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METAMORPHOSIS IN BOTH CARDIOTOCOGRAPHY AND UMBILICAL ARTERY DOPPLER IN PATIENTS WITH SEVERE PREECLAMPSIA AFTER LOADING DOSE OF MAGNESIUM SULPHATE

By

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ABSTRACT

Background: Preeclampsia often affects young and nulliparous women, whereas older women are at great risk of chronic hypertension with superimposed preeclampsia. Magnesium sulphate is widely used in obstetrics, and is a drug of choice in two important complications of pregnancy, preeclampsia and preterm labor. Magnesium sulphate is used to prevent seizures in preeclampsia patients.

Objective: To evaluate changes in Doppler velocimetry parameters of the umbilical artery together with continuous cardiotocography (CTG) parameters before and after magnesium sulphate administration in pregnant women with severe preeclampsia, and the possible effects of these changes on mode of delivery and neonatal outcome for fetal monitoring in these pregnant women.

Patients and methods: A prospective observational cohort study was conducted at the Obstetrics and Gynecology Department, Al-Hussein and Sayed Galal Hospitals, Al-Azhar University. One hundred women with severe preeclampsia were included in the study. Cases were recruited from the emergency unit during the period from December 2020 to May 2020.

Results: Patient's umbilical artery doppler showed a statistically significant decreased of RI and PI. Middle cerebral artery doppler showed a statistically significant decrease in RI and PI after 1 hours when it compared with baseline. Uterine artery doppler showed a statistically significant decrease of all uterine artery after 1 hours when it compared with baseline. All UA/MCA parameters decreased with no statistically significant differences.

Conclusion: $MgSO_4$ proved to cause many hemodynamic changes as it has vasodilator effect on maternal and fetal blood vessels. Doppler indices in the umbilical (decrease in PI and RI) significantly changed after administration of $MgSO_4$ in pregnant women.

Keywords: Severe Preeclampsia, CTG, Umbilical artery Doppler, Magnesium Sulphate.

INTRODUCTION

Preeclampsia is a common complication of pregnancy and occurs in about 5-10% of all pregnancies. Preeclampsia is defined as a development of hypertension (140/90 mm Hg) and new onset of one or more of the, proteinuria (> 300 mg of urinary protein in 24 h), end organ dysfunction after 20 weeks of

gestations and unfortunately is a major cause of maternal and fetal morbidity and mortality worldwide *(Rana et al., 2019)*.

In view of recent studies that indicate a minimal relation between quantity of urinary protein and pregnancy outcome in preeclampsia, massive proteinuria (greater than 5 g) has been eliminated from consideration of preeclampsia as severe. Also, because fetal growth restrictions are managed similarly in pregnant women with or without preeclampsia, it was removed as a finding indicating severe preeclampsia *(Mayrink et al., 2018)*.

In normal pregnancy, adequate uteroplacental perfusion depends on normal physiologic development of the placental vascular system through trophoblast invasion of the uterine spiral arteries. The placental vasculature is subsequently converted into a dilated, low-resistance system, through a process termed angiogenesis. Preeclampsia is thought to be the consequence of impaired trophoblastic invasion of the maternal spiral arteries *(Armaly et al., 2018)*.

Magnesium sulfate is a drug of choice in preeclampsia as an anticonvulsant rather than an antihypertensive. Regimens for administration of this drug have evolved over the years, but have not yet been formally evaluated *(Ueda et al., 2016)*.

In past, $MgSO_4$ was given according to Pritchard regime in which 5 grams of magnesium sulfate was administered four-hourly for 24 hours after loading with 14 grams. It was observed that many patients did not receive maintenance therapy due to fear of toxicity but they did not convulse any further. On the basis of this observation, many studies were planned to compare the efficacy of loading dose of magnesium sulfate versus the standard regime in the management of preeclampsia to prevent fits *(Li et al., 2020)*.

Ehrenberg and Mercer studied abbreviated postpartum magnesium administration in 200 women with mild preeclampsia. None of these women and none of the other cohort given the 24-hour magnesium infusion developed eclampsia. Implementation of magnesium sulfate would be strengthened if guidelines and recommendations for practice could be based on reliable evidence about the comparative effects of alternative regimens *(Khalifa et al., 2019)*.

Fetal circulation has long been studied by Doppler sonography, which can provide valuable information regarding neonatal prognosis and fetal well-being in compromised pregnancies. Doppler sonography has also been used for evaluation of various drugs on Doppler blood waveforms *(Sayin et al., 2010)*.

The aim of this study was to evaluate changes in Doppler velocimetry parameters (resistance index [RI], pulsatility index [PI] and systolic/diastolic [S/D] ratio) of the umbilical artery together with CTG parameters before and after magnesium sulphate administration in pregnant women with severe preeclampsia, and the possible effects of these changes on mode of delivery and neonatal outcome for fetal monitoring in these pregnant women.

PATIENTS AND METHODS

A prospective observational cohort study was conducted at the Obstetrics and Gynecology Department, Al-Hussein and

Saed Galal Hospitals, Al-Azhar University. Cases were recruited from the emergency unit during the period from December 2020 to May 2021.

One hundred women with severe preeclampsia were included in the study. CTG and assessment of umbilical artery Doppler velocimetry parameters (RI, PI, S/D) were performed before, 20 minutes and 1 hour after intravenous administration of 6 grams of magnesium sulfate.

Inclusion criteria: Singleton pregnancy, pregnant females ≥28 weeks of gestation, and diagnosed as severe preeclampsia by the following criteria: Sustained systolic blood pressure of ≥160 mmHg or a sustained diastolic blood pressure of ≥ 110 mmHg. Proteinuria measured as +1 or more dipstick or 24 hours urine collection with proteinuria ≥ 0.3 grams. Oliguria or creatinine > 1.1 mg%. Laboratory findings characteristic of HELLP syndrome. Symptoms suggestive of severe preeclampsia; severe headache, blurring of vision, epigastric pain.

Exclusion criteria: Multifoetal pregnancy, history of epilepsy, patients with diabetes, patients with renal disease, fetuses with congenital anomalies, patients receiving anticoagulants, e.g. heparin (unfractionated or low molecular weight), and patients with severe IUGR.

Patients were subjected to:

Complete history taking:

1. Personal history including
2. Name, Age, marital state, address menstrual history: including age of Menarche, menstrual disturbance, dysmenorrhea, related symptoms.
3. Obstetric history including parity and mode of delivery.
4. Present history of chronic diseases and medication.
5. Past history of HTN and DM.
6. Family history of similar conditions or diabetes
7. History of allergy to any medication.
8. Surgical history of operation, laparoscopic interference, and treatment of hirsutism by Laser.

Examination:

A. General examination: Evaluation of vital signs and measurement weight, height (BMI).

B. Abdominal and local clinical examination: To assess fundal level and gestational age, scar of previous operation, mass, tenderness or rigidity, and any abdominal or pelvic clinically detectable pathology.

C. Bimanual pelvic examination of both adenexa, and uterus for detection of any abnormality of female genitalia

D. Investigations:

Laboratory investigations according to the hospital policy.

- Doppler Studies: Resistance index [RI], pulsatility index [PI] and systolic/diastolic [S/D] ratio of the umbilical artery before, 20 minutes after and 1 hour after intravenous administration of 6 grams of magnesium sulfate (loading dose).
- Continuous cardiotocography (CTG) was performed for 20 minutes before, 20 minutes after and 1 hour after

intravenous administration of 6 grams of magnesium sulphate (loading dose).

Technique of blood pressure measurement *(ACOG, 2013)*:

Blood pressure was measured according to the following methodology:

- Patient was placed in the sitting or semi sitting position.
- Using a cuff of appropriate size.
- Cuff placed at the level of the heart.
- Kortokoff phase V was used to determine the diastolic blood pressure.

Regimen of magnesium sulphate:

The magnesium sulfate was given according to the regimen of 6 grams intravenous over 20 minutes as a loading dose followed by intravenous infusion at a rate of 1 g / hour and maintained for a period of 24 hours, with clinical assessments every four hours.

Statistical analysis:

The collected data were, tabulated, and statistically analyzed using SPSS program (Statistical Package for the Social Sciences) software version 20.0. Descriptive statistics were done for numerical parametric data as mean±SD (standard deviation) and minimum & maximum of the range and for numerical non parametric data as median and 1st& 3rd inter-quartile range, while they were done. The level of significance was taken at P value <0.050 is significant, otherwise is non-significant.

RESULTS

Age ranged from 21-42 years with a mean value 31.25±6.687 years. BMI ranged from 22.55-33.23 kg/m2 with a mean value 27.68±3.236 kg/m2. More than half of the studied sample was from rural places (51.0%). Gestational age ranged from 28-40 weeks with a mean value 34.11±3.484 weeks. Gravidity ranged from 0-7 with a mean value 3.32±2.122, parity ranged from 0-7 with a mean value 3.09±1.923, and abortion ranged from 0-3 with a mean value 0.23±0.617. Proteinuria of the studied group ranged from 2-4 mg% with a mean value 2.87±0.787 mg%. Regularity of menses of the studied group showed that 67(67%) had regular menses and 33(33.0%) had irregular menses **(Table 1)**.

Table (1): Distribution of studied sample according to patient's demographic data, obstetric history, proteinuria, and regularity of menses

	Range	**Mean±SD**
Age (years)	21-42	31.25±6.687
BMI	22.55-33.23	27.68±3.236
Gestational age (weeks)	28-40	34.11±3.484
Patient's obstetric history		
Gravidity	0-7	3.32±2.122
Parity	0-7	3.09±1.923
Abortion	0-3	0.23±0.617
Proteinuria	2-4	2.87±0.787
	Number	**Percent**
Residence		
Urban	49	49
Rural	51	51
Regularity of menses		
Regular	67	67
Irregular	33	33

Vital signs showed a statistically significant decreased of all vital signs **(Table 2)**.

Table (2): Comparison between different time as regards patient's vital signs

Vital signs	**Baseline**	**After 20 minutes**	**After 1 hour**
SBP	170.85±16.081	154.25±17.486	138.25±17.83
P value	$P_1<0.001$; $P_2<0.001$, $P_3<0.001$		
DBP	109.65±6.600	100.50±7.124	91.45±7.258
P value	$P_1<0.001$; $P_2<0.001$, $P_3<0.001$		
HR	80.52±11.568	71.27±11.664	62.52±12.085
P value	$P_1<0.001$; $P_2<0.001$, $P_3<0.001$		

P_1: Comparison between baseline and after 20 minutes
P_2: Comparison between baseline and after 1 hour
P_3: Comparison between after 20 minutes and after 1 hour

Patient's umbilical artery doppler showed a statistically significant decrease of RI and PI **(Table 3)**.

Table (3): Comparison between different time as regard to patient's umbilical artery doppler

Umbilical artery Doppler	Baseline	After 20 minutes	After 1 hour
RI	0.69±0.452	0.68±0.045	0.66±0.045
P value	P_1=0.025; P_2<0.001, P_3=0.028		
PI	1.09±0.110	1.05±0.111	1.01±0.112
P value	P_1=0.010; P_2<0.001, P_3=0.011		
S/D	3.31±0.406	3.24±0.405	3.17±0.405
P value	P_1=0.213; P_2=0.015, P_3=0.228		

P_1: Comparison between baseline and after 20 minutes
P_2: Comparison between baseline and after 1 hour
P_3: Comparison between after 20 minutes and after 1 hour

Middle cerebral artery doppler showed a statistically significant decrease in RI and PI after 1 hour on comparing with baseline **(Table 4)**.

Table (4): Comparison between different time as regards patient's middle cerebral artery doppler

Middle cerebral artery Doppler	Baseline	After 20 minutes	After 1 hour
RI	0.81±0.086	0.79±0.086	0.78±0.087
P value	P_1=0.224; P_2=0.015, P_3=0.217		
PI	1.45±0.238	1.41±0.237	1.37±0.238
P value	P_1=0.230; P_2=0.017, P_3=0.234		
S/D	4.96±1.167	4.89±1.168	4.82±1.168
P value	P_1=0.672; P_2=0.400, P_3=0.675		

P_1: Comparison between baseline and after 20 minutes
P_2: Comparison between baseline and after 1 hour
P_3: Comparison between after 20 minutes and after 1 hour

Uterine artery doppler showed a statistically significant decrease of all uterine artery after 1 hour on comparing with baseline **(Table 5)**.

Table (5): Comparison between different times as regards patient's uterine artery doppler

Uterine artery Doppler	Baseline	After 20 minutes	After 1 hour
RI	0.66±0.088	0.65±0.087	0.63±0.088
P value	P_1=0.240; P_2=0.020, P_3=0.243		
PI	1.24±0.221	1.20±0.221	1.16±0.221
P value	P_1=0.201; P_2=0.010, P_3=0.192		
S/D	2.71±0.420	2.64±0.420	2.57±0.422
P value	P_1=0.253; P_2=0.021, P_3=0.244		

P_1: Comparison between baseline and after 20 minutes
P_2: Comparison between baseline and after 1 hour
P_3: Comparison between after 20 minutes and after 1 hour

UA/MCA showed decrease of all UA/MCA parameters with no statistically significant differences **(Table 6)**.

Table (6): Comparison between different time as regard to patient's UA/MCA

UA/MCA	Baseline	After 20 minutes	After 1 hour
RI	0.83±0.160	0.83±0.164	0.83±0.169
P value	P_1=0.820; P_2=0.780, P_3=0.959		
PI	0.88±0.209	0.87±0.216	0.87±0.225
P value	P_1=0.927; P_2=0.847, P_3=0.920		
S/D	0.59±0.207	0.58±0.210	0.58±0.213
P value	P_1=0.850; P_2=0.709, P_3=0.853		

P_1: Comparison between baseline and after 20 minutes
P_2: Comparison between baseline and after 1 hour
P_3: Comparison between after 20 minutes and after 1 hour

DISCUSSION

As regard demographic data of the studied group. Age was ranged from 21-42 years with a mean value 31.25±6.687 years. BMI was ranged from 22.55-33.23 kg/m2 with a mean value 27.68±3.236 kg/m2. More than half of the studied samples were from rural places (51.0%). Gestational age was ranged from 28-40 weeks with a mean value 34.11±3.484 weeks.

Our results were supported by study of *Souza et al. (2010)* as they reported that forty participants were included in the study. Mean maternal age was 27 ± 7.42 years (mean ± SD) and mean gestational age when Doppler velocimetry was performed was 35.2 ± 3.43 weeks (mean± SD).

In the study of *Moussa et al. (2021)*, the demographic data of the studied groups showed that the age of group A (MgSO4 group) ranged between 22-32 years with a mean age of 27.44±3.52 years while in group B (control group) the age ranged between 23-31 years with a mean age of 28.10±2.72 years there was no statistically significant difference between both groups of the study regarding age. The BMI of group A ranged between 22-41 with a mean BMI of 28.34±3.3 while in group B the BMI ranged between 23-35 with a mean value of 29.14±2.53 there was no statistically significant difference between both groups of the study regarding BMI.

The present study showed that 67(67%) had regular menses and 33(33.0%) had irregular menses. As regard obstetric history of the studied group. Gravidity was ranged from 0-7 with a mean value 3.32±2.122. Parity was ranged from 0-7 with a mean value 3.09±1.923. Abortion was ranged from 0-3 with a mean value 0.23±0.617. However, in the study of *Maged et al. (2016)* the mean parity among their studied group was 1.6 ± 1.75 and their mean gravidity was 1.28± 1.55.

In the study of *Dasgupta et al. (2012)*, there was no statistically significant difference between interventional group ($MgSO_4$ group) and placebo group as regard parity.

The current study showed that Proteinuria of the studied group and it was ranged from 2-4 mg% with a mean value 2.87±0.787 mg%. Comparison between

different time as regard to patient's Vital signs and it show highly statistically significant decreased of all vital signs.

In agreement with our study, *Takenaka et al. (2016)* found that systolic and diastolic BPs after administration of magnesium sulfate was significantly lower than those before administration. In most effective cases, BP decreased to the mild level range for at least 2 h after administration. *Belfort et al. (2013)* reported that 45.7% of patients with severe preeclampsia decreased their BPs by loading 4–6 g of magnesium sulfate.

Our results were in agreement with study of *Jamileh et al. (2018)* as they revealed that maternal systolic blood pressure was significantly decreased after MgSO4 administration (121± 21.86 mmHg vs. 116.14±17.07 mmHg).

In the study of *Moussa et al. (2021),* on comparing between the two studied groups regarding blood pressure after treatment, it was found that the systolic blood pressure in experimental group was significantly lower than the control group, while the diastolic blood pressure was less than the control but the difference was insignificant.

In the study in our hands, as regard comparison between different times as regard to patient's Umbilical artery Doppler and it show highly statistically significant decreased of RI and PI.

Our results were in line with study of *Moussa et al. (2021),* as they revealed a significant decrease in umbilical artery Doppler parameters including pulsatility index, RI, S/D ratio and PSV in patients with magnesium sulfate administration.

In this study, it was found that umbilical artery Doppler PI show significant decrease after administration of the loading dose of $MgSO_4$. *Houlihan et al. (2010)* showed that there is evidence that $MgSO_4$ promotes vasodilatation of the umbilical artery with consequent decrease of vascular resistance. *Souza et al. (2010)* reported a reduction of umbilical artery Doppler velocimetry indices (RI, PI, and S/D) in pregnant women with preeclampsia, after intravenous administration of $MgSO_4$. and *Souza et al. (2010)* and *Belfort et al. (2013)* reported that while in patients with normal blood pressure levels the vasodilator effect of $MgSO_4$ is not evident; in patients with preeclampsia this effect is significant.

Dasgupta et al. (2012) evaluated whether prophylactic magnesium sulfate given in women with mild preeclampsia or gestational hypertension brings any significant change in umbilical artery and fetal middle cerebral artery pulsatility index. They showed that in their study that, there was a significant reduction in the post magnesium sulfate umbilical artery pulsatility index in the intervention group (median 0.88 [0.82-1.03]) when compared to the placebo group (median 1.00 [0.89–1.10]) and Post-magnesium sulfate fetal middle cerebral artery pulsatility index in the intervention group (median 1.78 [1.63–1.98]) did not show a significant change compared to the placebo group (median 1.65 [1.42–1.91]).

The present study showed that as regard comparison between different time as regard to patient's Middle cerebral artery Doppler and it show highly statistically significant decreased in RI

and PI after 1 hour when it compared with baseline.

According to *Farshchian et al. (2012)*, after injection of magnesium sulfate, the mean resistivity index (RI)-umbilical, and pulsatility index (PI)-cerebral showed a statistically significant reduction ($P < 0.001$). The cerebroumbilical C/U ratio increased after the intervention ($P < 0.001$).

Belfort et al. (2013) in another study evaluated the effects of magnesium sulfate on maternal and fetal blood flow in pregnancy-induced hypertension. They demonstrated that that a 6-gram loading dose of magnesium sulfate significantly vasodilates the vascular bed distal to the maternal middle cerebral artery, and increases blood velocity in this distribution.

Our results were in agreement with study of *Maged et al. (2016)* as they reported that there was a significant difference between middle cerebral artery Doppler PI before and after administration of $MgSO_4$ in the studied patients as (p value < 0.001).

Jamileh et al. (2018) demonstrated that in fetal MCA Doppler, middle cerebral artery pulsatility index (MPI) ($P<0.0001$) and middle cerebral artery resistance index (MRI) ($P<0.0001$) were increased significantly after $MgSO_4$ injection and peak systolic velocity (PSV) had not changed significantly.

In the study of *Kamel et al. (2019)*, they showed statistically significant increase in middle cerebral artery PI after treatment in magnesium sulfate group with a P value=0.000.

The current study showed that as regard comparison between different time as regard to patient's Uterine artery Doppler and it show highly statistically significant decreased of all Uterine artery after 1 hours when it compared with baseline. As regard comparison between different time as regard to patient's UA/MCA and it show decreased of all UA/MCA parameter with no statistically significant differences.

Our results were supported by study of *Souza et al. (2010)* as they reported that there was a statistically significant reduction in the mean RI, PI, and S/D ratio of the umbilical artery, of the fetal middle cerebral artery, of the right, and left uterine arteries and of the arithmetic mean of the two uterine arteries following infusion of magnesium sulfate in women with severe preeclampsia and there was a significant reduction in the PI and S/D ratio in all the arteries assessed.

Houlihan et al. (2010) study showed that there is no observed statistically significant difference before and after use of $MgSO_4$ with regard to the umbilical/middle cerebral ratio. This can be explained because of a mathematical reason. When it decreases the numerator (umbilical artery) and the denominator (middle cerebral artery), the result remains unchanged.

In the study of *Maged et al. (2016)*, there was a significant difference between uterine artery Doppler PI before and after administration of $MgSO_4$ in the studied patients as (p value < 0.001). There was no significant difference between umbilical artery/middle cerebral arteries with regard to PI. The decrease in the values of Doppler parameters before and

after administration of $MgSO_4$ was more in the middle cerebral artery than in the umbilical artery.

Furthermore, *Jamileh et al. (2018)* demonstrated that in uterine artery Doppler, uterine artery pulsatility index (UTPI) and uterine artery resistance index (UTRI) were significantly decreased after drug injection (P<0.0001 in both). Mother heart rate and fetal heart rate also were markedly decreased after drug injection (P=0.025 and P<0.0001, respectively). Study showed that there was a significant difference between MPI/UPI ratio before and after administration of maternal $MgSO_4$ (0.73± 0.31 vs. 0.64± 0.24; P<0.0001).

CONCLUSION

Magnesium sulfate proved to cause many hemodynamic changes as it has vasodilator effect on maternal and fetal blood vessels. Doppler indices in the umbilical (decrease in PI and RI) are significantly changed after administration of MgSO4 pregnant women.

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التغيرات في كلا من نبض الجنين و دوبلر الشريان السري للجنين بعد الجرعة الابتدائية من كبريتات الماغنسيوم في مرضي تسمم الحمل الشديد

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خلفية البحث: تسمم الحمل ناتج عن ضعف غزو الأرومة الغاذية للشرايين الحلزونية للأم. وكبريتات المغنيسيوم دواء مفضل في تسمم الحمل كمضاد للاختلاج بدلاً من خافض للضغط. تطورت أنظمة إعطاء هذا الدواء على مر السنين، وقد كان كبريتات ماغنيسيوم يعطي وفقًا لنظام بريتشارد حيث تم إعطاء 5 جرامات من كبريتات المغنيسيوم لمدة أربع ساعات لمدة 24 ساعة بعد تحميل 14 جرامًا. ولوحظ أن العديد من المرضى لم يتلقوا العلاج الوقائي بسبب الخوف من السمية لكنهم لم يتشنجوا أكثر.

الهدف من البحث: تقييم التغيرات في معاملات قياس سرعة دوبلر (مؤشر المقاومة ، مؤشر النبض ونسبة الانقباض / الانبساطي للشريان السري مع معلمات مراقبة قلب الجنين قبل وبعد كبريتات المغنيسيوم الإعطاء عند النساء الحوامل المصابات بمقدمات الارتعاج الشديدة والتأثيرات المحتملة لهذه التغييرات على طريقة الولادة والنتائج الوليدية. لرصد الجنين في هؤلاء النساء الحوامل.

المريضات وطرق البحث: هذه دراسة جماعية استطلاعية أجريت في قسم أمراض النساء والولادة ، بمستشفي الحسين وسيد جلال. و تم تضمين 100 امرأة مع تسمم الحمل الشديد في الدراسة, خلال الفترة من ديسمبر 2020 إلى مايو 2020.

نتـــائج البحـــث: فيمـــا يتعلـــق بـــدوبلر الشـــريان الســـري للمـــريض أظهـــر إنخفاضًـــا كبيـــرًا مـــن الناحيـــة الإحصـــائية فـــي مؤشـــر المقاومـــه و مؤشـــر النـــبض، وفيمـــا يتعلـــق بـــدوبلر الشـــريان الـــدماغي الأوســـط للمـــريض، أظهـــر إنخفاضًـــا كبيـــرًا مـــن الناحيـــة الإحصـــائية فـــي مؤشـــر المقاومـــه و مؤشـــر النـــبض بعـــد ســـاعة واحـــدة عنـــد مقارنتـــه بخـــط الأســـاس. إمـــا دوبلـــر الشـــريان الرحمـــي للمـــريض فقـــد أظهـــر إنخفاضًـــا كبيـــرًا مـــن الناحيـــة الإحصـــائية فـــي جميـــع الشـــرايين الرحميـــة بعـــد ســـاعة واحـــدة عنـــد مقارنتـــه بخـــط الأســـاس. وفيمـــا يتعلـــق بـــتحكم الشـــريان الرحمـــي / الشـــريان المخـــي الاوســـط الخـــاص بـــالمريض، فقـــد أظهـــر إنخفاضًـــا فـــي جميـــع معلمـــات الشـــريان الرحمـــي / الشـــريان المخـــي الاوســـط مـــع عـــدم وجـــود فـــروق ذات دلالة إحصائية.

الاســـتنتاج: أثبتـــت كبريتـــات الماغنســـيوم أنهـــا تســـبب العديـــد مـــن التغيـــرات فـــي الـــدورة الدمويـــة حيـــث لهـــا تـــأثير موســـع للأوعيـــة الدمويـــة لـــلأم والجنـــين. وتتغيـــر مؤشـــرات دوبلـــر فـــي الســـرة (إنخفـــاض مؤشـــر النـــبض ومؤشـــر المقاومـــة) بشـــكل ملحوظ بعد إعطاء كبريتات الماغنسيوم عند النساء الحوامل.

الكلمـــات الدالـــة: تســـمم الحمـــل الشـــديد، تخطـــيط القلـــب المســـتمر، دوبلـــر الشـــريان السري للجنين، كبريتات الماغنسيوم.