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Radiology

Place of Lung Ultrasound in Patients with Chronic End-Stage Renal Disease

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Abstract **Original Research Article**

Background: Pulmonary ultrasound is considered a promising technique for assessing fluid status in patients with chronic renal failure. The aim of this retrospective study was to evaluate its role and effectiveness in the management of these patients compared to conventional methods of assessing fluid status.

Keywords: End-stage renal disease–hemodialysis–lung ultrasound–pulmonary congestion.

Introduction

Pulmonary ultrasound has been the subject of several studies in recent years owing to its ability to accurately estimate pulmonary congestion in patients with renal failure [1]. The gradual extension of its use in nephrology has improved the management of patients undergoing hemodialysis. However, thorough knowledge of pulmonary ultrasound semiology and the limitations of this tool are required to ensure appropriate management.

Material and Methods

We report a prospective study conducted in the nephrology and hemodialysis department of the Avicenne Military Hospital in Marrakech, spread over a period of 06 months between September 2023 and February 2024, involving a series of 50 hemodialysis patients at the stage of chronic end-stage renal failure. All patients were > 18 years of age, had social security coverage, and received three dialysis sessions per week. Patients with a history of pulmonary involvement (interstitial or fibrosis) or cardiac involvement (heart failure or coronary artery disease in the last 04 months) were excluded from this study.

All patients underwent clinical, biological, and ultrasound evaluations. Pulmonary ultrasound was performed on all patients before and after each dialysis session using a Samsung-type device with two probes: a superficial linear probe (6–12 MHz) and a deep microconvex probe (2–5 MHz). Ultrasound examination was performed in the supine position with exclusive longitudinal sections of the intercostal spaces along the parasternal, mid-clavicular, and axillary (anterior and posterior) lines of each hemithorax. The assessment was based on the B-line score, which corresponded to the sum of the B-lines recorded in the different sectors explored and delimited by the above anatomical lines. The patients were divided into three groups according to the severity of pulmonary congestion: mild (5-15 B-lines), moderate (15-30) and severe (>30). A total number of B-lines < 5 was considered normal. Statistical analyses were performed using Microsoft Excel and SPSS version 21 for Windows. The study was conducted ethically with respect to the anonymity and confidentiality of patients' medical information.

Results

The mean age of our patients was 53.5 years with extremes of 21 and 67 years, respectively. Men accounted for 62% of cases, and the sex ratio (M/F) was 1.63. The predominant causative nephropathy was diabetes (40% of cases), hypertension (24%), gout (8%), and of undetermined origin in 16% of cases (Figure 1). Eighty% of our patients had at least one associated comorbidity: arterial hypertension was the most common (66%), followed by diabetes (50%), smoking (30%), and hypercholesterolemia (26 %) (Table I).

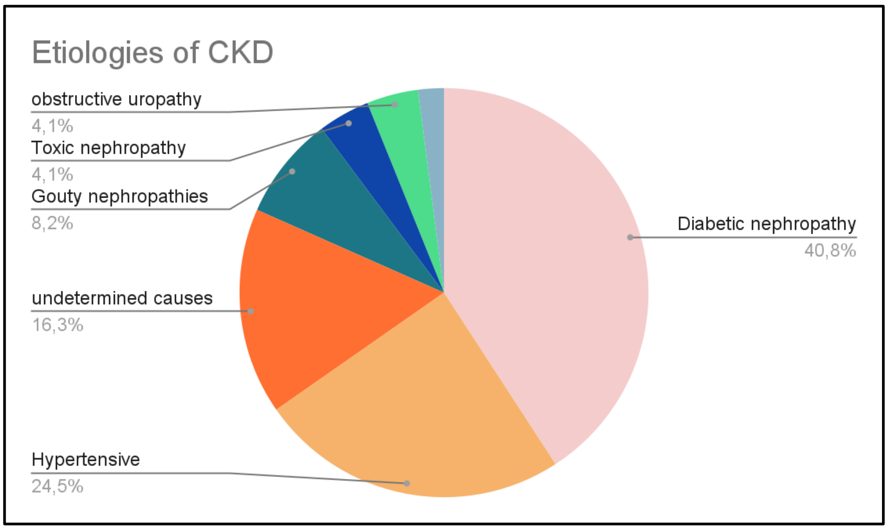

Figure 1: Distribution of haemodialysis patients by etiology of CKD

Table I: Distribution of comorbidities in chronic hemodialysis patients

Comorbidity	Number	Percentages
Hypertension	33	66%
Diabetes	25	50%
Smoking	15	30%
Hypercholesterolemia	13	26%
Heart failure	1	2%
Peripheral vascular disease	1	2%

On ultrasound and pre-dialysis, the mean B-line was 59.14±27.39. Pulmonary congestion was classified as moderate in five patients and severe in 45 patients (90 %) (Figure 2). After dialysis, the mean B-line score was 25.2±14.38. Pulmonary congestion was classified as mild in 14 patients (28%), moderate in 14 patients (28%), and severe in 20 patients (40%), with no B-lines in 02 patients (4%) (Figure 3). Among 45 patients with severe pulmonary congestion before dialysis, the results showed a significant change after treatment. Fifteen patients (33.3%) became moderately congested, with an average weight loss of 1.94 kg. Six patients (13.3%) became mildly congested with an average weight loss of 2.17 kg. Two patients (4.4%) completely eliminated congestion with an average weight loss of 2.35 kg. Twenty patients (44.4%) continued to have severe pulmonary congestion, with an average weight loss of 1.73 kg (Figure 4). The five patients with moderate congestion before dialysis became mildly congested after the session. This study showed that there was a high percentage of subclinical pulmonary congestion, and that the degree of post-dialysis pulmonary decongestion was correlated with the extent of weight loss.

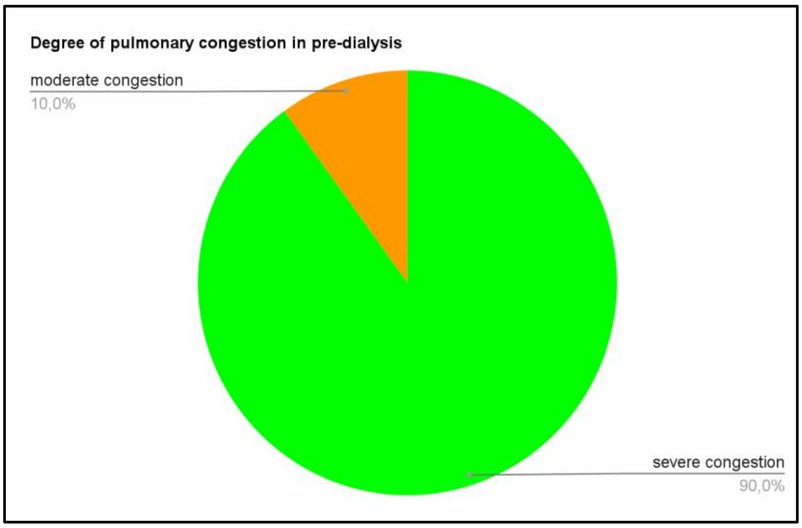

Figure 2: Degree of pulmonary congestion in pre-dialysis patients

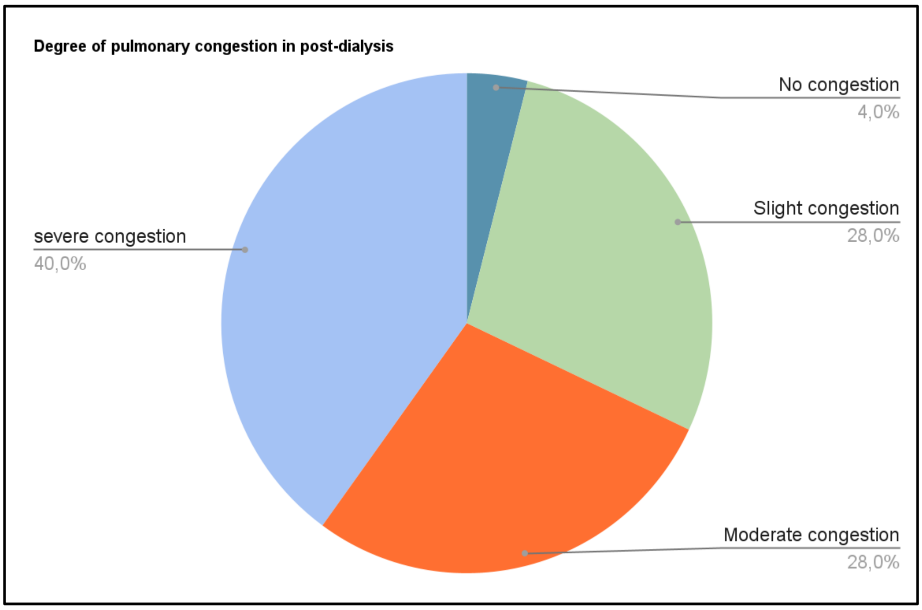

Figure 3: Degree of pulmonary congestion in post-dialysis patients

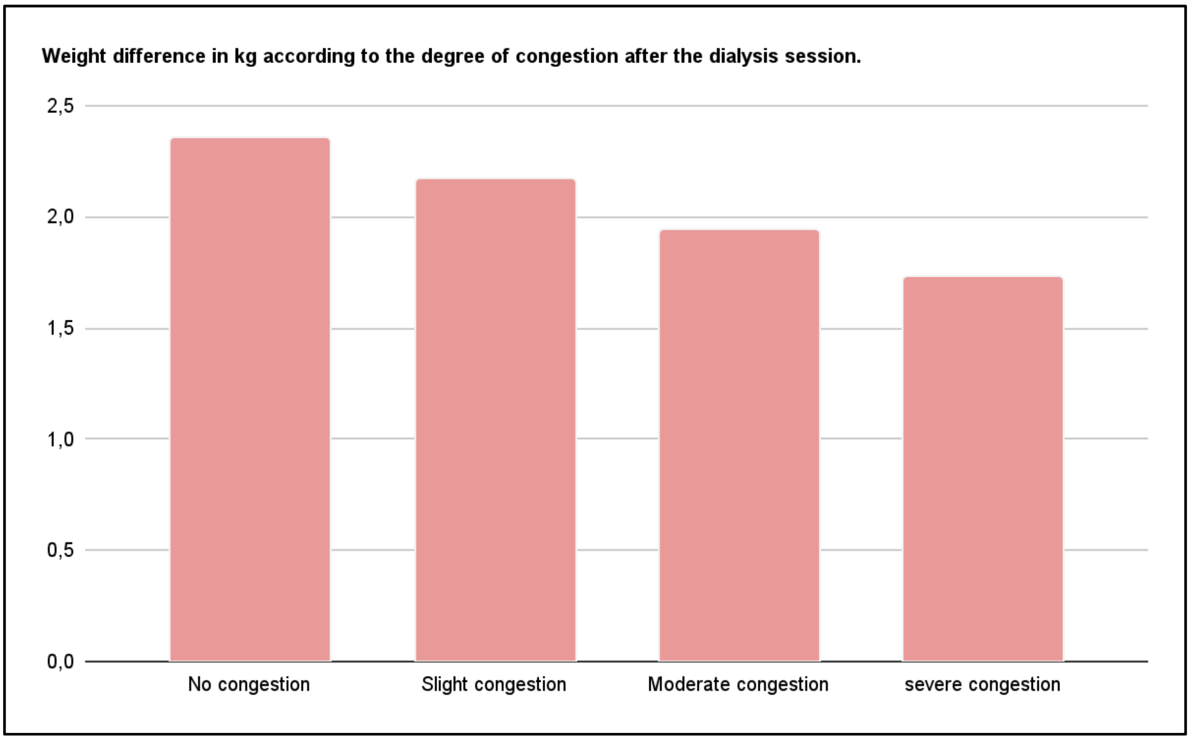

Figure 4: Weight difference in kg according to the degree of congestion after the dialysis session

DISCUSSION

End-stage renal disease (ESRD) is defined as a glomerular filtration rate (GFR) <15 ml/min/1.73 m2. It is synonymous with renal death and is a vital requirement for renal function replacement. Haemodialysis, peritoneal dialysis, and renal transplantation are the means of extrarenal purification for CKD [2]. The lack of regulation of body fluid composition at this stage of CKD is associated with a high risk of acute or chronic volume overload, which affects patient morbidity and mortality [3]. As a result, blood volume assessment is a daily concern for nephrologists working with patients undergoing hemodialysis. Similarly, the concept of dry weight (lowest tolerated post dialysis weight), traditionally determined by clinical examination data, remains subjective and sometimes inadequate.

Subclinical extravascular pulmonary water was often observed. Its clinically silent nature has a negative impact on the quality of life and survival of patients with CKD [4]. Ventricular performance, pulmonary permeability, and volume overload are the most important pathophysiological factors [5].

Pulmonary ultrasound can be used to measure extravascular pulmonary water and, therefore, to accurately estimate pulmonary congestion in patients with renal failure [1]. The presence of multiple diffuse B-lines on the anterolateral walls of the thorax is an ultrasonographic characteristic of pulmonary edema, with a negative predictive value superior to that of chest X-ray data in ruling out pulmonary water overload [6]. Ultrasound provides a quantitative or semiquantitative assessment of interstitial lung water based on the number of B lines. A count (from 0 to 10) of the B lines is made in each intercostal space of the different areas explored, and if these lines meet, their estimate is evaluated by dividing the percentage of the costal space covered by the B lines by 10 [6]. Thus, congestion is considered mild when the number of B lines is between 5 and 15; it is said to be moderate between 15-30 B lines and severe above 30 B lines. A total of < 5 B-lines were considered normal [7]. However, these comet-tail ultrasound images, associated with the expansion of extravascular lung water, may be of variable etiology. They may be seen focally or diffusely in various clinical situations, such as pneumonia, acute respiratory distress syndrome, pulmonary fibrosis, pulmonary contusion, pleural disease, and neoplasia [6, 8]. Therefore, interpretation is based on the patient's medical history and clinical picture. However, certain situations limit the use of this ultrasound technique. These include the presence of large covering dressings, diffuse emphysema or subcutaneous edema, respiratory distress with draught, and obesity [9, 10].

Conclusion

Owing to its ability to accurately estimate lung congestion, lung ultrasound can be used to search for subclinical extravascular lung water, which affects patients' quality of life and survival. This could prove to be an effective additional tool for improving the management of hemodialysis patients.

Conflict of Interest: The authors declare that they have no conflict of interest.

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