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Assessment of Serum Urea and Creatinine Levels in Diabetic Patients

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ABSTRACT

Diabetic nephropathy is the leading cause of renal morbidity which occurs when chronic diabetes destroys the filtering system of the kidneys. Serum urea and creatinine are widely used as renal function test parameters. This study aims to assess the level of serum urea and creatinine in diabetic patients and their relationship with each other. The study was conducted in Ayub Teaching Hospital from September 15 to December 20, 2019. A total of 176 samples from confirmed diabetic patients were analyzed including 85 female and 91 male patients. Also, 83 control samples were taken for this study. Serum urea and creatinine levels were assessed to evaluate diabetic nephropathy in diabetic patients. SPSS (version 23) was used for statistical analysis. Pearson correlation analysis was used to check the relationship of blood sugar level, creatinine, and urea. Descriptive statistics (mean ± SD) were measured for the continuous variable. Scatter plot diagrams were added for the easy visualization and interpretation of the data. The significant level was set at $p < 0.05$. Out of the 176 diabetic samples, 32 had abnormally high serum creatinine and 66 had abnormal serum urea. In controls, one individual had high creatinine and three individuals had high serum urea. A significant increase in both urea and creatinine levels was observed in diabetic samples. Both serum urea and creatinine showed a strong positive correlation with the level of glucose and remained statistically significant ($p < 0.01$). Similarly, blood glucose level showed a strong correlation with the renal function test parameters. Hence, it was concluded that serum urea and creatinine are important parameters to assess kidney function in diabetes mellitus.

Keywords: creatinine, diabetic, diabetes, glucose, serum urea

1. INTRODUCTION

Diabetes mellitus (DM) is a collective term used for a group of metabolic disorders characterized by hyperglycemia that occurs due to an insufficient metabolism of glucose because of a defect in insulin secretion, functional defect in insulin, or both at the same time [1, 2]. Diabetes, which was considered earlier as a minor threat, is now regarded as one of the major threats to human health [3]. It is the common cause of kidney failure and diabetic nephropathy leads to chronic renal failure [4].

Diabetic nephropathy is associated with proteinuria, nephrotic syndrome, and the chronic kidney disease (CKD) [5]. In the early stages of diabetic nephropathy, glomerular filtration rate (GFR) is significantly higher than normal. Although, it worsens later on. Urinary proteinuria can be detected through the urine dipstick test known as overt nephropathy [6]. Diabetic nephropathy is one of the common causes

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of chronic renal failure [7]. It develops in 40% of patients with insulin dependent diabetes mellitus (IDDM) [8].

In 2017, approximately 8.8% of the total world population was diagnosed with DM, making 424.9 million individuals [9]. This number is expected to increase up to 693 million individuals by 2045 [10]. In 2022, Pakistan was ranked at number 03 for diabetes cases among 195 countries of the world with 7.5 million cases [11]. In 2020, Pakistan had 33 million cases of diabetes [12]. Moreover, about 32.3% of cases in Pakistan lead to diabetic nephropathy [13].

Serum creatinine is the metabolic product of muscle protein creatine. The normal range of creatinine in blood is 0.8-1.4 mg/dl. Men usually have higher serum creatinine than women because of greater muscle mass [14]. Urea is the metabolic product of protein metabolism with its normal value ranging from 7-20 mg/dl in blood. Both these parameters are used to assess the renal function [15]. This study aims to measure serum urea and creatinine levels in diabetic patients and also strives to determine the relationship between the blood glucose level and serum creatinine and urea levels.

2. MATERIALS AND METHODS

This study was conducted at Ayub Medical Complex (AMC), Medical Teaching Institution (MTI), Abbottabad, KPK from September 15, 2019 to December 20, 2019. The permission to conduct this research and the relevant information was obtained from the ethical committee of the above institution. Samples from 176 confirmed diabetic patients were analyzed. Among these, 85 were female patients and 91 were male patients. A set of 83 normal controls were also included in the study. The main parameters analyzed were serum glucose and renal function test parameters (blood urea and creatinine). The diagnosis of all parameters was conducted according to the criteria of the World Health Organization (WHO). Patients with chronic kidney disease (CKD), congestive heart failure (CHF), urinary tract infections (UTIs), and muscles disorders were excluded from the study.

Venous blood samples (5 mm volume) were taken from the patients’ arms and serum glucose, urea, and creatinine were estimated from these samples. The method used to estimate glucose was glucose oxidase and peroxidase [16], while the method used to estimate creatinine was Jaffe’s picrate method [17]. Finally, serum urea levels were estimated by using Berthelot method [18]. The age of diabetic patients was coupled with the age of normal controls. The normal values for these three parameters are 70-140 mg/dl for random glucose, 0.7-1.4 mg/dl for creatinine, and 18-45 mg/dl for urea.

2.1. Statistical Analysis

SPSS (version 23) was used for statistical analysis. Pearson correlation analysis was used to check the relationship of BSL (blood sugar level), creatinine, and urea. Descriptive statistics mean ± SD were measured for the continuous variable. Scatter plot diagrams were added for easy visualization and interpretation of the data. The significant level was set at \( p < 0.05 \).

3. RESULTS

Out of the 83 control samples, all were found to have normal serum urea and creatinine levels, except for 1 individual who had a high creatinine level and 3 individuals who had high serum urea levels. On the other hand, 32 out of 176 patients had abnormally high serum creatinine and 66 out of 176 had abnormally high serum urea values (Table 1).
Table 1. Comparison of Serum Urea and Creatinine in Diabetic and Control Subjects

<table>
<thead>
<tr>
<th>Sample type</th>
<th>Total Samples</th>
<th>High Creatinine</th>
<th>High Urea</th>
<th>Genfer wise distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetic</td>
<td>176</td>
<td>32</td>
<td>66</td>
<td>91 85</td>
</tr>
<tr>
<td>Control</td>
<td>83</td>
<td>1</td>
<td>3</td>
<td>43 40</td>
</tr>
</tbody>
</table>

Table 2. Mean of Serum Creatinine, Urea, and Glucose compared with the Mean of Healthy Individuals

<table>
<thead>
<tr>
<th>Investigation</th>
<th>Diabetics (n=176) Mean ± SD</th>
<th>Control (n=83) Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of the individual</td>
<td>50.47 ± 17.71</td>
<td>51.01 ± 17.26</td>
</tr>
<tr>
<td>Blood Sugar</td>
<td>313.85 ± 114.35</td>
<td>126.36 ± 21.232</td>
</tr>
<tr>
<td>Serum Creatinine</td>
<td>1.212 ± 0.81</td>
<td>1.29 ± 0.24</td>
</tr>
<tr>
<td>Serum Urea</td>
<td>39.48 ± 36.33</td>
<td>20.08 ± 3.06</td>
</tr>
</tbody>
</table>

The mean (± S.D.) for creatinine in control results was 1.29±0.24, whereas in patients results it was 1.212±0.81. The mean (± S.D.) for serum urea level in controls was 20.08 ± 3.06 and in patients it was 39.48±36.33. For random blood sugar, the mean (± S.D.) was 126.36 ± 21.232. On the other hand, for control samples and for diabetic patients, it was 313±114.35 (Table 2).

Both serum urea and creatinine showed a strong positive correlation with the glucose level with an r value of 0.950 and 0.904, respectively (Table 3). The line in the graph below has an upward direction indicating a strong positive correlation (Figure 1A, 1B).

Figure 1A and 1B. Scatter Plots Showing the Relationship Between Blood Sugar Level and Serum Urea and Creatinine Levels in Diabetic Subjects (Strong Correlation).
Table 3. Gender-wise Correlation of Glucose, Urea, and Creatinine in Diabetic Subjects

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Diabetics</th>
<th>“r value”</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Blood Sugar</td>
<td>313.85 ± 114.35</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Serum Creatinine</td>
<td>1.212 ± 0.81</td>
<td>0.904</td>
<td>0.908</td>
</tr>
<tr>
<td>Serum Urea</td>
<td>39.48 ± 36.33</td>
<td>0.950</td>
<td>0.956</td>
</tr>
</tbody>
</table>

In 176 patients, 18% showed abnormal creatinine and 38% showed abnormal serum urea, as shown in Table 1. This shows that there is a significant relationship between diabetes and renal parameters. Serum urea showed greater change with glucose in diabetes than serum creatinine.

4. DISCUSSION

This study was conducted to assess serum urea and creatinine levels in diabetic patients. It was observed that renal function parameters showed significant changes in diabetic patients. These two parameters are routinely used to assess the renal function. The parameters remain abnormally high in serum when the kidneys are not functioning properly. The abnormally high serum creatinine and urea levels clearly indicate that hyperglycemia is associated with kidney dysfunction [19]. This conforms to the results of other studies which stated that hyperglycemia is one of the main causes of progressive kidney damage [20, 21]. The study conducted by Noor et al. (2020) on rats demonstrated that abnormally high serum urea and creatinine in diabetes results in progressive renal and kidney damage [1]. Hyperglycemia leads to hyperfiltration which results in micro and macrovascular changes. These changes result in increased GFR which is associated with high serum urea and creatinine levels [3].

In this study, the duration and severity of diabetes was found to be strongly associated with serum urea levels. It was observed that diabetic individuals with age more than 50 years are more likely to develop renal impairment. Patients with diabetes for more than 5 years are at a greater risk of developing abnormal renal parameters. Abnormally high values were observed in individuals of age more than 60 years. So, abnormality was likely due to high protein intake or due to increased muscle mass. An increase in urea can also be seen in high blood pressure [22]. This study reported that raised serum creatinine and urea levels in diabetic patients may be associated with pre-renal damage. Both serum urea and creatinine levels are the markers for the renal function test, although urea is more sensitive than creatinine.

Both serum urea and creatinine can be used to track the prognosis of diabetic nephropathy and the severity of damage to the kidneys in diabetes. If the level of glucose is effectively controlled in the initial stages of diabetes, then its progression to diabetic nephropathy can be stopped and renal mortality and morbidity can be reduced [23]. According to a study, most of the cases of diabetic nephropathy occur in patients with Type 2 DM. Assessing the parameters of the renal function test is a reliable and the most economic method available to diagnose nephropathy in diabetic patients [24].

4.1. Conclusion

Based on statistical analysis and findings, the current study established that uncontrolled diabetes is associated with
diabetic nephropathy. Both serum urea and creatinine levels showed deviation from normal with hyperglycemia. These two parameters can be widely used to monitor renal impairment. Serum urea and creatinine are reliable, easy to perform, and economical parameters used to monitor renal impairment in poorly controlled diabetic patients.

REFERENCES


