The relationship between hypertension and cerebral complications in stroke

La relación entre hipertensión y complicaciones cerebrales en el accidente cerebrovascular

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Abstract

Infarctions within the heart, such as myocardial infarctions (MI), are caused by sudden decreases in blood flow. This condition can have severe consequences, including various neurological complications. Myocardial infarction, commonly referred to as a heart attack, occurs when there is a sudden reduction in blood flow to the heart muscle. The aim of this study is to determine the levels of high-sensitivity cardiac troponin (hs-cTn) in the serum of acute myocardial infarction (AMI) patients and a control group, as well as to assess the levels of certain trace and essential elements in AMI patients and the control group. The study involved the analysis of two hundred samples, consisting of 100 patients with acute myocardial infarction and 100 healthy individuals in the control group. The age range for both groups was between 40 and 80 years. Statistical analysis of the results was performed using IBM SPSS v26 software. The study revealed elevated levels of TNHS (ng/l) and Cd (ng/ml) (262.44 ± 240.11, 1.004 ± 0.264) in AMI patients, along with decreased levels of Se (ng/ml), Zn (μg/ml), and Cr (ng/ml) (62.55 ± 5.01, 0.558 ± 0.056, and 0.414 ± 0.254) compared to the control group. In the control group, there were lower levels of TNHS (ng/l) and Cd (ng/ml) (5.02 ± 4.29, 0.599 ± 0.139) and higher levels of Se (ng/ml), Zn (μg/ml), and Cr (ng/ml) (84.621 ± 8.623, 0.702 ± 0.073, and 0.561 ± 0.156) with highly significant differences (p-value ≤ 0.001). The results of the study indicate that the concentrations of troponin and cadmium were higher in AMI patients compared to the control group, while the concentrations of selenium, zinc, and chromium were lower in AMI patients. Furthermore, there was a positive and significant correlation between the concentration of troponin and diabetes mellitus in the patient group, but no significant correlation was observed in the control group. These findings emphasize the importance of monitoring these biomarkers and trace elements in patients with acute myocardial infarction, as they may have implications for the development of complications, including neurological ones.

Keywords: Hypertension, Arterial pressure, Brain complications, Stroke, Blood flow

Resumen

Los infartos dentro del corazón, como los infartos de miocardio (IM), son causados por disminuciones repentinas en el flujo sanguíneo. Esta condición puede tener consecuencias graves, incluidas diversas complicaciones neurológicas. El infarto de miocardio, comúnmente conocido como ataque cardíaco, ocurre cuando hay una reducción repentina del flujo sanguíneo al músculo cardíaco. El objetivo de este estudio es determinar los niveles de troponina cardíaca de alta sensibilidad (hs-cTn) en el suero de pacientes con infarto agudo de miocardio (IAM) y un grupo control, así como evaluar los niveles de ciertos elementos traza y esenciales. en pacientes con IAM y el grupo control. El estudio implicó el análisis de doscientas muestras, compuestas por 100 pacientes con infarto agudo de miocardio y 100 individuos sanos

en el grupo de control. El rango de edad para ambos grupos estuvo entre 40 y 80 años. El análisis estadístico de los resultados se realizó utilizando el software IBM SPSS v26. El estudio reveló niveles elevados de TNHS (ng/l) y Cd (ng/ml) (262,44 ± 240,11, 1,004 ± 0,264) en pacientes con IAM, junto con niveles reducidos de Se (ng/ml), Zn (µg/ml) y Cr (ng/ml) (62,55 ± 5,01, 0,558 ± 0,056 y 0,414 ± 0,254) en comparación con el grupo control. En el grupo control, hubo niveles más bajos de TNHS (ng/l) y Cd (ng/ml) (5,02 ± 4,29, 0,599 ± 0,139) y niveles más altos de Se (ng/ml), Zn (µg/ml), y Cr (ng/ml) (84,621 ± 8,623, 0,702 ± 0,073 y 0,561 ± 0,156) con diferencias altamente significativas (valor de p ≤ 0,001). Los resultados del estudio indican que las concentraciones de troponina y cadmio eran mayores en los pacientes con IAM en comparación con el grupo de control, mientras que las concentraciones de selenio, zinc y cromo eran más bajas en los pacientes con IAM. Además, hubo una correlación positiva y significativa entre la concentración de troponina y la diabetes mellitus en el grupo de pacientes, pero no se observó una correlación significativa en el grupo de control. Estos hallazgos enfatizan la importancia de monitorear estos biomarcadores y oligoelementos en pacientes con infarto agudo de miocardio, ya que pueden tener implicaciones para el desarrollo de complicaciones, incluidas las neurológicas.

Palabras clave: Hipertensión, Presión arterial, Complicaciones cerebrales, Accidente cerebrovascular, Flujo sanguíneo

Introduction

Cardiovascular diseases (CVD) encompass a range of conditions that affect the heart and blood vessels, including arteries and veins. These diseases are a major health concern worldwide, contributing significantly to mortality and morbidity in modern societies[1-5]. One of the most prevalent cardiovascular diseases is hypertension, commonly referred to as high blood pressure, which can have severe consequences on the brain[6,7]. Hypertension, often referred to as high blood pressure, is a condition in which the force of blood against the artery walls is consistently too high[8,9]. This excessive pressure can lead to a variety of health problems, with one of the most critical being its impact on the brain[10-12].

Mortality and morbidity rates in contemporary society are predominantly driven by cardiovascular diseases, with atherosclerosis playing a pivotal role in their development[13,14]. Atherosclerosis is a process where lipid-laden plaques gradually build up inside blood vessels, causing a narrowing of the arteries and potentially leading to their rupture[15]. This can result in tissue hypoxia (oxygen deficiency) and necrosis (cell death), which can manifest as serious health issues, such as heart attacks, strokes, and lower limb diseases[16-18].

In 2016, there were more than 290 million cases of cardiovascular diseases, resulting in over 4 million deaths, with 1.736 million attributed to coronary heart diseases and over 2 million to strokes in China alone[19,20]. These diseases have significant social and economic impacts. Fortunately, cardiovascular diseases can be controlled and prevented by effectively managing and limiting their progression[21-24]. There are two main categories of risk factors for coronary heart disease. The first category comprises modifiable risk factors, including age, sex, race (ethnicity), and family history. The second category includes non-modifiable risk factors such as diabetes mellitus (T2DM), hypertension, smoking, and dyslipidemia[25-27].

Atherosclerosis, a key factor in the development of myocardial infarction (heart attack), is a condition characterized by the buildup of fatty plaques in the coronary arteries[28,29]. Myocardial infarction and coronary artery calcification are significant causes of sudden death. The release of cardiac markers, including lactate dehydrogenase, creatine kinase, aspartate aminotransferase, myoglobin, and troponin, occurs when myocardial necrosis (cell death) occurs due to ischemia (reduced blood supply)[30-31]. These cardiac markers serve as essential biomarkers in diagnosing and responding to heart diseases. Early detection and intervention are critical in managing cardiovascular conditions[32,33].

Furthermore, the concentration of essential trace elements in the body, such as selenium, zinc, and chromium, plays a vital role in overall health and well-being[34,35]. Disturbances in the levels of these elements can lead to various pathological conditions[36]. Inadequate presence of these essential trace elements in the diet can result in deficiencies[37,38]. Additionally, there are toxic trace elements that can be harmful to the body and are closely related to environmental conditions[39-41]. In light of these considerations, our study aimed to determine the levels of high-sensitivity cardiac troponin (hs-cTn) in the serum of acute myocardial infarction (AMI) patients and a control group. We also assessed the concentrations of certain trace and essential elements, including selenium, zinc, cadmium, and chromium, along with various risk factors for coronary artery disease (CAD), such as smoking, hypertension (HTN), diabetes mellitus (DM), and lipid profiles.

Subjects and samples

A total of 200 patients, comprising 100 individuals with unstable angina and 100 with myocardial infarction, were included in this research. The age range for both groups was 38 to 80 years. The primary objective of this study was to assess the presence of cadmium, selenium, chromium, and zinc in the blood samples of patients who had experienced myocardial infarction (MI) within the age range of 38 to 80 years (n=100). The study was conducted in the emergency and cardiac care units of Al-Sadder Teaching Hospital, Al-Fayhaa Teaching Hospital, and Al-Qurna General Hospital in Basra, where patients suffering from heart attacks were admitted. To conduct the analysis, 3 ml of pink blood was collected and treated with EDTA K3 FV01003 anticoagulant. The blood was then placed in a vacuum tube model G1326331 with gel and clot activators and subsequently centrifuged to separate the serum. The required analytes for the study were measured from this serum, and the samples were stored at temperatures between -20°C and -80°C to maintain their integrity. The research protocol was approved by the Iraq Study Protocol Committee and received ethical clearance from the Ethics Committee of the Basra Health Department. In this study, enrolled patients were not only assessed for high-sensitivity troponin (hsTn) levels but also for clinical indicators associated with acute myocardial infarction (MI). The determination of both form and quantity of biomarkers in MI patients was deemed crucial for the research objectives.

Hypertension, or high blood pressure, is a common medical condition with potentially severe consequences, including neurological complications. In this study, we investigate the relationship between hypertension and its impact on brain health, specifically focusing on the determination of various elements and biomarkers.

Determination of Selenium (Se) Levels

To assess the levels of selenium in blood, a flameless atomic absorption spectrophotometer (Shimadzu, GFA-7000f, Japan) was employed at the Chemical Analysis laboratory. A slit width of 0.2 nm and a lamp current of 5 mA were utilized, and the wavelength 196.1 nm was selected. Se levels were determined through extrapolation of the criterion curve and subsequent multiplication by the dilution factor.

Determination of Zinc (Zn) Levels

Similarly, serum zinc levels were determined using the same flameless atomic absorption spectrophotometer. A slit width of 0.5 nm and a lamp current of 5 mA were employed, with Zn levels measured at a wavelength of 213.9 nm. The criterion curve was extrapolated to calculate Zn levels, and they were multiplied by the dilution factor.

Determination of Cadmium (Cd) Levels

Cadmium levels were determined through flameless atomic absorption spectrophotometry using the Shimadzu GFA-7000f spectrophotometer (Japan). The measurement parameters included a slit width of 0.5 nm and a lamp current of 3 mA, with Cd levels assessed at a wavelength of 228.8 nm. The levels of Cd were established by extrapolating the criterion curve and multiplying the result by the dilution factor.

Determination of Chromium (Cr) Levels

Blood levels of chromium were calculated using a Shimadzu GFA-7000f atomic absorption spectrophotometer through flameless atomic absorption spectrophotometry at the Chemical Analysis lab. The measurements were conducted with a slit width of 0.7 nm and a lamp current of 10 mA, with Cr levels assessed at a wavelength of 357.9 nm. Cr levels were determined by extrapolating the criterion curve and multiplying it by the dilution factor.

Assay of Highly Sensitive Troponin I (TNHS)

To measure cardiac biomarkers, specifically TNHS, in serum, immunoassay kits from Vidas Biomérieux France were used according to the manufacturer's instructions.

Determination of Lipid Profile

The study included the assessment of the following lipid parameters: total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C). Biolabo, Maizy, France, provided standard commercial kits for these measurements.

Determining Glucose and HbA1c

Glycated hemoglobin (HbA1c) in whole blood was measured to assess glucose levels. It's important to note that individuals taking zinc, selenium, and copper supplements, as well as those with orthopedic implants, were excluded from the study due to their potential influence on the results. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) to explore the relationships between the variables of interest. Qualitative variables were assessed using the Chi-Square test, while parametric quantitative variables were evaluated using Pearson's test, Spearman's test, Student t-test, Mann Whitney test, and Spearman's test. A significance level was established with a probability value less than 0.05, indicating a statistically significant relationship. This study aims to shed light on the impact of hypertension on various biological parameters and its potential neurological repercussions.

The text discusses a study involving patients with myocardial infarction (heart attacks) and the measurement of various elements in their blood samples, including selenium (Se), zinc (Zn), cadmium (Cd), and chromium (Cr). The study focuses on the correlation between these elements and cardiac biomarkers, specifically troponin, and their potential implications for myocardial infarction (MI). Myocardial infarction, commonly known as a heart attack, is a condition associated with high morbidity and mortality, often leading to severe complications. One of the key biomarkers for MI is troponin, which is highly specific to cardiac myocytes and is used as a diagnostic indicator for MI.

In the context of this study, elevated troponin levels are associated with MI, and it is considered a gold standard biomarker for the condition. Furthermore, the study explores the relationship between selenium, zinc, cadmium, and chromium levels in the blood and their potential roles in the development and complications of MI. Selenium is discussed as playing a role in normal physiology and pathophysiology, with research linking its levels to conditions characterized by inflammation and oxidative stress, such as diabetes, metabolic syndrome, cancer, cardiovascular disease, and neurodegenerative diseases. It's also mentioned that selenium-binding protein 1 (SELENBP1) is considered an important biomarker for adverse events in patients with suspected acute coronary syndrome.

The study finds that there is a statistically significant difference in the concentration of selenium in the serum of MI patients compared to the control group, with lower levels in the patient group. This may suggest a potential association between low selenium levels and an increased risk of MI.

Zinc, another element analyzed in the study, is discussed as having lower levels in the serum of MI patients compared to the control group. The study suggests that low zinc levels may serve as an indicator for assessing prognosis after an MI and may contribute to the development of coronary heart disease, MI, and sudden cardiac death.

Cadmium, a toxic heavy metal, is found to have higher levels in the serum of MI patients compared to the control group. Cadmium exposure is associated with an increased risk of cardiovascular diseases and mortality, and the study supports this association. Chromium, which plays a role in lipid and carbohydrate metabolism, is discussed as having lower levels in the serum of MI patients compared to the control group. Elevated blood sugar levels are mentioned as a risk factor for diabetes.

The study also explores the correlations between these elements and various parameters, including lipid profiles, diabetes mellitus, and other risk factors. In summary, the study provides insights into the potential roles of selenium, zinc, cadmium, and chromium in the development and prognosis of myocardial infarction and its associated complications. Overall, the findings suggest that these elements may serve as valuable markers and indicators for assessing the risk, prognosis, and management of myocardial infarction. Further research is needed to fully understand their roles and potential clinical applications.

Table 1. Serum levels of hs-cTnT and essential elements (Se, Zn, Cn, Cr) of MI patients and healthy control. Values were expressed as (means)

Parameters	Control	Patients	P-value
	Mean ± SD	Mean ± SD	
Cardiac-hs-cTnT ng/L	5.02 ± 4.29	262.44 ± 240.11	0.001
Selenium(ng/ml)	84.62 ± 8.62	62.55 ± 5.01	0.001
Zinc(μg/ml)	0.702 ± 0.073	0.558 ± 0.056	0.0001
Cadmium(ng/ml)	0.599 ± 0.139	1.004± 0.264	0.001
Chromium(ng/ml)	0.561 ± 0.156	0.414 ± 0.254	0.001

Table 2. Correlation serum levels of hs-cTnT and essential elements (Se, Zn, Cd, Cr) with lipid profile and DM of MI patients and healthy control. Values were expressed as (means ± SD)

Category	Criteria	correlations	HbA1c	FBS	CHO.	TG	LDL	HDL
Patient	TNHS	R.	0.311	0.228	0.235	0.015	0.300	-0.211
		Sig.	**0.002**	**0.022**	**0.018**	0.884	0.002	0.036
Control	TNHS	R.	0.074	0.080	0.134	-0.067	0.102	-0.110
		Sig.	0.467	0.431	0.183	0.510	0.315	0.275
Patient	Se	R.	-0.188	-0.185	-0.330	-0.069	-0.285	0.246
		Sig.	0.061	0.065	0.001	0.496	0.004	0.014
Control	Se	R.	-0.074	-0.047	-0.087	-0.136	-0.135	0.087
		Sig.	0.464	0.640	0.387	0.178	0.181	0.392
Patient	Zn	R.	-0.018	-0.043	-0.306	-0.067	-0.306	0.217
		Sig.	0.857	0.673	0.002	0.510	0.002	0.030
Control	Zn	R.	-0.054	-0.139	-0.174	-0.031	-0.136	0.001
		Sig.	0.591	0.167	0.084	0.760	0.176	0.993
Patient	Cd	R.	0.067	0.067	0.282	0.248	0.274	-0.104
		Sig.	0.511	0.509	0.004	0.013	0.006	0.301
Control	Cd	R.	0.071	0.116	0.124	0.103	0.119	-0.163
		Sig.	0.484	0.250	0.221	0.306	0.239	0.106
Patient	Cr	R.	-0.462	-0.530	-0.289	-0.125	-0.222	0.086
		Sig.	0.001	0.001	0.004	0.216	0.026	0.369
Control	Cr	R.	-0.406	-0.513	-0.041	-0.036	-0.133	0.137
		Sig.	0.003	0.002	0.685	0.726	0.188	0.174

Table 3. Correlation of Minerals (Se, Zn, Cd, and Cr) with TNHS in patient and control

Minerals	Correlation	TNHS	
		patient	Control
Se	R	-0.226	-0.080
	Sig.	0.024	0.426
Zn	R	-0.225	-0.093
	Sig.	0.025	0.357
Cd	R	0.183	0.099
	Sig.	0.068	0.327
Cr	R	-0.185	-0.026
	Sig.	0.065	0.797

Conclusions

This study aimed to determine the levels of high-sensitivity cardiac troponin (hs-cTn) in the serum of acute myocardial infarction (AMI) patients and a control group. It also sought to assess the concentrations of specific trace and essential elements such as selenium, zinc, cadmium, and chromium in AMI patients compared to the control group. Additionally, the study explored the relationship between these trace and essential elements (selenium, zinc, cadmium, and chromium) and certain risk factors of coronary artery disease (CAD), including diabetes mellitus and lipid profile. The results revealed that the concentration of troponin and cadmium in AMI patients was higher than in the control group. Conversely, the concentrations of selenium, zinc, and chromium in AMI patients were lower than in the control group. Notably, troponin concentration showed a significant positive correlation with diabetes mellitus in the patient group but not in the control group. Furthermore, troponin concentration exhibited a positive significant correlation with total cholesterol and low-density lipoprotein (LDL) but a negative correlation with high-density lipoprotein (HDL) in the patient group. No significant correlation was found with triglycerides (TG) in the patient group, and there was no significant correlation with the lipid profile in the control group. Additionally, the study confirmed that the concentrations

of selenium, zinc, and cadmium had no significant correlation with diabetes mellitus in both the patient and control groups. Selenium and zinc concentrations showed a significant negative correlation with total cholesterol and LDL, as well as a significant positive correlation with HDL in the patient group. However, no significant correlation was found with TG in the patient group, and there was no significant correlation with the lipid profile in the control group. Furthermore, the concentration of cadmium exhibited a significant positive correlation with total cholesterol, LDL, and TG but no significant correlation with HDL in the patient group. Similar to other trace elements, there was no significant correlation with the lipid profile in the control group. The concentration of chromium had a significant negative correlation with diabetes mellitus in both the patient and control groups, with a stronger correlation in the patient group. Chromium concentration also displayed a significant negative correlation with total cholesterol and LDL but had no significant correlation with TG and HDL in the patient group. Similarly, there was no significant correlation with the lipid profile in the control group. Finally, troponin concentration had a significant negative correlation with selenium and zinc in the patient group but not in the control group. Troponin concentration had no significant correlation with cadmium and chromium in both the patient and control groups.

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