

Comparative Study between Serum Calcium and Magnesium Levels in Pre-eclampsia Versus Normal Pregnancy

HANAN M. EL-SAIED A. AL-BEHAIRY, M.D.

The Department of Obstetrics & Gynecology, Faculty of Medicine, Tanta University, Damanshour, Behera

Abstract

Background: Numerous clinical studies had clarified the alliance between preeclampsia and disturbances in maternal biochemical macronutrients, involving serum calcium (Ca^{+2}) and magnesium (Mg^{+2}). Up till now, there is an escalated concern in benefitting from nutritional approach in the preeclampsia management with respect to calcium and magnesium supplementation.

Aim of Study: To assess serum levels of calcium and magnesium in pregnant females who suffered from preeclampsia in comparison with normal pregnant ladies.

Patients and Methods: This study was a case-control one that recruited 100 pregnant women (50 pregnant preeclampsia cases and 50 normal pregnant females) from obstetrics clinics of Damanshour General hospital, and El-Sayed Galal Hospital of Al-Azhar University after the 20th week of gestation during the period of research from February 2020 to December 2020 for estimation off serum calcium and magnesium.

Results: The mean serum calcium level in the control group was $8.99 \pm 0.52 \text{ mg/dl}$, and mean serum magnesium level was $2.21 \pm 0.3 \text{ mg/dl}$. Both were higher than those in the patients group as the mean serum Ca^{+2} was $8.05 \pm 0.51 \text{ mg/dl}$ and mean serum Mg^{+2} level was $1.86 \pm 0.25 \text{ mg/dl}$ ($p < 0.001$). Calcium had significantly higher diagnostic accuracy than magnesium to differentiate normotensive pregnant women from preeclamptic pregnant women. ROC curve showed that the optimum cut off for calcium was 8.55 (mg/dL) with sensitivity of 80%, specificity of 84%, PPV of 83.3%, and NPV of 80.8%. Calcium had largest area under the curve (AUC) were 0.898; CI: (0.840-0.956) ($p < 0.001$), indicating its importance for predicting preeclampsia. While the cut off value of magnesium was less than 2.15 (mg/dL), the sensitivity was 88%, specificity was 60%; an area under the ROC curve (AUROC) 0.806 (95% CI: 0.721-0.891). In addition, ROC curve showed the optimum cutoff for serum calcium was 8.15 (mg/dL) for predicting adverse outcome of pregnancy with sensitivity 60.6%, specificity 86.6%; and an area under the ROC curve (AUROC) 0.792 (95% CI: 0.701-0.883). While the cut off value of serum magnesium was less than 1.945 (mg/dL), the sensitivity was 69.7%, specificity was 67.2%; an area under the ROC curve (AUROC) 0.726 (95% CI: 0.618-0.834).

Correspondence to: Dr. Hanan M. El-Saied A. Al-Behairy, The Department of Obstetrics & Gynecology, Faculty of Medicine, Tanta University, Damanshour, Behera

Conclusion: Both serum calcium and serum magnesium in preeclamptic pregnant women were lesser in comparison to their healthy pregnant counterparts. These outcomes supported the postulation that there is a cause-consequence liaison between hypocalcaemia and hypomagnesaemia as potential etiologic factors incriminated in of preeclampsia pathogenesis.

Key Words: Preeclampsia – Calcium – Magnesium.

Introduction

PREECLAMPSIA, tagged as a syndrome of theories, is a recognized health challenge with devastating foeto-maternal consequences. It has been with numerous postulations suggested to unravel its aetiopathogenesis [1].

It is a multisystem disorder that affects 2-8% of pregnant females, and it is a profound complication of pregnancy characterized by new onset of hypertension with significant proteinuria after 20 weeks' gestation [2].

It is the third most common cause of maternal death worldwide. Developing countries are more adversely affected as 20-80% of increased maternal mortality is associated with pre-eclampsia [3].

Since the pathogenesis of preeclampsia has not been fully elucidated, the search for predictive markers and preventive strategies remains an unfulfilled issue [4].

Even though a multitude of novel for example; serum placental growth factor (PIGF), soluble fms-like tyrosine kinase 1, and soluble endoglin have been determined to aid as initial predictors of preeclampsia. Also, serum calcium and magnesium may be applicable and cost-effective predictors for preeclampsia since the beginning of pregnancy [5].

Deficiencies in mineral constituents as calcium, magnesium, zinc, etc., have been documented to

cause remarkable health troubles for women of reproductive age, particularly in developing countries attributable to inadequate dietary intake. The risk of deficiency is augmented through pregnancy owing to exaggerated requirements for various nutrients by the growing fetus [6].

It has been hypothesized that oscillations in maternal serum ions may be the instigating cause of elevated blood pressures in preeclampsia. Dietary deficiency of mineral ions has been displayed to have a deleterious effect on the both maternal and fetal health and may be possibly complicated by preeclampsia [7].

Once more, nutritional deficiency role in the pathogenesis of preeclampsia has been highlighted. Numerous clinical studies have focused on the association between preeclampsia and deficiencies in maternal biochemical macronutrients, comprising calcium and magnesium with an increasing concern in the management of preeclampsia via nutritional approach especially calcium and magnesium supplementation [8].

This study aimed to assess serum levels of calcium and magnesium in pregnant females who suffered from pre-eclampsia in comparison with normal pregnant ladies.

Patients and Methods

This study was a case-control one that recruited 100 pregnant women (50 pregnant preeclampsia cases and 50 normal pregnant females) from obstetrics clinics of Kafr El-Sheikh General Hospital and El-Sayed Galal Hospital of Al-Azhar University after the 20th week of gestation during the period of research from February 2020 to December 2020 for estimation of serum calcium and magnesium. Inclusion criteria were maternal age between 15-45 years, gestational age after the 20th week of gestation. Preeclampsia cases were diagnosed according to the American College of Obstetrics and Gynecology (ACOG) with systolic blood pressure ≥ 140 mm Hg and or diastolic blood pressure ≥ 90 mm Hg after 20th week of gestation on two occasions each 6 hours apart [9]. Written consents were obtained from the patients.

Exclusion criteria: Maternal systemic disorder; chronic hypertension, diabetes mellitus, chronic kidney disease (CKD), ischemic heart disease (IHD), history of immunosuppression intake, history of previous poor pregnancy outcomes (intra-uterine growth retardation, recurrent abortions), history of smoking, any disease recognized to disturb serum calcium or magnesium e.g renal

disease, known digestive disorders or, known thyroid or adrenal disease, eating disorders, antenatal vitamin or mineral supplementation.

The elected patients were subjected to detailed history taking complete general, abdominal examination and ultrasonographic examination. Then, about 5ml of venous blood was collected once from both study group and control group by antecubital vein-puncture, using a sterile disposable syringe, without using elastic band tourniquet half of the amount collected were transferred immediately into commercially prepared concentration of Ethylene Di-amine Tetra-acetic Acid (EDTA) containers. The remaining half was allowed to clot and the serum was obtained by centrifugation at 3000 rpm for 10 minutes or the remaining investigations including serum calcium, magnesium concentrations estimation using Atomic Absorption Spectrophotometer.

Statistical analysis:

Statistical analyses of data were carried out using SPSS version 23. Shapiro-Wilks test was used to test normal distribution of variables. Numerical data were expressed as mean \pm standard deviation or median and range. Categorical data were summarized as percentages. The significance for the difference between groups was determined by using two-tailed Student's *t*-test. Also Qualitative variables were assessed by chi-squared χ^2 test. The probability (*p*) values of ≤ 0.05 were considered statistically significant indicated. The Receiver Operating Characteristic (ROC) was constructed to obtain the most sensitive and specific cutoff value for serum Ca^{+2} and Mg^{+2} . Mann whitney test was used to compare data that were not normally distributed.

Results

Overall, 100 pregnant women were recruited in this study during the period of research from February 2020 to December 2020 to Obstetrics Clinic of Damanhour General Hospital and El-Sayed Galal Hospital of Al-Azhar University. All eligible cases were recruited after the 20th week of gestation. They were divided into 2 groups: 50 controls and 50 pregnant women who developed preeclampsia with systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg after 20th week of gestation on two occasions each 6 hours apart. The mean age of patients group was 29.92 ± 7 years while it was 29.72 ± 4.51 years in control group. There were no statistically significant differences in the mean age of both studied groups ($p=0.866$). Also, these results indicated that there

was no statistically significant difference between all studied groups according to body mass index, gravidity, and parity ($p>0.05$).

Additionally, there was a significant difference between the two studied groups with regards to blood pressure both systolic and diastolic which increased with the occurrence of preeclampsia ($p<0.001$). The results showed that the average systolic blood pressure among cases was found to be 159.8mmHg compared with 113.6mmHg among controls. Furthermore, average diastolic blood pressure was found to be 103.12mmHg among preeclampsia cases compared with 70.8mmHg among controls.

In preeclampsia group, thirty-four (68%) delivered by cesarean section whereas sixteen cases delivered vaginal (32%). A significantly higher occurrence of Cesarean section in the preeclamptic group than in the control group ($p=0.026$). Also, there was a significant difference between the two studied groups with regards to appearance of protein in urea which increased in patients with preeclampsia ($p<0.001$). All control cases hadn't have proteinuria whereas, in preeclampsia group, Sixteen (32%) of the cases showed proteinuria level ranged from (+1 - +2), whereas 34 (68%) of them showed a level ranged from (+3-+4).

It was observed that, in preeclampsia cases, the mean gestational age at delivery was significantly lower than that in the controls (33.58 ± 3.82 vs 36.94 ± 2.21 , $p<0.001$). Furthermore, patients with preeclampsia had significantly lower mean birth weights for the neonates compared to controls (1671.4 ± 670.8 g vs 3297 ± 339.2 g ($p<0.001$). Among the control group, all babies were of weight more than 2.5kg, whereas 72% of newborns to preeclampsia mothers had weight less than 2kg, 26% were of weight 2-2.5kg and remaining babies (2%) were more than 2.5kg weight (Table 1).

Among the study group, 44% had Intra Uterine Growth Retardation (IUGR) babies, 6% had intra uterine fetal death (IUFD), 10% developed eclampsia and 2% developed HELLP syndrome. Among the control group, 8% has IUGR babies, 8% had PPROME, and 2% had Intra Uterine death (Table 1).

The results showed that there was statistically significant decrease in the hemoglobin levels platelets count as well as leucocytes count among cases with preeclampsia compared to that of controls (12.14 ± 1.2 (g/dL) vs. $12,63 \pm 1.3$ (g/dL); $p=0.05$) & (219.337 ± 74.56 ($\times 10^3 / \mu\text{L}$) vs. 276.72 ± 52.88

($\times 10^3 / \mu\text{L}$); $p<0.001$) and ($8536.5 \pm 3118.3 / \mu\text{L}$ vs. $11542.8 \pm 2357 / \mu\text{L}$; $p<0.001$). While, there was no significant difference in the mean value of RBCs between studied groups ($p>0.05$) (Table 1).

The current study also showed that the mean serum albumin level was not significantly different in control cases (3.46 ± 0.3) (g/dL) compared to that detected among patients (3.34 ± 0.4) (g/dL); ($p=0.92$).

Regarding calcium and magnesium levels, the results showed progressively increase in the mean serum calcium and magnesium levels in control cases compared to PE cases (8.99 ± 0.52 mg/dL vs. 8.05 ± 0.51 mg/dL) and (2.21 ± 0.3 mg/dl vs. 1.86 ± 0.25 mg/dL) respectively. The present study showed that the mean serum calcium and magnesium level in the study group who developed preeclampsia were lower than the control group who remained normotensive ($p<0.001$), which is statistically significant (Table 1).

The present study showed that calcium had significantly higher diagnostic accuracy than magnesium for differentiate normotensive pregnant women from preeclamptic pregnant women. ROC curve showed that the optimum cut off for calcium was 8.55 (mg/dL) with sensitivity of 80% and specificity of 84%, PPV of 83.3 %, NPV of 80.8%. Calcium has largest area under the curve (AUC= were 0.898; CI: (0.840-0.956) ($p<0.001$), indicating its importance for predicting preeclampsia (Table 3 and Fig. 1). While the cut off value of magnesium was less than 2.15 (mg/dL), the sensitivity was 88%, specificity was 60%; an area under the ROC curve (AUROC) 0.806 (95% CI: 0.721-0.891).

Table (4) and Fig. (2) illustrated the ROC plots to assess the diagnostic efficiency of serum calcium and magnesium for predicting poor outcome of pregnancy. ROC curve analysis showed that calcium had significantly higher diagnostic accuracy than magnesium in predicting outcome of pregnancy.

ROC curve showed the optimum cutoff for serum calcium was 8.15 (mg/dL) for predicting adverse outcome of pregnancy with sensitivity 60.6% and specificity 86.6%; an area under the ROC curve (AUROC) 0.792 (95% CI: 0.701-0.883). While the cut off value of serum magnesium was less than 1.945 (mg/dL), the sensitivity was 69.7%, specificity was 67.2%; an area under the ROC curve (AUROC) 0.726 (95% CI: 0.618-0.834).

Table (1): Demographic data and biochemical parameters of the patients and controls.

Variables	Groups	Preeclampsia Group (n=50)	Healthy Controls (n=50)	p-value
Age (Yrs.)		29.92±7	29.72±4.51	0.866
BMI at enrollment		27.97±6.8	27.38±3.3	0.577
Gravidity		2.78±1.48	2.7±1.66	0.8
Parity		0.28±0.57	0.26±0.44	0.846
Systolic Blood Pressure (mmHg)		159.8±20.25	113.6±9.9	<0.001
Diastolic Blood Pressure (mmHg)		103.12±11.6	70.8±6.7	<0.001
Gestational age at delivery (weeks)		33.58±3.82	36.94±2.21	<0.001
<i>Mode of delivery:</i>				
Vaginal		16 (32%)	28 (56%)	0.026
Cesarean section		34 (68%)	22 (44%)	
<i>Appearance of proteinuria:</i>				
None		0 (0%)	50 (100%)	0.001
1-2		16 (32%)	0 (0%)	
3-4		34 (68%)	0 (0%)	
Birth weight [g]		1671.4±670.8	3297±339.2	<0.001
<i>Complications:</i>				
None		25 (50%)	45 (90%)	<0.001
IUGR		22 (44%)	4 (8%)	
PPROM		0 (0%)	4 (8%)	
HELLP		1 (2%)	0 (0%)	
Eclampsia		5 (10%)	0 (0%)	
IUFD		3 (6%)	1 (2%)	
Hemoglobin (g/dL)		12.14±1.2	12.63±1.3	0.053
RBCs count (x10 ⁶ / μ L)		4.02±0.645	4.08±0.319	0.586
Leukocytes count (/ μ L)		8536.5±3118.3	11542.8±2357	<0.001
PLT (x10 ³ / μ L)		219.337±74.56	276.72±52.88	<0.001
Albumin (g/dL)		3.34±0.4	3.46±0.3	0.92
Serum Calcium (mg/dL)		8.05±0.51	8.99±0.52	<0.001
Serum Magnesium (mg/dL)		1.86±0.25	2.21±0.3	<0.001

Values are expressed as mean \pm standard deviation or n (%) unless otherwise specified.

BMI: Body mass index. PLI: Platelets

- Mann whitney test was used to compare groups regarding gravidity, parity, leucocytes, RBSs, and platelets because cases were not normally distributed.

Table (2): Correlation of serum calcium and magnesium levels and other parameters of all studied cases.

Parameters	Electrolytes		Calcium (mg/dl)		Magnesium (mg/dl)	
	r	p-value	r	p-value	r	p-value
Age	-0.027	0.790	-0.054	0.596		
Gestational age	0.374	0.001***	0.192	0.056		
Birth weight	0.610	<0.001***	0.419	0.001***		
Gravidity	0.052	0.606	0.00	0.997		
Parity	-0.045	0.659	-0.08	0.430		
BMI (Kg/m ²)	0.015	0.881	0.059	0.561		
Route of delivery	-0.172	0.086	0.061	0.544		
Systolic Blood pressure	-0.629	<0.001***	-0.554	<0.001***		
Diastolic Blood Pressure	-0.653	<0.001***	-0.553	<0.001***		
Albumin	0.029	0.776	0.157	0.118		
Proteinuria	-0.652	<0.001***	0.482	<0.001***		
Hemoglobin	0.160	0.112	0.106	0.295		
WBCs	-0.327	0.001***	-0.184	0.067		
Platelet count	0.383	<0.001***	0.278	0.001***		
RBCs	-0.056	0.580	-0.042	0.676		
Fetal complications	-0.426	<0.001***	-0.288	0.004**		
Maternal complications	-0.159	0.114	-0.212	0.034*		

Table (3): Diagnostic values of serum calcium and magnesium for differentiate normotensive pregnant women from preeclamptic pregnant women.

	Cutoff	Sens-itivity	Spec-ificity	PPV	NPV
Calcium (mg/dL)	8.55	80%	84%	83.3%	80.8%
Magnesium (mg/dL)	2.15	88%	60%	68%	83.3%

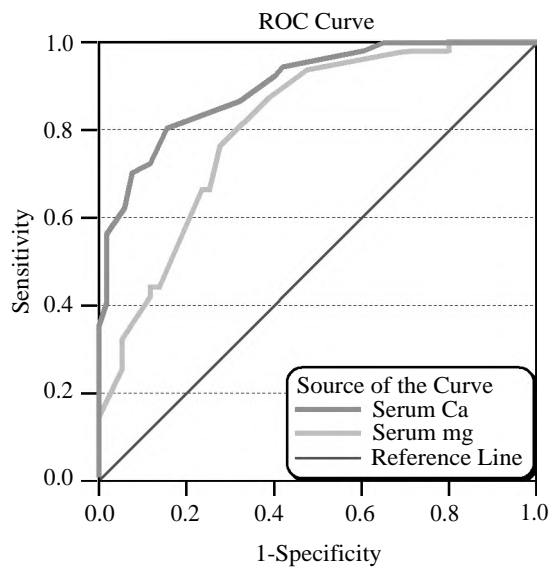


Fig. (1): ROC curve of serum calcium and magnesium for discriminating normotensive pregnant women from preeclamptic pregnant women.

Table (4): Diagnostic values of serum calcium and magnesium for predicting outcome of pregnancy.

	Cutoff	Sens-itivity	Spec-ificity	PPV	NPV
Calcium (mg/dL)	8.15	60.6%	86.6%	69%	81.7%
Magnesium (mg/dL)	1.945	69.7%	67.2%	51.1%	81.8%

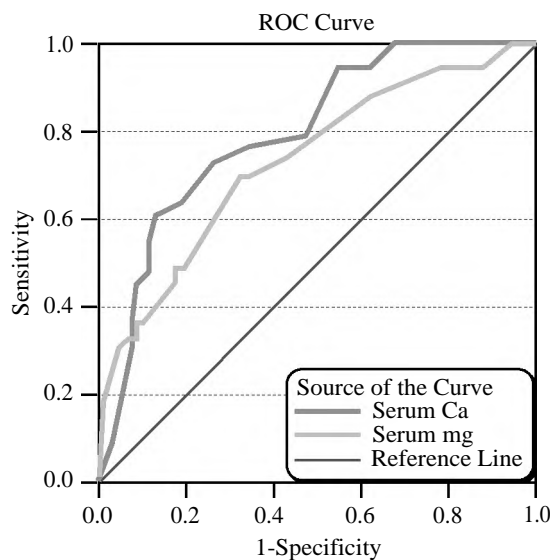


Fig. (2): ROC curve of serum calcium and magnesium (mg/dL) for predicting outcome of pregnancy.

Discussion

Regarding serum calcium and magnesium, the mean serum calcium and magnesium levels in the control group were higher than those in the patients group.

The present study demonstrated that serum calcium was positively correlated with gestational age, birth weight, and platelets count. However, it was negatively correlated systolic blood pressure, diastolic blood pressure, proteinuria, WBCs, and fetal complications. On the other hand, serum magnesium was positively correlated with birth weight, and platelets count, whereas it was negatively correlated systolic blood pressure, diastolic blood pressure, proteinuria, fetal complications, and maternal complications.

The present study showed that calcium had significantly higher diagnostic accuracy than magnesium for differentiate normotensive pregnant women from preeclamptic pregnant women. Calcium has largest area under the curve, indicating its importance for predicting preeclampsia.

In addition, ROC curve showed the optimum cutoff for serum calcium and magnesium for predicting adverse outcome of pregnancy.

Calcium plays a crucial part in the function of the vascular smooth muscles. Variation of plasma calcium concentration leads to elevated blood pressure. Moreover, magnesium acts as co-factor for several enzymes and is involved in peripheral vasodilatation. A number of studies displayed that blood calcium and magnesium have a relaxant influence on the blood vessels of pregnant women [10].

The findings of lower levels of serum calcium and magnesium in women with pre-eclampsia is in tandem with previous studies Kanagal et al., [11]; Onyegbule et al., [12]; Olusanya et al., [13]; Ugwuja et al., [8]; Aslam et al., [5] and Okoror et al., [14]. The tendency for occurrence of maternal hypocalcemia during pregnancy has been authenticated for decades. Over the pregnancy course, total calcium tends to diminute and more significant decrease ids reported in pre-eclampsia [15].

Changes in serum calcium levels are concomitant with blood pressure alteration. During the third trimester, around 200mg of calcium per day is deposited in the fetal skeleton via the placenta pregnancy and thru this period, maternal excretion of the urinary calcium is doubled. Diminutions in serum calcium level provotes the release of rennin

and parathyroid hormones that trigger increase in the intracellular calcium concentration in vascular smooth muscle cells. This stimulates vasoconstriction as well as increased peripheral vascular resistance, augmenting the raised blood pressure. Consequently, aberrations in calcium homeostasis may make a contribution to the abnormal vasculopathy that has been already established in preeclampsia [16].

In agreement to our results, Tavana and Hosseinmirzaei [6] found that serum magnesium in pre-eclampsia cases was significantly less than the control group that consisted of normal pregnant women.

Furthermore, multitude of research works have reported a decrease in serum magnesium levels as a probable etiology of preeclampsia Jain et al., [17]; Roberts et al., [18]; Akinloye et al., [19] and Ugwuja et al., [8]. This evidence is reinforced by the effectiveness of magnesium sulfate therapy for prophylaxis and treatment of preeclampsia / eclampsia allied seizures [7].

Magnesium, a fundamental intracellular cation, contributes to neurotransmission and peripheral vasodilation. At the sub-cellular level, magnesium acts as an indispensable cofactor in the ATPase activation thus controlling metabolic regulation of energy-dependent cytoplasmic and mitochondrial pathways and regulating oxidative-phosphorylation processes. Moreover, it controls contractile proteins, modulates transmembrane transport of ions like calcium, sodium, and potassium, and influences DNA and protein synthesis [8].

In accordance to our results, novel work conducted by Okoror et al. [14] reported a statistically significant elevation in the prevalence of hypocalcemia among pre-eclampsia caases contrasted to the controls. A potential justification for this finding is the elevated intracellular calcium that ensues after low serum calcium with resultant vasoconstriction and elevated blood pressure [20].

Okoror et al. [14] found also a negative correlation between serum calcium and blood pressure and positive correlation between serum magnesium and calcium in their study.

There are no well-established policies for the preeclampsia prevention. Particular studies have shown that dietary calcium supplementation seemed to be applicable in downgrading the risk of preeclampsia occurrence [16].

A meta-analysis done in the developing country shows that calcium supplementation during preg-

nancy is used to prevent pregnancy-induced hypertension disorder and its complication. Another systemic review evidenced that low dose calcium supplementation [21,22].

The recommended dietary allowance in the USA recommends that pregnant women should take 1 to 1.5gms of calcium daily for pre-eclamptic complication prevention. Milk, soy milk, yogurt, cheese and vegetables like cabbage, broccoli, almonds, sardine and salmon with bones and calcium fortified orange juice are good sources of calcium. The daily requirement of magnesium is about 350mg/day. Foods rich in magnesium include whole grains, nuts and green vegetables. Green leafy vegetables are particularly good sources of magnesium. The limitation of our study was that a detailed dietary assessment of the subjects was not done. Pregnant women in developing countries should be encouraged to consume food rich in calcium and magnesium. If the intake is less than the recommended dose, a supplement can be given [11].

Nonetheless, Chukwunyerere et al. [23] in contrary to the current work, showed non-significant difference between the mean serum calcium level in normotensive pregnant women, gestational hypertensions, and PE.

Darkwa et al. [7] also observed no statistically significant dissimilarity in mean entire serum calcium and magnesium levels of pre-eclamptic females when paralleled to normal pregnant women, and they mentioned that hypomagnesemia and hypocalcemia as etiopathologic factors in the development of preeclampsia are not a universal finding in literature. Numerous research work from different regions across the globe have reported varying results concerning the role of these trace elements in the etio- pathogenesis of preeclampsia [17,19,24].

Golmohammad Lou et al. [25] have disputed about the role of calcium and trace elements in high blood pressure, particularly, pre-eclampsia. They explicated that, although slightly lesser, there was no significant discrepancy was found in calcium and magnesium concentrations between women with pre-eclampsia and their normal healthy counterparts.

This however, is slightly debatable as magnesium supplementation during pre-eclampsia and seizures treatment had shown to avert calcium-dependent arterial vasoconstriction and may antagonize the surge in intracellular calcium concentration. A Cochrane review simultaneously with WHO

recommendations on pre-eclampsia and eclampsia prevention and management and consistently reinforced that these minerals supplementation in pregnancy is allied to significant reduction in the pre-eclampsia risk Hofmeyr et al., [26]; Ephraim et al., [27] and Hofmeyr et al., [22]. Therefore, exemptions to the consensus that decreased serum calcium and magnesium levels exist in preeclampsia cases may not be still justified and need further research works.

Conclusion:

Both serum calcium and serum magnesium in preeclamptic pregnant women were lesser in comparison to their healthy pregnant counterparts. These outcomes supported the postulation that there is a cause-consequence liaison between hypocalcaemia and hypomagnesaemia as potential etiologic factors incriminated in of preeclampsia pathogenesis.

Ethical approval: Approval of ethical committee was obtained from quality education assurance unit, Faculty of Medicine, Al-Azhar University Egypt.

Conflict of interest: The authors declare that they have no conflicts of interest.

References

- 1- FASANU A.O., KOLAWOLE O.O., ISAWUMI A.I., BELLO N.O. and ATIBA A.S.: Effect of calcium on preeclampsia among pregnant women in Osogbo, South Western Nigeria. *International Journal of Modern and Alternative Medicine Research*, 7: 8-16, 2020.
- 2- SHAH S.: Hypertensive Disorders in Pregnancy. *Obstetric and Gynecologic Nephrology*, 4: 11-23, 2020.
- 3- EZE S.C., ODODO N.A., UGWU E.O., ENEBE J.T., ONYEBULE O.A., EZE I.O. and EZEM B.U.: Serum selenium levels of pre-eclamptic and normal pregnant women in Nigeria: A comparative study. *Plos One*, 15 (8): e0238263, 2020.
- 4- LAKSHMY S.R., PRAVEEN KUMAR M., SHOBANA U. and THASLEEM Z.: Uterine artery Doppler: changing concepts in prediction and prevention of PE and FGR. *Journal of Fetal Medicine*, 5 (2): 93-105, 2018.
- 5- ASLAM F., HAYAT I., ZAKIR F.A., HAIDER S.S., NISA S.U. and NISA S.U.: Comparative analysis of serum calcium and magnesium as a better predictor in cases of mild and severe pre-eclampsia. *The Professional Medical Journal*, 27 (08): 1722-1727, 2020.
- 6- TAVANA Z. and HOSSEIN MIRZAEI S.: Comparison of maternal serum magnesium level in pre-eclampsia and normal pregnant women. *Iranian Red Crescent Medical Journal*, 15 (12): 1-10, 2013.
- 7- DARKWA E.O., ANTWI-BOASIAKO C., DJAGBLETEY R., OWOO C., OBED S. and SOTTIE D.: Serum magnesium and calcium in preeclampsia: A comparative study at the Korle-Bu Teaching Hospital, Ghana. *Integrated blood pressure control*, 10: 9-15, 2017.
- 8- UGWUJA E.I., FAMUREWA A.C. and IKARAOHA C.I.: Comparison of serum calcium and magnesium between preeclamptic and normotensive pregnant Nigerian women in Abakaliki, Nigeria. *Annals of Medical and Health Sciences Research*, 6 (1): 33-37, 2016.
- 9- ACOG Practice Bulletin No. 202: Gestational Hypertension and Preeclampsia. *Obstetrics and Gynecology*, 133: e1-25, 2019.
- 10- MITTAL S., SHAIKH M.K., THAKUR R. and JAIN D.: Comparison of serum calcium and magnesium levels between preeclamptic and normotensive healthy pregnant women. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*, 3: 959-962, 2014.
- 11- KANAGAL D.V., RAJESH A., RAO K., DEVI U.H., SHETTY H., KUMARI S. and SHETTY P.K.: Levels of serum calcium and magnesium in pre-eclamptic and normal pregnancy: A study from Coastal India. *Journal of clinical and diagnostic research: JCDR*, 8 (7): OC01-OC04, 2014.
- 12- ONYEBULE O.A., MELUDU S.C., DIOKA C.E., UDIGWE G.O., UDO J.N., EZIDIGBOH A.N. and OS-AKUE N.: Comparison of serum levels of calcium and magnesium among preeclamptic and normotensive pregnant women at Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria. *International Journal of Research in Medical Sciences*, 2 (2): 404-408, 2014.
- 13- OLUSANYA A., OGUNTAYO A.O. and SAMBO A.I.: Serum levels of calcium and magnesium in pre-eclamptic-eclamptic patients in a tertiary institution. *Italian Journal of Gynaecology and Obstetrics*, 27: 101-110, 2015.
- 14- OKOROR C.E., ENABUDOSO E.J., OKOROR O.T. and OKONKWO C.A.: Serum calcium _magnesium ratio in women with pre-eclampsia at a tertiary hospital in Nigeria. *International Journal of Gynecology & Obstetrics*, 149 (3): 354-358, 2020.
- 15- INDUMATI V., KODLIWADMATH M.V. and SHEELA M.K.: The role of serum electrolyte in pregnancy-induced hypertension. *Journal of Clinical and Diagnostic Research*, 5:66-69, 2011.
- 16- AGHADE S.M. and BAVIKAR J.S.: Comparative Study of Serum Calcium in Preeclampsia and Normal Pregnancy at Government Medical College and Hospital, Aurangabad City, India. *Indian Journal of Medical Biochemistry*, 21 (2): 147-150, 2017.
- 17- JAIN S., SHARMA P., KULSHRESHTHA S., MOHAN G. and SINGH S.: The role of calcium, magnesium, and zinc in pre-eclampsia. *Biological Trace Element Research*, 133 (2): 162-170, 2010.
- 18- ROBERTS J.M., MYATT L., SPONG C.Y., THOM E.A., HAUTH J.C., LEVENO K.J., PEARSON G.D., WAPNER R.J., VARNER M.W., THORP Jr. J.M. and MERCER B.M.: Vitamins C and E to prevent complications of pregnancy-associated hypertension. *New England Journal of Medicine*, 362 (14): 1282-1291, 2010.
- 19- AKINLOYE O., OYEWALE O. and OGUNTIBEJU O.O.: Evaluation of trace elements in pregnant women with pre-eclampsia. *African Journal of Biotechnology*, 9 (32): 5196-5202, 2013.

- 20- GOULOPOULOU S. and WEBB R.C.: The symphony of vascular contraction: How smooth muscle cells harmony to signal increased vascular resistance in hypertension. Hypertension, 63: e33-e39, 2014.
- 21- IMDAD A., JABEEN A. and BHUTTA Z.A.: Role of calcium supplementation during pregnancy in reducing risk of developing gestational hypertensive disorders: A meta-analysis of studies from developing countries. BMC Public Health, 11 (3): 1-3, 2011.
- 22- HOFMEYR G.J., LAWRIE T.A., ATALLAH A.N., DULEY L. and TORLONI M.R.: Calcium supplementation during pregnancy for preventing hypertensive disorders and related problems. Cochrane Database Systemic Reviews, 6: 1-10, 2014.
- 23- CHUKWUNYERE C.F., AWONUGA D.O., OLUNUGA T.O. and UDENZE I.C.: Comparison of serum calcium level in hypertensive and normotensive pregnant women. Nigerian Journal of Medicine, 29 (4): 555-560, 2020.
- 24- FARZIN L. and SAJADI F.: Comparison of serum trace element levels in patients with or without pre-eclampsia. International Journal of Research in Medical Sciences, 17 (10): 938-941, 2012.
- 25- GOLMOHAMMAD LOU S., AMIRABI A., YAZDIAN M. and PASHAPOUR N.: Evaluation of Serum Calcium, Magnesium, Copper, and Zinc Levels in Women with Pre-eclampsia. The Iranian Journal of Medical Sciences, 33 (4): 231-234, 2008.
- 26- HOFMEYR G.J., LAWRIE T.A., ATALLAH A.N. and DULEY L.: Calcium supplementation during pregnancy for preventing hypertensive disorders and related problems. Cochrane Database Systemic Reviews, 8: 1-10, 2010.
- 27- EPHRAIM R.K., OSAKUNOR D.N., DENKYIRA S.W., ESHUN H., AMOAH S. and ANTO E.O.: Serum calcium and magnesium levels in women presenting with pre-eclampsia and pregnancy-induced hypertension: A case-control study in the Cape Coast metropolis, Ghana. BMC pregnancy and childbirth, 14 (1): 1-8, 2014.

دراسة مقارنة بين مستويات الكالسيوم والماغنسيوم في حالات تسمم الحمل مقابل الحمل الطبيعي

خلفية البحث : أوضحت العديد من الدراسات الإكلينيكية حتى الان العلاقة بين ارتفاع ضغط الدم المصاحب للحمل والاضطرابات في العناصر الغذائية والمعدن لدى الأم، والتي تشمل الكالسيوم والماغنسيوم في الدم، وهناك اهتمام متزايد بشأن الاستفادة من التغذية السليمة في إدارة تسمم الحمل فيما يتعلق بمكملات الكالسيوم والماغنسيوم.

الهدف من البحث : تقييم مستويات الكالسيوم والماغنسيوم في الدم لدى النساء الحوامل اللواتي تعانين من تسمم الحمل بالمقارنة مع النساء ذات الحمل الطبيعي.

المريضات وطرق البحث : استقطبت هذه الدراسة ١٠٠ امرأة حامل (٥٠ حالة تسمم الحمل و ٥٠ سيدة ذات حمل طبيعية) بعد ذلك. الأسبوع العشرين من الحمل خلال فترة البحث من فبراير ٢٠٢٠ إلى ديسمبر ٢٠٢٠ لتقدير مستويات الكالسيوم والماغنسيوم في الدم.

النتائج : كان متوسط مستوى الكالسيوم في الدم في المجموعة الضابطة 8.99 ± 0.52 مجم/ديسيلتر وكان متوسط مستوى الماغنسيوم في الدم 2.21 ± 0.3 مجم/ديسيلتر، وكان كلاهما أعلى من النسب الموجودة في مجموعة المرضى حيث كان متوسط مستوى الكالسيوم في الدم 8.05 ± 0.51 مجم/ديسيلتر ومتوسط مستوى الماغنسيوم في الدم 1.86 ± 0.25 مجم/ديسيلتر. وأظهرت الدراسة الحالية أن الكالسيوم كان له دقة تشخيصية أعلى بكثير من الماغنسيوم للتمييز بين النساء الحوامل المصابات بارتفاع ضغط الدم والنساء الحوامل الأصحاء. وكان الحد الأمثل لقيمة القطع للكالسيوم كان 8.55 (مجم/ديسيلتر) مع حساسية 80% وخصوصية 84% ، قيمة تنبؤية إيجابية و 3.83% قيمة تنبؤية سلبية، مما يشير إلى أهميته للتنبؤ بتسمم الحمل. بينما كانت القيمة المقطوعة للماغنسيوم أقل من 2.15 (مجم/ديسيلتر)، كانت الحساسية 88% ، وخصوصية 60% ، بالإضافة إلى ذلك، أظهر منحني روك أن الحد الأمثل للكالسيوم كان 8.15 (مجم/ديسيلتر) للتنبؤ بالنتائج السلبية للحمل مع حساسية 60.6% وخصوصية 86.6% ، بينما كانت القيمة المقطوعة للماغنسيوم الدم أقل من 1.945 (مجم/ديسيلتر)، كانت الحساسية 69.7% ، وكانت الخصوصية 67.2% .

الإستنتاج : كان متوسط مستويات كلا من الكالسيوم والماغنسيوم في الدم في النساء الحوامل المصابات بتسمم الحمل أقل بالمقارنة مع نظيراتهم الحوامل الأصحاء. وتدعم هذه النتائج الافتراض بأن هناك علاقة سبب ونتيجة بين نقص كالسيوم الدم ونقص ماغنسيوم الدم كعوامل مسببة محتملة متضمنة في التسبب في تسمم الحمل.