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Impact of Cardiac Disorders on Renal Function Tests and Serum Electrolytes in Sudanese Patients with Acute Myocardial Infarction

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Abstract

Acute myocardial infarction (AMI) is the most serious clinical manifestation of coronary artery disease leading to irreversible heart necrosis due to prolonged ischemia. From being an illness prevalent predominantly in developed countries, AMI is now becoming increasingly more common in developing countries. The study aims to estimate renal function test and serum electrolytes in acute myocardial infarction patients to reflect the effect of AMI on renal function. Case control study conducted at Cardiac center, Wad Medani, Gezira State, from September 2017 to February 2021. A total of three hundred and forty blood samples were collected, one hundred and seventy from acute myocardial infarction patient and one hundred and seventy from health control group. Data were collected by questionnaire and analyzed using SPSS version (21). A total 170 AMI patients with chest pain (100%), positive Troponin I (100%) and had not pervious history for renal disease (100%) were enrolled in this study, the majority of whom are male (67%), their age is over 60 (51%), and the majority of them have chronic diseases such as hypertension (68.2%) and diabetes (64%). The levels of blood urea, serum creatinine and urea / creatinine ratio were significantly increased in AMI patients when compared with control group with P. value (0.000), while the serum Sodium concentration was significantly decreased in AMI patients with P. value (0.005). On other hand, the level of serum Potassium and Sodium / Potassium ratio were not significant deferent between AMI patients and Non-AMI healthy individuals. Also, urea had significant positive moderate correlation with Creatinine, potassium, and urea / Creatinine ratio, whereas it had a significant negative weak correlation with sodium. Inconclusion, Acute Myocardial Infarction was affected on renal functions which lead to decrease renal clearance for body metabolism waste and decrease the ability of renal to reabsorbed sodium.

Keywords: Renal function test, Serum Electrolytes, Sudanese, Pre-renal disease, Creatinine, Acute myocardial function

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Introduction

Acute kidney injury (AKI) is a clinical syndrome that can have many underlying causes. It is a major public health concern on a global scale [1]. While AKI is known to be responsible for significant morbidity and mortality worldwide, data on the global burden of disease are lacking, and the incidence rate is on the rise [2]. There are 13 million episodes of AKI in the world every year, and 85 percent of them occur in low-income countries [3]. Four out of five cases of AKI occur in developing countries [4-5]. An acute kidney injury commonly occurs when there is diminished kidney function due to various pathophysiological events, which eventually lead to retention of waste products, altered electrolyte balance, altered drug concentration's ability, and generalized inflammatory processes [6]. According to recent estimates, AKI is prevalent in 1% to 66% of patients, which may complicate into end-stage renal disease (ESRD) [7]. Depending on the severity and cause of AKI, Kidney Disease Improving Global Outcomes (KDIGO) clinical guidelines provide tips categorizing the AKI which influence prognosis and treatment plan [5].

The occurrence of MI is caused by a severely reduced blood flow during a coronary artery occlusion or near occlusion, resulting in some of the heart muscles supplied by that arterial branch to become infarcted [8]. An acute myocardial infarction (AMI) is one of the most common conditions diagnosed in hospitalized patients sudden cardiac arrest contributes to about 3 million deaths globally each year [9]. Myocardial infarction (AMI) is the world's leading cause of death [10]. AMI can be diagnosed by at least two of the three criteria; typical symptoms as a chest pain, changes on the ECG, and elevation on cardiac biomarkers [11].

Among hospitalized patient for AMI the most accompanying conditions is AKI [12-13]. The relationship between renal impairment and expanded mortality is well characterized in patients with AMI [10]. Intense myocardial tissue injury (AMI) is one of the vital conditions causing AKI [14]. This is often in portion due to the presence of comorbid variables, changes in hemodynamic, and the utilization of drugs that lead to kidney injury [15]. Among patients

with AMI, those with AKI had a 20- to 40- times higher mortality rate when compared to AKI free patients [16]. Patients with AKI too had more long-term complications, counting repetitive AMI, cardiac failure, progressive chronic kidney impairment, and long-term mortality [17]. Research demonstrated that the frequency of AKI extended from 7.1% to 29.3% among hospitalization in patients with AMI [18]. The objective of present study was to estimate renal function test and serum electrolytes in acute myocardial infarction patients to reflect the effect of AMI on renal function.

Patients and Methods

A case control hospital-based study, conducted at Wad Medani Cardiac Center, Wad Medani, Gezira state, Sudan, included Sudanese patients diagnosed with acute myocardial infarction and their age matched with control attended at Wad Medani Cardiac Center during September 2017 to February 2021. AMI cases were included according to the final diagnoses by Wad Medani Cardiac Center physicians depending on at least two of the following criteria: chest pain, electrocardiography (ECG) elevation, and levels on cardiac biomarkers. AMI patients with history of renal diseases or Patients under treatment with drugs contain sodium and potassium was excluded from this study.

Ethical clearance was obtained from the ethical committee at the Gezira State Health Ministry and Wad Medani Cardiac Center, University of Gezira. All participants agreed and signed informed consent before included in the study. Data was collected by using a well-structured questionnaire includes demographic and clinical characteristics of the patients such as: age, sex, chest pain, ECG result, smoking, DM, family history of renal disease, Hypertension, Troponin I, RFT levels (B. Urea, P. Creatinine, P. Sodium, P. Potassium, Ur: Cr Ratio, Na: K Ratio). Under aseptic precautions 3 ml of venous samples was collected in Heparin containers, the blood was mixed with anticoagulant by inverting the tubes several times, mixing was continued and the tube was labeled corresponding to the patient's number in the questionnaire. A non-allergic adhesive spot was placed over the vein puncture. Blood Urea was measured by Kinetic test with urease and glutamate dehydrogenase (Roche© COBAS Diagnostics) - Normal value: 15 – 45 mg/dl. Plasma Creatinine was measured by kinetic colorimetric assay is based on the Jaffé method. (Roche© COBAS) - Normal value: up to 1.4 mg/dl. Sodium and potassium were measured by Roche 9180 Electrolyte Analyzer, which used ion selective electrode method - Normal value: Plasma Na: 135- 145 mmol/l Plasma K: 3.5 – 5 mmol/l

Data was analyzed using SPSS software version 22. Patient clinico-demographic and investigative characteristics were presented as frequencies (n and %), mean \pm standard deviation (SD) and range of values. The Independent Samples T test compared the means

of RFT between two groups, whereas used correlation test to study the correlation between study parameters. A P value ≤ 0.05 was considered as statistically significant.

Results

From 340 individuals were enrolled in this study about 170 healthy persons as control group and 170 patients with AMI as cases. All cases had chest pain symptoms, positive Troponin I and had not previous history for renal disease, the majority of whom are male (67%), their age is over 60 (51%), and the majority of them have chronic diseases such as hypertension (68.2%) and diabetes (64%). The levels of blood urea, serum Creatinine and urea / Creatinine ratio were significantly increased in AMI patients when compared with control group with P. value (0.000), while the serum Sodium concentration was significantly decreased in AMI patients with P. value (0.005). On other hand, the level of serum Potassium and Sodium / Potassium ratio were not significant deferent between AMI patients and non-AMI healthy individuals. Also, urea had significant positive moderate correlation with Creatinine, potassium, and urea/Creatinine ratio, whereas it had significant negative weak correlation with sodium.

Table 1.

The frequency of risk factors and diagnostic criteria in AMI patients

	Risk Factors	Number	Percent %
Age	Less than or equal 60 years	84	49.4
	More than 60 years	86	50.6
Sex	Male	114	67
	Female	56	33
Obesity	Obese	39	22.9
	Normal Weight	131	77.1
Smoking	Smoker	61	35.9
	Non-Smoker	109	64.1
Hypertension	Hypertensive	116	68.2
	Normotensive	54	31.8
Diabetes Mellitus	Diabetic	109	64.1
	Non-Diabetic	61	35.9
Chest Pain	With Chest Pain	170	100
Troponin I	Positive Result	170	100
History of Renal Disease	Without History	170	100
Total		170	100

Table 2.

The statistic characteristic of study parameters among AMI patients

	Age (Year)	Urea (mg/dl)	Creatinine (mg/dl)	Na (mmol/l)	K (mmol/l)	Ur: Cr Ratio	Na: K Ratio
Mean	60.74	41.13	1.36	134.88	3.92	33.03	34.97
N	170	170	170	170	170	170	170
Std. Deviation	13.58	29.34	1.12	4.95	0.51	16.00	4.68
Median	61.50	32.00	1.10	135.00	3.90	31.32	34.87
Minimum	21	3	0.50	115	2.90	2.00	22.55
Maximum	100	181	8.50	145	5.60	93.75	47.24

Table 3.

The Comparisons between study parameters among AMI patients and Non AMI group

	Case Control	N	Mean	Std. Deviation	P. value
Urea (mg/dl)	Case	170	41.13	29.34	0.000
	Control	170	23.62	6.74	
Creatinine (mg/dl)	Case	170	1.36	1.12	0.000
	Control	170	0.80	0.20	
Na (mmol/l)	Case	170	134.88	4.95	0.005
	Control	170	139.21	3.46	
K (mmol/l)	Case	170	3.92	0.51	0.912
	Control	170	3.71	0.52	
Ur: Cr Ratio	Case	170	33.03	16.00	0.001
	Control	170	31.08	11.40	
Na:K Ratio	Case	170	34.97	4.68	0.509
	Control	170	38.13	4.79	

Table 4.

The Correlation between study parameters among AMI patients

		Sex	Urea	Creatinine	Na	K	Ur: Cr Ratio	Na: K Ratio	age
Sex	Pearson Correlation	1	-.033	-.155*	.014	.156	.156	.142	
	P. value		.673	.043	.854	.042	.042	.064	
Urea	Pearson Correlation	-.033	1	.639**	-.277**	.502	.502	-.272	.218**
	P. value	.673		.000	.000	.000	.000	.000	.004
Creatinine	Pearson Correlation	-.155*	.639**	1	-.141	-.212*	-.212*	-.215**	.034
	P. value	.043	.000		.067	.005	.005	.005	.662
Na	Pearson Correlation	.014	-.277**	-.141	1	-.097	-.097	.366**	-.088
	P. value	.854	.000	.067		.208	.208	.000	.252
K	Pearson Correlation	-.152*	.286**	.231**	-.144	-.016*	-.016*	-.956**	.130
	P. value	.047	.000	.002	.060	.836	.836	.000	.090
Ur: Cr Ratio	Pearson Correlation	.156*	.502**	-.212**	-.097	1*	1*	.004**	.248**
	P. value	.042	.000	.005	.208			.955	.001
Na: K Ratio	Pearson Correlation	.142	-.272**	-.215**	.366**	.004	.004	1**	-.134
	P. value	.064	.000	.005	.000	.955	.955		.083
	N	170	170	170	170	170	170	170	170

Discussion

The prevalence of myocardial infarction is increased over the last few decades in Gezira state, Sudan 25%, due to increase the prevalence of risk factors governing AMI as some diseases and habit [19]. Myocardial infarction is serious disease can lead to increased mortality and morbidity [20]. A total of 340 blood samples were collected, 170 from acute myocardial infarction patient and 170 from health control group. The distribution of demographic data showed that 67% of patients were males and 33% were females. 50.6% of patients' age above 60 years old, whereas distributions according to their risk factor; 23% were obese, 36% were smokers, 68% of patients were hypertensive, and 64% diabetic patients. Level of blood urea (mg/dl), plasma Creatinine (mg/dl) and Urea/Creatinine Ratio were significantly increased in acute myocardial infarction patients (41.13 ± 29.34), (1.36 ± 1.12) and (33.03 ± 16.00) when compared with control group (23.62 ± 6.7) and (0.80 ± 0.20) and (31.08 ± 11.40) with p value (0.000) and (0.001) respectively, the increase mean of blood urea and plasma Creatinine in AMI patients may be due to decreased blood flow reaching the kidneys and affecting on renal functions which lead to decrease the ability of renal to wash away of waste was produced by human body especially urea and Creatinine, this disorders known as Pre-renal disease, this finding was agree with study done by Mandole MB et al. in India [21]. According to blood electrolytes level in AMI patients; the level of plasma sodium (mmol/l) concentration was significant decreased in acute myocardial infarction patients (134.88 ± 4.95) when compared with control mean (139.21 ± 3.46) with (p value =0.005), decreased plasma sodium may be due to hypoxia and ischemia, which increase the permeability of muscle cell membrane to sodium, and no significant different in plasma potassium (mmol/l) and Sodium/Potassium ratio in acute myocardial infarction patients (3.92 ± 0.51) and (34.97 ± 4.68) when compared with control mean (3.71 ± 0.52) and (38.13 ± 4.74) with p value (0.912) and (0.509) respectively, this result was agreed in sodium and disagree in potassium with study done by Mandole MB et al. in India [21] and other study done by EL-Shareif, E. F. and N. E. Abubaker in Sudan [9]. Blood urea level had positive moderate correlation with serum Creatinine level, serum potassium and Urea/Creatinine Ratio (Pearson Correlation: 0.639, 0.502, and 0.502) respectively with p. value (0.000), thus was good indicator for use urea with Creatinine in diagnosis of renal function tests which were parallel in pattern and any one was confirm other. Whereas it had positive weak correlation with age (Pearson Correlation: 0.218) with p. value (0.000), this finding was similar to literature and facts that concluded to decrease renal function with increase in age. And had negative weak correlation with serum sodium (Pearson

Correlation: 0.277) with p. value (0.000), this result was near to literature and scientific explanation for renal electrolyte.

Conclusion

Renal play important role in excretion of metabolic waste products and water electrolytes balance, which this function depends on the permeability of glomerulus membrane and high pressure in the glomerular capillaries, whereas the lastly was low in acute myocardial infarction patients which affected on renal functions which lead to decrease renal clearance for body metabolism waste and decrease the ability of renal to reabsorbed sodium.

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Ethical Approval

The study was approved by the Ethical Committee.

Conflicts of Interest

The authors declare that they have no competing interests.

Authors' Contributions

All authors shared in conception, design of the study, acquisition of data, and manuscript writing, the critical revising and final approval of the version to be published.

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