CATALASE ACTIVITY AND SOME BIOCHEMICAL PARAMETERS IN PATIENTS WITH KIDNEY FAILURE

Mohammed Habeeb Hadi¹, Dr. Salma Abdul-Rudha Abbas²
¹²Department of Chemistry, College of Science, Mustansiriyah University, Baghdad, Iraq.

ABSTRACT

Oxygen is a highly reactive nonmetal and an oxidizing agent that readily forms oxides with most elements as well as with other compounds. Chronic kidney disease produces ROS as a result of pro-inflammatory, increase ROS if their oxidative stress and these factors increase the probability of cardiovascular disease. A catalase (E.C. 1.11.1.6) is one of the most important antioxidant enzymes. The role of catalase activity and some biochemical parameter were evaluated in 101 patient 62 men 61.4%, and 39 woman 38.6%. The age was between 40 to 70 years old, divided into three groups: first group (G1) patient in end-stage kidney disease without hypertension and diabetes mellitus, the second group (G2) patient in end-stage kidney disease with hypertension, the third group (G3) patient end-stage kidney disease with hypertension and diabetes mellitus. And the control group was 30 person 16 male 53.3%, and 14 female 46.7%. The correlation between catalase activity, serum creatinine, blood urea, calcium, phosphorous, sodium, and potassium showed there were no significant differences in result between the patient and control group p > 0.05. There was a significant increase in potassium, serum creatinine, blood urea, and phosphorous compared to the control group P < 0.05. And there was a significant decrease in serum calcium, sodium, compared to the control group P < 0.05. In conclusion: The ROS effected on the End Stage Kidney Disease (ESKD) dialysis patient with chronic kidney (CKD) disease and the catalase activity did not effected.

Keyword: ROS, Catalase Activity, Kidney Failure.

I. INTRODUCTION

Antioxidants are categorized depending on defense lines: preventive antioxidant as the initial line of defense such as SOD, CAT, GPx, glutathione reductase, and several types of minerals, for example, selenium (Se), manganese (Mn), copper (Cu), and iron (Fe). radical-scavenging antioxidant in the second line of defence vitamins E and C, flavonoids, and uric acid. and, lastly, repair and de-novo enzymes as the third line of defence, as further elaborated[1]. The AO can be endogenous or exogenous.

Endogenous Antioxidants (EnAOs)

Endogenous antioxidants (EnAO) are the enzymes or cofactors that eliminate ROS. superoxide dismutase SOD, catalase CAT, and glutathione peroxidase (GPx) are the three enzymatic systems that perform an important role in the EnAO characteristic of biological systems against free radicals[2]

Exogenous Antioxidants (ExAOs)

Exogenous antioxidants (ExAOs) are a large group of molecules, that can be divided into three subgroups, namely: polyphenols, vitamins and derivatives, and AO minerals[3]. A catalase (E.C. 1.11.1.6) is one of the most important antioxidant enzymes It distinguishes into three group: heme monofunctional catalases, heme catalase-peroxidases, and manganese catalases. the heme active site is responsible for catalytic reactions in catalase enzyme[4]. It is present in almost all aerobic organisms. The enzyme has a molecular mass of approximately 220-240 kDa. Catalase has a channel in its structure that plays an important role for transport the substrate H₂O₂ to the active site[5]. Catalase breaks down two hydrogen peroxide molecules into one molecule of oxygen[6] and two molecules of water in a two-step reaction[7].

\[
\text{Catalase} + H_2O_2 \rightarrow \text{Compound I} + H_2O
\]
Compound I + $H_2O_2$ $\rightarrow$ Catalase + $H_2O + O_2$  \hspace{1cm} (2)

Catalase deficiency or malfunctioning is associated with many diseases: Neurological disorders such as Alzheimer’s disease, Metabolic disorders such as type I and II diabetes and Hypertension

Other disorders such as Anemia and Cancer[8]

1.1. Free Radical

Free radicals are atoms, molecules or ions with unpaired electrons that are highly unstable and active towards chemical reactions with other molecules They derive from three elements: oxygen, nitrogen and sulfur then the term of reactive species has been expanded to cover reactive chlorine, bromine, and iron species, [9], [10].

1.2. Reactive Oxygen Species (ROS) Source and Type

Those formed as a result of mitochondrial respiratory chain, respiratory burst and the actions of NADPH oxidase, xanthine oxidase, lipooxygenases, glucose oxidase, myeloperoxidase, nitric oxide synthase, cyclooxygenase, and transition metals are endogenous.

1.3. Reactive Oxygen Species (ROS)

Oxygen is a highly reactive nonmetal and an oxidizing agent that readily forms oxides with most elements as well as with other compounds[9]. ROS act like a ‘double-edged sword’, meaning that they are essential for killing pathogens; however, they can also be harmful to host tissues. However, the enzymatic background of non-phagocytic ROS production was unknown. Beginning from 1999, several enzymes were identified at the molecular level, which are now proven to be responsible for regulated ROS production observed in diverse tissues[11]. Reactive species (RS) are highly active moieties, some of which are direct oxidants, and some have oxygen or oxygen-like electronegative elements produced within the cell during cellular metabolism or under pathological conditions. The imbalance between production and quenching of these reactive substances through antioxidant mechanisms causes oxidative stress[8]. Reactive oxygen species (ROS) is a collective term that mostly refers to oxygen radicals. All are capable of reacting with membrane lipids, nucleic acids, proteins and enzymes, and other small molecules, resulting in cellular damage. ROS are generated by a number of pathways[10].

1.4. Oxidative Stress (OS)

a disruption in redox signaling and control or a pathophysiologic imbalance between oxidants and antioxidants in favour of the oxidants[12]. OS can result from diminished antioxidant enzymes or antioxidant levels or defects in antioxidant machinery in expressing antioxidant genes[10]. Some pattern of oxidative stress, increased renin-angiotensin-aldosterone system activity during heart failure may cause inflammation, oxidative stress, and endothelial dysfunction, which have deleterious effects on the kidney[13].

1.5. Hypertension

Hypertension (HTN or HT), also known as high blood pressure (HBP), is a long-term medical condition in which the blood pressure in the arteries is persistently elevated. High blood pressure typically does not cause symptoms. There are three main reasons for renal dysfunction related to cardiac dysfunction decreased renal blood flow / GFR, Anemia, and endothelial dysfunction[13]. In kidney failure, there are some factors that accumulate in the blood and when be high it will lead to reducing nitric oxide NO

This is why it leads to Hypertension[14]. Kidney disease and heart disease are closely related, as when the heart deteriorates, the kidneys are affected directly and vice versa[15], [16]. The patients who have heart failure showed consistent and significant associations with developing ESKD [15]. The main reason for increased blood pressure is to activate RAAS system, and this system, in turn, lead to reabsorption of sodium and water and increases blood flow to the glomerular, for that its recommended to a patient who has hypertension and no diabetes to use RAAS inhibitors [17].

1.6. Diabetes Mellitus
Diabetes mellitus is a common disease nowadays. They are caused by a bundle of metabolic disorders, distinguished by high levels of glucose in the blood due to improper secretion of insulin or its activity or both. Type 2 diabetes mellitus is the most common form of the disease, accounting for approximately 90% of all diabetes cases. It occurs primarily due to low production of insulin and secondarily also due to insulin resistance by the body’s cells. The β cells of islets of Langerhans become damaged which make them unable to produce insulin. Oxidative stress has been demonstrated to be an important factor responsible for the advancement of type 2 diabetes. In patient with diabetic kidney disease, the treatment reduces the risk of ESRD [18]–[20]. It has been demonstrated that hydrogen peroxide acts as an oxidant and damages the β cell interrupting the signaling pathway of insulin production[21]. High blood sugar leads to thickening of blood vessels[22]. Diabetes is linked to proliferative diabetic retinopathy, They cause microvascular remodeling, and ultimately result in end-organ damage [23].

II. PATIENT AND METHOD

Samples were collected from patients who attended the Shahid Ghazi Al-Hariri Hospital, Center for Kidney Diseases and Transplantation, and Baghdad Hospital, the National Center for Dialysis (Baghdad medical city) during the period from November 2020 to May 2021.

The patient number in this steady was 101 include 62 men 61.4%, and 39 woman 38.6%. The age was between 40 to 70 years old. Patients divided to three group the first group (G1) was 30 patients 22 male 73.3%, and 8 female 26.7%, with end-stage kidney disease (ESKD) without hypertension or diabetes mellitus. The second group (G2) was 41 patients 19 male 46.3%, and 22 female 53.7%, with ESKD they have hypertension. The last group (G3) was 30 patients, 21 male 70%, and 9 female 30%, with ESKD have hypertension and diabetes mellitus. And the control group (C) was 30 person 16 male 53.3%, and 14 female 46.7%.

We use L.Goth methods to determined catalase activity in dialysis patient with chronic kidney disease, and healthy people. And we use biochemistry full automated analyzer A15 from biosystem company, to determined other barometers such as serum blood urea, serum creatinine, serum albumin, and electrolytes.

III. RESULT AND DISCUSSION

Creatinine is a biomarker for acute kidney injury and chronic kidney disease and if any, problems happening in the kidney then the serum creatinine will raise. There are a significant correlation between control and dialysis patient with kidney failure. Also there were a significant statistic between G2 and, G3 There were a high significant increase in the serum levels of creatinine in ESKD of dialysis patient with CKD compared to control group (p < 0.001). the result also showed a non significant increase in the levels of creatinine in the patient with end stage kidney disease G1, compared with ESKD, G2, and G3 dialysis patient with CKD. (p > 0.05). There were a high significant decrease in the serum levels of creatinine in ESKD of G3 cases dialysis patient with CKD compared to ESKD with G2 group (p < 0.001). our result agreement with D, Pandya et al, in hypertension but when the patient have hypertension and diabetes we showed conversely result. Creatinine was higher in ESKD G2dialysis patient with CKD compared to ESKD G3 with CKD dialysis patient [24]. Diabetic nephropathy is one of the major causes of chronic renal failure. After many years of diabetes the delicate filtering system in the kidney becomes gradually destroyed, initially becoming leaky to larger blood proteins such as albumin which are then lost in the urine. Both serum urea and creatinine are widely used to assess the function of kidney[25]. The result in this study agreement with many other result, the serum creatinine, and blood urea increase significantly in dialysis patient with end stage kidney disease, creatinine is completely filtered across the glomerular membrane, and is neither reabsorbed nor metabolized in the kidney and is partly secreted into the proximal tubule. However, serum creatinine levels are influenced by variability related to age and gender. In addition plasma creatinine is also effected by body composition and dietary factors [26]–[28].

Renal failure is a late consequence of end-stage liver disease (ESLD). For that the testing for liver enzyme and albumin is important. There were a highly significant decrease in serum levels of albumin G1 and G3 dialysis patient with CKD compared to control (p = 0.019). The result also showed there were none significant change in serum level of albumin in G2 dialysis patient with CKD compared to control (p- value > 0.05). Many liver diseases coexist with chronic renal disease, because many systemic conditions affect both the liver and the kidneys. Certain liver diseases are also common in patients with chronic renal disease, especially viral hepatitis, either because the renal disease occurs as a complication of viral hepatitis, or the viral hepatitis is acquired as a result of dialysis. Our result agreement with Zhang, J et al the result of serum level of albumin decrease in patient G3 compared to control group[29].
In this study the result for calcium levels showed a highly significant decrease in serum calcium among patient group compared with control the same finding were observed by other study[30], [31]. These observation were attributed to the fall in the synthesis of (1,25(OH)2vitD3) phosphate clearance decrease, and plasma levels of phosphate increase[32].

There were a high significant increase in the serum levels of phosphors in patient with ESKD compared with control group (p < 0.001). the result also showed a non significant increase in the levels of phosphorus (phos) in patient compared to each other. Zhang, Lu et al. observed that serum phosphorus levels were a highly significantly increase in CKD patient compared to control group[31].

Hyperphosphatemia lead to progressive ESKD and increase mortality[33]. Phosphors retention and hyperphosphatemia are extremely common in patients with end stage kidney disease[34]. This is a result of the decreased ability of the failing kidney to excrete phosphors in the urine, as a consequence of the decrease in the glomerular filtration rate, which would lead retention of phosphor in blood, causing serum phosphorus to rise. This transient episode of hyperphosphatemia would give rise to decrease in the levels of ionized calcium in the blood, which would then trigger an increase in the secretion of parathyroid hormone [35].

There were a non significant increase in the serum levels of catalase activity in dialysis patient with CKD compared to control group (p > 0.05). the result also have shown non significant increase in dialysis patient with CKD compared to each other.

Martín et al. there were a significant increase in serum levels of catalase activity in patient compared to control[36]. This disagreed with our result.

Other study for Aziz et al. showed a high significant increase in serum levels of catalase in patients compared to control[37]. This disagreed with our result.

There were many study agreement with each other about decrease glutathione peroxidase and increase Other study for Aziz et al. showed a high significant increase in serum levels of catalase in patients compared to control[30], [31]. These observation were attributed to the fall in the synthesis of (1,25(OH)2vitD3) phosphate clearance decrease, and plasma levels of phosphate increase[32].

There were a high significant increase in the serum levels of phosphors in patient with ESKD compared with control group (p < 0.001). the result also showed a non significant increase in the levels of phosphorus (phos) in patient compared to each other. Zhang, Lu et al. observed that serum phosphorus levels were a highly significantly increase in CKD patient compared to control group[31].

Hyperphosphatemia lead to progressive ESKD and increase mortality[33]. Phosphors retention and hyperphosphatemia are extremely common in patients with end stage kidney disease[34]. This is a result of the decreased ability of the failing kidney to excrete phosphors in the urine, as a consequence of the decrease in the glomerular filtration rate, which would lead retention of phosphor in blood, causing serum phosphorus to rise. This transient episode of hyperphosphatemia would give rise to decrease in the levels of ionized calcium in the blood, which would then trigger an increase in the secretion of parathyroid hormone [35].

There were a non significant increase in the serum levels of catalase activity in dialysis patient with CKD compared to control group (p > 0.05). the result also have shown non significant increase in dialysis patient with CKD compared to each other.

Martín et al. there were a significant increase in serum levels of catalase activity in patient compared to control[36]. This disagreed with our result.

Other study for Aziz et al. showed a high significant increase in serum levels of catalase in patients compared to control[37]. This disagreed with our result.

There were many study agreement with each other about decrease glutathione peroxidase and increase malondialdehyde [36]–[38]. But Sindhu et al. showed in there study the glutathione peroxidase not significantly affected. and catalase activity was decrease[39].

IV. CONCLUSION

In patients with ESKD, there was a significant increase in some biometer, also there was a significant decrease in other. And catalase activity in this study showed a none significant difference in result between the patients and control group.

REFERENCES

16. doi:10.1681/ASN.2019060574


