns to its non-pregnant condition could be the basis for this pattern [34].

Our study is limited by that it is a single-centre study may result in different findings than elsewhere; also, a small sample size may produce insignificant results.

Conclusion: Rt and Lt UAPI and UARI are significantly high in hypertensive women compared to normotensive during antepartum [30 weeks until birth], early postpartum [within 2 days], and late postpartum periods [3 weeks]. Diastolic notch shows a significant appearance in the antepartum period only then becomes indifferent in the postpartum period in pregnancy-induced hypertension women. Rt and Lt UAPI and UARI are still high in the late postpartum [3 weeks] for follow-up.

Financial and non-financial relations and activities of interest: None

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IJMA

International Journal of Medical Arts

Volume 6, Issue 1, January 2024

P- ISSN: 2636-4174
E- ISSN: 2682-3780