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Evaluation of Kidney Function in Patients with COVID-19 at the Epidemiological Treatment Centre in CHNU Fann

Thioune Ndeye Mareme[1], Kandji Pape Matar[1], Djite Moustapha[1,2], Barry Nene Oumou Kesso[1,2], Zaamoumi Bassma[1], Kane Mame Coumba[1], Diagne Bineta[1], Mbacke Mame Ndoumbé[1], Sagne René Ngor[1], Ndour El Hadji Malick[2], Gueye-Tall Fatou[2], Lopez-Sall Philomene[2], Cisse Aynina[2], Diop Pape Amadou[2], Gueye Papa Madieye[1,2]

[1]Laboratory of Biochemistry-Hematology, National University Hospital of Fann, Dakar, Senegal
[2]Laboratory of Pharmaceutical Biochemistry, Faculty of Medicine, Pharmacy, Cheikh Anta Diop University, Dakar, Senegal
Email: thiounemaria09@gmail.com

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Abstract

Alteration of renal function during SARS-CoV-2 infection is frequent and is associated with excess mortality. It is multifactorial, involving mechanisms more specific to COVID-19: viral invasion, endothelitis and thrombosis, activation of the renin-angiotensin-aldosterone system, and elevation of pro-inflammatory cytokines. Thus, the objective of this work was to assess renal function in patients with moderate and severe forms of COVID-19. This was a prospective cross-sectional study of patients with COVID-19. The parameters studied were age, sex, uremia, creatinine and glomerular filtration rate (GFR). All biological parameters were measured with the A15 Biosystems automated system (Barcelona, Spain) and the GFR was calculated according to the MDRD formula. Data processing was carried out with the SPSS (Statistical Package for Social Sciences) software version 23. Our study population consisted of 192 subjects with COVID-19, of which 111 were moderate and 81 were severe. The mean age of our subjects was 60 years and a sex ratio of 1.02. GFR assessment showed that 28% of the population had a lowered GFR (<60 mL/min/1.73m^2). Analysis of the results according to the clinical forms showed frequencies of 19% of disturbance of renal function for the moderate forms against 40% for the severe forms. Impaired renal function appears to be frequent in patients with severe SARS-CoV-2 infection and is associated with a bad prognosis. Any patient hospitalized with SARS-CoV-2 should benefit from an initial nephrological assessment which could be used as a marker to dictate the prognosis of the severity of COVID-19.

Keywords

COVID-19, CTE, GFR, Renal Function, SARS-CoV-2

1. Introduction

SARS-CoV-2 is the pathogen responsible for acute respiratory distress syndrome (ARDS), which was first identified in December 2019 [1]. SARS-CoV-2 infection has a wide variability in clinical expression, ranging from asymptomatic to multivisceral failure. The initial clinical presentation is that of a viral infection affecting the upper respiratory airways, which may be complicated by interstitial lung disease [2]. In addition to pulmonary involvement, all organs may be affected and suffer considerable damage. Acute renal failure is the most common complication of COVID-19 pneumonia, and over 20% of patients requiring ventilatory support develop renal failure. In addition, chronic kidney disease is a major risk factor for the severity and mortality of COVID-19 [3]. All these data demonstrate the relevance of assessing renal function in patients with COVID-19 and the need for early diagnostic and therapeutic approaches. Thus, the objective of this work was to evaluate renal function in patients with moderate and severe forms of COVID-19.

2. Materials and Methods

This was a prospective cross-sectional study, lasting nine months from January 1, 2021 to September 30, 2021. Recruitment was carried in the epidemiological treatment center (ETC) of the CHNU of Fann. Biological analyses were carried out in the biochemistry laboratory of the ETC. This work focused on patients infected with SARS-CoV-2 followed at the ETC, patients in whom the diagnosis of COVID-19 was evoked on the basis of clinical and biological arguments (positive RT-PCR). The study did not include suspected patients with negative RT-PCR and patients with a history of renal disease. The parameters studied were epidemiological (age, sex) and biological (urea, creatinine, glomerular filtration rate). Blood samples were collected in a dry tube and centrifuged at 3000 rpm for 5 minutes. The biological parameters were measured with the A15 Biosystems automated system (Barcelona, Spain), the GFR was calculated according to the MDRD formula. We considered a GFR threshold of <60 mL/min/1.73m^2 to be lowered and to indicate a disturbance in renal function. We used the WHO 2021 criteria to divide the clinical forms. Subjects with clinical signs of pneumonia (fever, cough, dyspnea, rapid breathing), but no signs of severe pneumonia, including $SpO_2 \geq 90\%$ on room air were considered moderate forms. Those with clinical signs of pneumonia (fever, cough, dyspnea), plus one of the following signs or symptoms: respiratory rate > 30 breaths/min; severe respiratory distress; or $SpO_2 < 90\%$ on room air were considered severe forms. Data recording was

performed with Microsoft EXCEL software (version 2016). Data processing was carried out with SPSS (Statistical Package for Social Sciences) version 23. The Chi-square test was used for frequency comparison. A p-value of less than 0.05 was considered statistically significant.

3. Results

The study population included 192 subjects with COVID-19, of which 111 were moderate and 81 severe forms. The average age of the subjects was 60 ± 14 years with extremes of 20 and 89 years. The sex ratio was 1.02 (Table 1). Determination of the mean values of the biochemical parameters studied in the patients according to the clinical stage showed a mean level of 0.35 ± 0.25 (g/l), 11.84 ± 5.67 (mg/l) and 77.34 ± 29.3 (mL/min/1.73m^2) for moderate forms and a mean level of 0.57 ± 0.43 (g/l), 16.68 ± 13.43 (mg/l) and 73.05 ± 41.99 (mL/min/1.73m^2) for severe forms for uraemia, creatininaemia and GFR respectively (Table 2). Comparison of the means of GFR and biochemical parameters according to clinical stage showed significant differences for all parameters studied.

The frequency of patients with a lowered GFR was 28% (Figure 1). The analysis of renal function disturbances by age shows a frequency of 25% in the age group (41 - 60 years) and 31% in the age group (61 - 81 years) (Figure 2). Analysis of renal function impairment by gender showed that 29% of men had a GFR of less than 60 mL/min/1.73m^2 compared to 26% of women (Figure 3).

Analysis of the frequency of renal function impairment according to clinical form showed that 19% of patients with moderate forms had renal function impairment compared with 40% of patients with severe forms (Figure 4), 56% of patients with moderate forms were women and 55% of patients with severe forms were men. The analysis of the results according to age showed a predominance of disturbance of renal function in subjects over 61 years of age (Table 3).

Table 1. General characteristics of the population.

Number of patients	192
Average age (years)	60 (±14 ans)
Sex-Ratio	1.02
Moderate forms	111
Severe forms	81

Table 2. Average GFR and biological parameters by clinical stage.

Parameters	Moderate forms	Sevrate forms	p-values
Uraemia (g/L)	0.35 ± 0.25	0.57 ± 0.43	0.003
Creatinine (mg/L)	11.84 ± 5.6	16.68 ± 13.4	0.039
GFR (mL/min/1.73m^2)	77.34 ± 29.3	73.05 ± 41.9	0.004

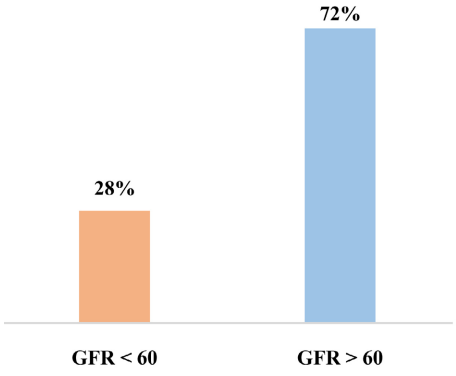

Figure 1. Frequency of patients with lowered GFR in our population.

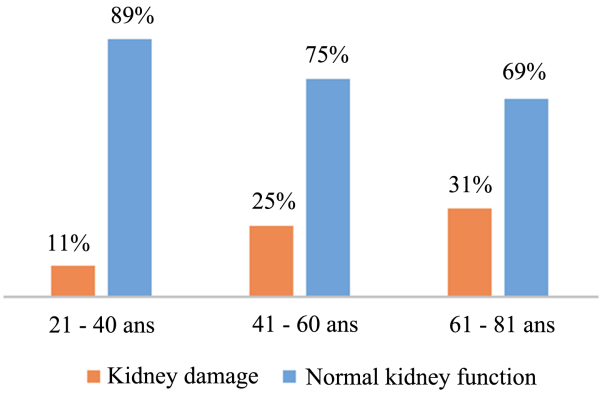

Figure 2. Frequency of patients with lowered GFR by age.

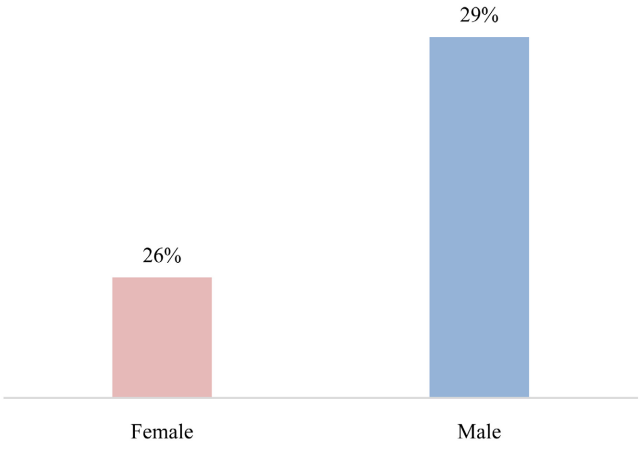

Figure 3. Frequency of patients with lowered GFR by gender.

Table 3. Frequency of renal function disturbances according to age and sex for the two clinical forms.

	Frequency according to sex		Frequency according to age	
	Men	**Women**	**<61 years old**	**> 61 years old**
Moderate forms	44%	56%	40%	60%
Severe forms	55%	45%	28%	72%

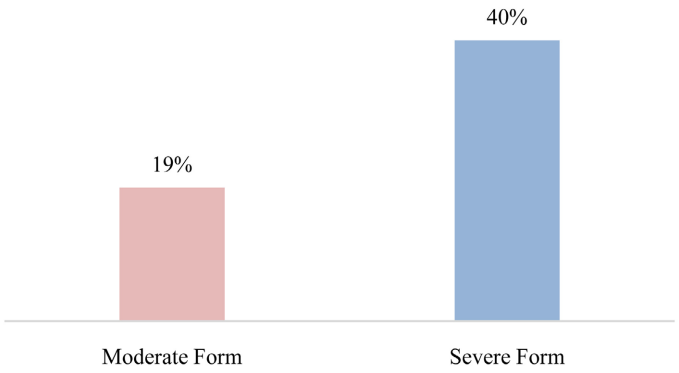

Figure 4. Frequency of patients with lowered GFR by clinical stage.

4. Discussion

Impaired renal function during severe SARS-CoV-2 infection is common and associated with excess mortality. In this context, we aimed to evaluate the influence of COVID-19 on renal function in patients infected with SARS-CoV-2. Our results showed that the average age of our population was 60 years. Our results are similar to those of Donamou *et al.* and Wang *et al.* who found a mean age of 59 years [4] [5]. These results could be explained by the fact that advanced age is a risk factor for severe disease and that young people develop an asymptomatic form most of the time [4]. The gender distribution of the study population showed a sex ratio of 1.02. Our results are similar to those of Cheng *et al.* [6]. The predominance of males in patients infected with SARS-CoV-2 has already been reported by several studies such as S. Majdoub *et al.* [7]. This may be related to a higher expression of the ACE2 receptor in males compared to females [8]. Other studies have attributed it to hormonal difference as testosterone is known to suppress the immune system while estrogen is known to stimulate the immune system and this could be the reason why women have a stronger immune response to fight bacteria and viruses [9]. Comparative analysis of the variation in GFR and biochemical parameters according to clinical stage showed a significant difference for creatinine and GFR, the mean level was 11.84 ± 5.67 and 77.34 ± 29.3 mL/min/1.73m^2 for moderate forms and 16.68 ± 13.43 and 73.05 ± 41.99 mL/min/1.73m^2 for severe forms. The disturbance of these two parameters in patients with severe forms of COVID-19 has been reported in several studies such as those of Anish R. *et al.* [10] and Luwen Wang *et al.* [11]. Elevated creatinine levels are more frequently observed in patients who will experience an unfavorable hospital course such as admission to intensive care or death. After admission to the ICU, the need for dialysis occurs in about 5.5% - 11.9% of patients and results in a very high mortality [12]. For GFR we found 77.34 and 73.05 ml/min/1.73m^2 respectively for moderate and severe forms. Rubin S. *et al.* found lower GFRs than our results, the mean at admission was (68.8 ml/min/1.73m^2) [13]; Hirsch *et al.* also found lower GFRs than our results in patients with known AKI (56 ml/min/1.73m^2) and slightly higher results than ours in patients without known AKI (82.5 ml/min/1.73m^2) [14]. Frequency analysis

showed that 28% had impaired renal function while 72% had normal renal function. Already in the early months of the pandemic, several studies reported renal impairment in patients with COVID-19 [14]. According to age groups, the analysis of the results shows a frequency of 11% of disturbed renal function in the age group (21 - 40 years), 25% of disturbed renal function in the age group (41 - 60 years) and 31% in patients aged over 61 years. Our results are similar to those found in the literature (age is a risk factor) [13]. The analysis of the results according to the clinical form showed a disturbance of the renal function in 19% of the patients with moderate forms against 40% in the severe forms. The frequencies obtained by our study were higher than those obtained by Ling H *et al.* who estimated the frequency of renal impairment at 23% on average (14% - 35%) [15]. The most recent studies, mainly in Europe, show a higher prevalence of kidney damage [16] [17] and these differences between China and Western countries could be partly explained by genetic factors [18]. The high frequency of renal function impairment in the severe forms is explained by the use of vasopressors or invasive mechanical ventilation (MV). In the study by Hirsch *et al.*, AKI was noted in 90% of intubated patients compared to 22% without the use of MV. This ARF occurred within 24 hours of intubation [14]. In another study by Cantaluppi *et al.*, it was explained that the observation of renal failure on admission or the development of AKI during the stay was associated with an increase in the use of mechanical ventilation and the risk of death [3]. The study by Lowe R *et al.* In AKI requiring dialysis, mortality is even higher, at 63% according to Gupta *et al.* [19] [20]. It has been noted that any kidney damage is associated with 10 times increase in mortality [21].

5. Conclusions

Impaired renal function appears to be common in patients with severe SARS-CoV-2 infection and associated with a negative prognosis. Any patient hospitalized with SARS-CoV-2 should benefit from an initial nephrological assessment which could be used as a marker to dictate the prognosis of the severity of COVID-19.

However, a detailed and thorough assessment of kidney outcomes in the post-COVID-19 infection phase is not yet available. A better understanding of post-COVID-19 renal outcomes would enable the development of care strategies to improve the health and well-being of people with COVID-19 infection.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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