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Correlation of serum creatinine, BUN and BUN: Creatinine ratio with the renal health

Aditya Narayan Singh[1], Yaran Allamyradov[1], Prashanthi Karyala[1], Malathi R[1*]

[1]Department of Biochemistry, Indian Academy Degree College Autonomous, Hennur Cross, Bangalore, Karnataka, India

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Abstract

The circulating concentration of creatinine and BUN are subject to homoeostatic control, they are also affected by diet, lifestyle and genetic factors. Individuals may have different circulating serum creatinine and BUN levels, because of the dissimilarities in dietary protein sources, lifestyle and metabolism. Not many studies have been carried out to determine the correlation between serum creatinine and BUN levels as a tool for assessment of renal health. The main objective of this study is to investigate the differences in serum creatinine and BUN level followed by determining the BUN:creatinine ratio and assessment of renal health and trying to identify the causes of any deviations from the appropriate reference clinical values. The concentration of creatinine was determined by Jaffe's method and BUN levels were determined by carbamido-diacetyl monoxime method, colorimetrically. The correlation was made between creatinine concentration and BUN level followed by determining the ratio using the appropriate statistical tests. There were significant changes in the creatinine concentration and BUN level and their ratio.

Keywords

diet, serum, creatinine, BUN, BUN: creatinine, GFR, renal health.

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1. INTRODUCTION:

Urea is the chief nitrogenous waste product eliminated by the body as a result of the physiological functions taking place inside the body. It is mainly generated from protein metabolism in the body and is eliminated maximally by the kidneys. Urea has a greater historical significance in clinical estimations for kidney functioning. It is the most abundant eliminated constituent in the urine. It was discovered by Dutch physician Hermann Boerhaave in 1727 and was isolated in an impure form from the urine [1]. The presence of urea in blood followed by its presence in urine was demonstrated in 1822 [1] but reliable methods of its estimation in blood came in early 20th century [2]. By mid 19th century it became clear by the help of urea estimation methods that kidney disease was associated with decreased concentration in urine and increased concentration in the plasma. Estimation

of plasma/serum urea was the most widely adopted method for determination of renal health and functioning.

On the other hand, creatinine, a breakdown product of Creatine phosphate in muscles, is excreted only by the kidneys. Earlier diagnosis of renal health was carried out by the estimation of urea concentration in the plasma/serum which was later carried out alternatively by the estimation of plasma/serum creatinine. The current diagnosis of renal health is also relied on estimation of plasma/serum creatinine and plasma/serum urea: creatinine ratio. This article focuses on exploring the clinical significance of the above-mentioned estimations and their effectiveness in determining the renal health.

The use of plasma creatinine / urea levels is indicative of glomerular filtration rate (GFR). GFR defines the kidney function in clinical tests. Any kidney disease is closely associated with increase or decrease in GFR [3]. In order to observe a rise in the concentration of plasma/serum urea or creatinine above their respective reference ranges, the GFR must be reduced by approximately 50% [4]. In comparison to urea, creatinine fulfils the criteria more closely. Hence it is preferred for assessment of renal function [5].

As mentioned earlier, the determination of renal health is also relied on the collective estimation of plasma/serum urea and creatinine and determining the plasma/serum urea: creatinine ratio.

The increased plasma/serum urea: creatinine ratio can be because of the following reasons:

- Increased plasma/serum urea and normal plasma/serum creatinine
- Normal plasma/serum urea and decreased plasma/serum creatinine
- Higher increase in plasma/serum urea as compared to increase in plasma/serum creatinine.

The increase in plasma/serum urea :creatinine ratio can be attributed to the following factors: dehydration, high protein diet, gastrointestinal bleeding, trauma, stress, starvation, decrease in muscle mass in the body and increased dietary protein consumption [3].

2. MATERIALS AND METHODS:

2.1. **Reagents and sample**: Creatinine and urea estimation kits were purchased from Coral Clinical Systems. 5ml of blood was taken from 50 volunteers using disposable syringes purchased from Dispovan by a certified medical practitioner.

2.2. **Isolation of test serum**: 5ml of blood was allowed to coagulate at room temperature for 1 hour. The serum was collected in separate tubes using a micropipette.

2.3. **Estimation of Creatinine and Urea**: The estimation of creatinine was carried out by Jaffe's method [6] and of urea by Berthelot method [7].

2.4. **Calculation of BUN and BUN: Creatinine**:

BUN= urea (mg/dl) × 0.467

BUN: Creatinine = BUN (mg/dl)/ Creatinine(mg/dl)

3. RESULTS AND DISCUSSION:

Around 50 volunteers were selected and their serum urea, creatinine, BUN and BUN: creatinine ratio were estimated using the standard methods mentioned above. Table 1 represents the concentration of urea, creatinine, BUN and BUN: creatinine ratio of the 50 volunteers. 4 out of 50 volunteers showed reduced concentration of BUN while 6 of them showed increased concentration of BUN. 5 out of 50 volunteers showed reduced concentration of creatinine while 10 of them showed increased concentration of creatinine. Only 3 out of 25 volunteers having abnormal values showed change in both creatinine and BUN while the remaining population showed a change in either BUN or creatinine. 25 out of 50 volunteers (50%) were found healthy with no significant abnormal values for either of BUN or creatinine. However only 23 out of 50 volunteers showed abnormal BUN: creatinine ratio. 4 out of 23 individuals showed abnormal values for neither of BUN or creatinine but showed a reduced ratio which is seen to be caused due to BUN concentrations near the lower reference value. Only 1 out of 23 showed abnormally high ratio because of excessively low concentration of creatinine. Table 2 represents the serum urea, creatinine, BUN, BUN: creatinine ratio with SEM. Figure 1,2 and 3 represents the concentration of serum urea, creatinine, BUN, BUN: creatinine ratio.

Table 1: Serum urea, creatinine, BUN and BUN: Creatinine for 50 volunteers. The values in grey scale represent abnormal values compared to the normal range.

S.NO.	SERUM UREA (mg/dL)	BUN (mg/dL)	SERUM CREATININE (mg/dL)	BUN: Creatinine
1	11.80	5.51	1.10	5.009
2	21.00	9.80	1.40	7.00
3	17.67	8.25	1.40	5.89
4	12.50	5.83	2.00	2.91
5	15.00	7.00	1.67	4.19
6	11.50	5.37	1.00	5.37
7	22.50	10.50	0.66	15.90
8	16.25	7.58	1.67	4.53
9	12.50	5.83	0.66	8.83
10	15.50	7.23	1.10	6.57
11	24.24	11.32	0.18	62.88
12	36.36	16.98	1.25	23.58
13	50.90	23.77	1.02	23.03
14	20.60	9.62	1.25	7.69
15	16.96	7.92	1.02	7.76
16	24.20	11.37	1.12	10.15
17	31.51	14.71	1.12	13.13
18	31.51	14.71	1.02	13.13
19	24.24	11.32	0.18	14.15
20	27.87	13.01	1.25	10.40
21	47.28	22.05	1.63	13.52
22	67.87	31.69	1.02	31.06
23	31.51	14.71	1.12	13.13
24	37.58	17.54	1.12	15.66
25	31.51	14.71	1.02	13.13
26	31.51	14.71	1.63	9.02
27	63.03	29.43	1.25	23.54
28	24.24	11.32	1.12	10.10
29	29.09	13.58	1.25	10.86
30	27.87	13.01	1.25	10.40
31	15.75	7.33	1.12	6.54
32	31.51	14.71	1.12	13.10
33	24.25	11.33	1.25	9.06
34	30.3	14.15	1.02	13.87
35	15.75	7.35	1.54	4.77
36	19.39	9.05	1.25	7.24
37	21.81	10.18	1.02	9.98
38	21.81	10.18	0.80	12.72
39	16.96	7.92	0.86	9.20
40	24.24	11.32	0.98	11.55
41	24.24	11.32	4.00	2.83
42	121.21	56.06	1.00	56.06
43	19.39	9.05	1.25	7.24
44	21.81	10.18	1.63	6.24
45	19.39	9.05	1.09	8.30
46	19.39	9.05	1.69	5.33
47	19.39	9.05	2.36	3.38
48	46.06	21.51	1.25	17.20
49	37.57	17.54	0.84	20.88
50	24.24	11.32	1.00	11.32

Table 2: Statistical values for the analysed parameters of the recruited volunteers.

S. No	Parameters	Values (Mean ± SEM)
1	Serum urea	28.21±2.54
2	BUN	13.16±1.18
3	Serum creatinine	1.23±0.07
4	BUN: Creatinine	12.78±1.59

Reference values:

- Urea= 14-40mg/dL (as per test kit)
- Creatinine= 0.7-1.2 (females), 0.9-1.4 (males) [8]
- BUN: Creatinine= 8-15 [9]

Figure 1

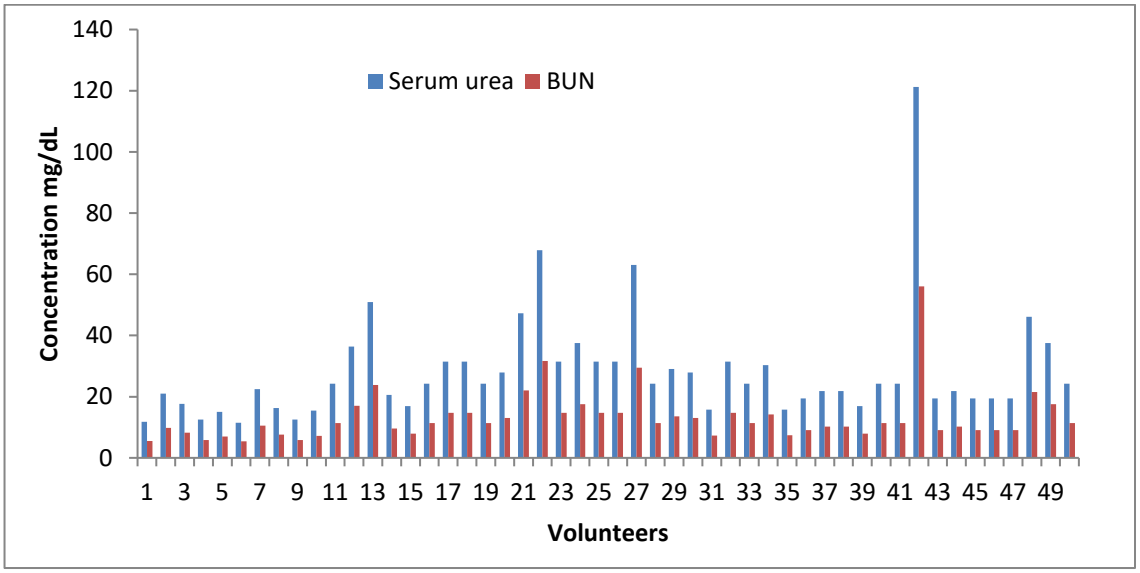


Figure 2

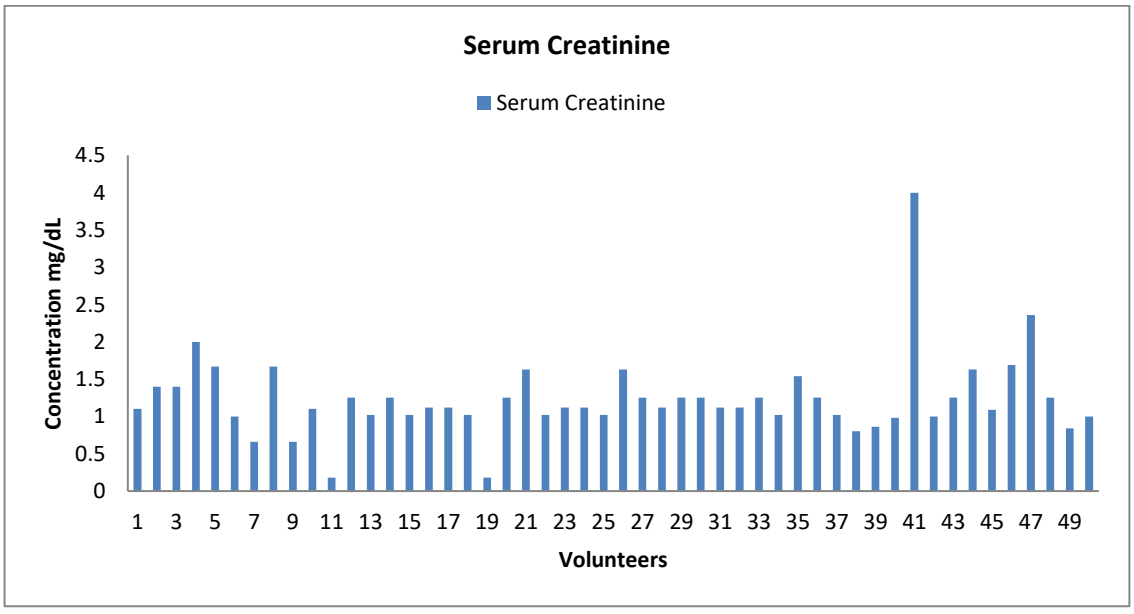
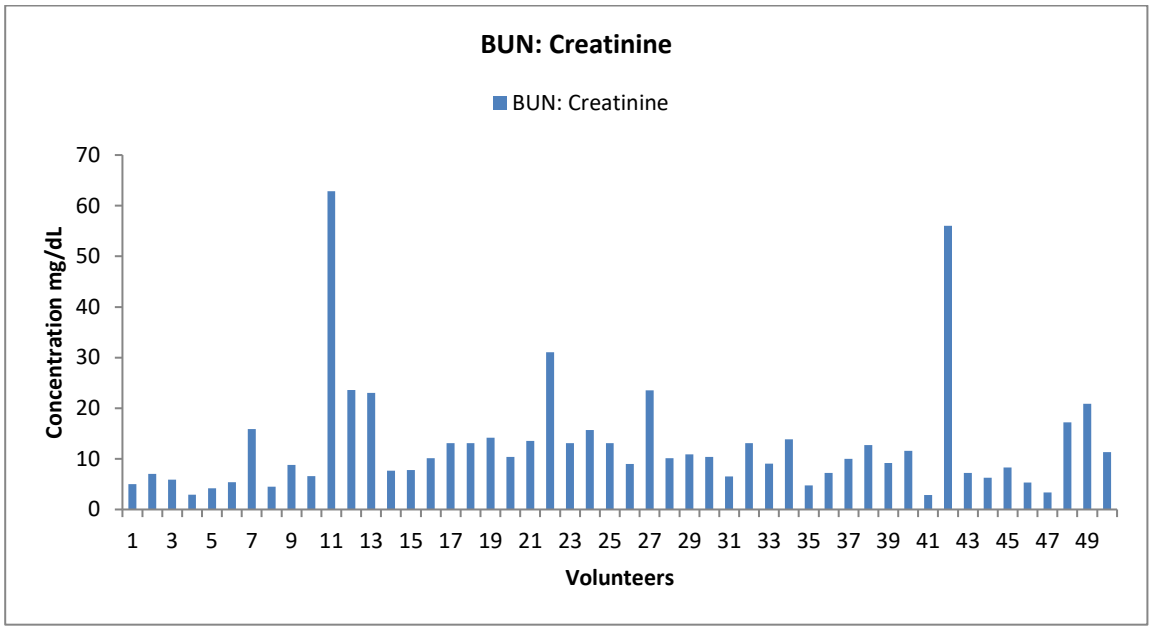


Figure 3



In recent times, plasma creatinine estimation has emerged as the preferred first-line test for laboratory assessment of renal function [8],[9] but measurement of plasma/serum urea concentration continues to have clinical value. The basis for the use of creatinine or urea measurement to assess renal function is that plasma/serum levels of both be a sign of glomerular filtration rate (GFR), the parameter that defines kidney function for the clinician. Irrespective of its cause, kidney disease is associated with decrease in GFR, and the severity of kidney disease correlates closely but inversely with GFR. Increased plasma creatinine is almost invariably a consequence of reduced GFR and therefore has a renal cause. Although reduced GFR (i.e. renal disease) is also associated with increased plasma urea concentration, there are other non-renal conditions that can give rise to increased plasma urea [10].

The BUN and creatinine are screening tests of renal function. Because they are handled primarily by glomerular filtration with little or no renal regulation or adaptation in the course of declining renal function, they essentially reflect GFR [11]. BUN: Creatinine ratio may give important information about Gastrointestinal bleed, acute kidney injury, heart failure etc. So, the volunteers showing abnormal values were suggested for diagnosis of actual cause of their abnormality under urologist and further for their treatment.

5. CONCLUSION:

Concentration of serum/plasma urea and creatinine has been clinically significant methods of determining glomerular filtration rate followed by renal health since a long period of time carrying an old history of assessment techniques. These assessments have been developed with time for increased accuracy in estimations of these metabolites in blood. Even though circulating concentration of creatinine and BUN are subject to homoeostatic control, they are also affected by diet, lifestyle and genetic factors. The serum of volunteers under study was assessed following Jaffe's method and Berthelot method and BUN: creatinine ratio was determined for each volunteer. It was seen that 50% of the population under test were normal to both BUN and creatinine. Few volunteers out of abnormal ratio showed normal values for both the analytes but the ratio was found to be low because of BUN and creatinine near to their lower and upper reference limits. Those showing significant deviations in either of /both BUN and creatinine were accordingly informed and guided for appropriate treatment if required.

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