The role of chest ultrasound in detection of pulmonary congestion in hemodialysis patients

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Background Volume overload is a risk factor for mortality in hemodialysis. Pulmonary congestion may be present and mostly asymptomatic between hemodialysis patients, but its outcomes are unknown.

Aim The aim of this study was to assess the role of chest ultrasound (US) in detecting pulmonary congestion in hemodialysis patients.

Patients and methods This study included 40 patients diagnosed with chronic renal failure on regular hemodialysis. The patients were selected from the Hemodialysis Unit, Dar El Shefa Hospital. Chest US was done predialysis and postdialysis.

Results The study was conducted on 40 patients. The age of our patients ranged between 19 and 55 years old; history of hemodialysis ranged between 1 and 8 years; 35% were smokers; 26 (65%) patients were hypertensive; and 17 (42.5%) patients were diabetic. Lung congestion, detected by chest US predialysis, was mild in nine (22.5%) patients, moderate in 17 (42.5%) patients, and severe in 14 (35%) patients. The chest US Kerly's B-line scores significantly reduced after dialysis, and were normal in seven (17.5%) patients, were mild in 19 (47%) patients, moderate in 12 (30%) patients, and severe in two (5%) patients.

Conclusion Chest US can be used as a bedside test for the assessment of lung congestion in hemodialysis patients.

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Introduction

Volume expansion is the most common risk factor for mortality among hemodialysis patients [1]. Excessive interdialytic weight gain is an independent risk factor for death and cardiac problems among dialysis patients [2]. Measurement of total body water do not provide sufficient information regarding the removal of extracellular fluids among those patients. Measuring of extravascular lung water may guide us for ultrafiltration prescription in hemodialysis patients [3].

Pulmonary congestion may be present and mostly asymptomatic between hemodialysis patients. Lung ultrasound (US) is a novel technique that has been used to evaluate lung water in cardiac patients [4]. In the presence of lung congestion, the US beam is reflected by thickened interlobular septa, called lung comets [5]. Pulmonary congestion measured by the Ultrasound B-lines score (BL-US) score is quite common among asymptomatic hemodialysis patients [6].

The aim of this study was to assess the role of chest US in detecting pulmonary congestion in hemodialysis patients.

Patients and methods

The currents study included 40 patients, who were diagnosed with chronic renal failure on regular dialysis and fulfilled the selection criteria, from the Hemodialysis Unit, Dar El Shefa Hospital. Inclusion criteria were: patient's age above 18 years and below 60 years old and is on regular hemodialysis for more than 6 months. Cardiac patients and patients with chronic chest disease were excluded.

The study protocol was approved by the ethic committee, and informed written consents was obtained from each patient, full history taking with attention to: age, smoking history, occupational history, duration of illness, medication used and associated illness such as diabetes or hypertension, full clinical examination, laboratory investigations, plain chest radiography and chest US predialysis and postdialysis.

The transthoracic US was done by using with Philips Affinity 70 ultrasound system (Philips Healthcare, Best, The Netherlands).

Technique of B-line detection by chest US:

Examinations were performed in supine position. Scanning of the anterior and laterals chest was performed on both sides of the chest, from the second to the fourth (on the right side to the fifth) intercostal spaces. Lung comets were defined as a hyperechoic US bundle. These comets arise from the pleural line. The sum of lung comets produces a score reflecting the extent of lung waters accumulation. On the basis of this score, there were three categories of patients (mild: <14 comets, moderate: 14–30 comets, and severe: >30 comets) [7].

Statistical analysis

Patients data were tabulated and processed using qualitative data were presented by number and percent. They were compared by χ^2-test, analysis of variance test, and *t*-test when appropriate. The *P* value was considered significant if less than 0.05.

Results

This study was conducted at Dar El Shefa Hospital, which involved 40 patients diagnosed with chronic renal failure on regular hemodialysis, their age ranged between 19 and 55 years old, 26 (65%) men and 14 (35%) women (Table 1). Thirty-five percent were smokers; 5% were ex-smokers; 26 (65%) patients were hypertensive; and 17 (42.5%) patients were diabetic (Table 2). The laboratory investigations performed on patients were: hemoglobin, urea, creatinine, sodium, potassium, calcium, albumin levels (Table 3). Chest US Kerley's B-lines predialysis were mild in nine (22.5%) patients, moderate in 17 (42.5%), and severe in 14 (35%). There was high significant reduction in chest US Kerley's B-lines ($P<0.001$) after dialysis that were normal in seven (17.5%) patients, mild in 19 (47.5%) patients, moderate in 12 (30%) patients, and severe in two (5%) patients postdialysis (Table 4). IVC diameter ranged between 1.19 and 3.61 predialysis and ranged between 0.89 and 2.2 postdialysis. There was statistically significant reduction of chest ultrasound IVC diameter in postdialysis patients (Table 5).

Table 1 Demographic data of the studied patients

Age (years)	
Range	19–55
Mean±SD	40.450±9.449
History of dialysis (years)	
Range	1–8
Mean±SD	3.863±1.860

Discussion

Dyspnea due to lung congestion is frequently present in hemodialysis patients. Excessive extravascular lung water may be due to increase in total body extracellular volume or due to heart disease. Both situations are common in hemodialysis patients. Identifying the 'ideal' body weight for hemodialysis patients is important, affecting their prognosis and their quality of life [8].

Lung US has been useful in detecting pulmonary congestion, through the assessment of Kerley's B-lines that showed significant reduction after a dialysis session [9]. Lung congestion is a common problem among hemodialysis patients and mostly due to volume overload and cardiac disease that are commonly present especially in elderly patients [10].

Several methods can be used to identify the patient ideal body weight and to avoid lung congestion among hemodialysis patients starting for the clinical assessment of the patient and others, like evaluating

Table 2 Past medical history and special habits in the studied patients

	n (%)
Smoking	
Nonsmoker	24 (60)
Smoker	14 (35)
Ex-smoker	2 (5)
Hypertension	
Negative	14 (35)
Positive	26 (65)
Diabetes mellitus	
Negative	23 (57)
Positive	17 (42.5)

Table 3 Laboratory findings of the studied patients

	Range	Mean±SD
Serum hemoglobin (male: 13.5–17.5; female: 12–15.5) (g/dl)	5.9–10.7	8.515±1.284
Serum urea (7–20) (mg/dl)	50–312	165.750±59.596
Serum creatinine (male: 0.6–1.2; female: 0.5–1.1) (mg/dl)	4.3–18	10.710±3.373
Serum sodium (135–145) (mEql/l)	117–144	133.650±5.695
Serum potassium (3.5–5.0) (mEql/l)	4.1–7.8	5.315±0.774
Serum calcium (8.5–10.2) (mg/dl)	6.4–9.3	8.075±0.911
Serum albumin (3.5–5.5) (g/dl)	2.7–4.9	3.603±0.507

Table 4 Comparison between number of Kerly's B-lines detected by chest ultrasound predialysis and postdialysis among the studied patients

Chest ultrasound B-Kerly's lines	Predialysis [*n* (%)]	Postdialysis [*n* (%)]	χ^2	*P*-value
Normal	0 (0)	7 (17.5)	20.433	<0.001
Mild	9 (22.5)	19 (47.5)		
Moderate	17 (42.5)	12 (30)		
Sever	14 (35)	2 (5)		
Total	40 (100)	40 (100)		

Table 5 Comparison between IVC diameter detected by chest ultrasound among the studied patients predialysis and postdialysis

	Chest ultrasound IVC diameter		Paired differences		Paired samples test	
	Range	Mean±SD	Mean	SD	*t*	*P*-value
Predialysis	1.19–3.61	2.111±0.607	0.672	0.565	7.513	<0.001
Postdialysis	0.89–2.2	1.439±0.371ss				

dimension and collapsibility of the inferior vena cava, chest radiography signs [11].

Chest US is a simple technique for the assessment of lung water. The number of B-lines in chest US correlates with the degree of excessive extravascular lung water. Number of lines showed marked reduction after the hemodialysis session, reflecting its accuracy in detecting lung congestion [12].

The present study was carried out in Dar El Shefa Hospital in collaboration with the Radiology Department and Hemodialysis Unit. Forty patients on regular hemodialysis were involved in this study, whose age ranged between 19 and 55 years. The patients were subjected to plain chest radiography and transthoracic US.

Those patients who had cardiac diseases or chronic chest diseases were excluded from the study. The studied patient's weight ranged between 51 and 85 kg, history of dialysis in years ranged between 1 and 8 years.

Nonsmoker patients were 24 (60%) patients, smokers were 14 (35%) patients, ex-smokers were two (5%) patients, 26 (65%) patients were hypertensive, and 17 (42.5%) patients were diabetic. There was no significant effect of smoking, history of hypertension and history of diabetes on the number of Kerley's B-lines in the patients of this study.

Regarding chest US Kerley's B-lines were mild in nine (22.5%) patients, moderate in 17 (42.5%), and severe in 14 (35%) patients predialysis. And was normal in seven (17.5%) patients, mild in 19 (47%), moderate in 12 (30%), and severe in two (5%) patients postdialysis. There was highly significant reduction in chest US Kerley's B-lines ($P<0.001$) after dialysis.

In harmony with this study, Adamson *et al.* [13] found that chest US can detect lung congestions in asymptomatic dialysis patients. Around 50% of asymptomatic patients had moderate to severe congestion.Also, Zoccali *et al.* [14], conducted a prospective, randomized study to evaluate the possibility for detection of lung congestion using chest US and determining its prevalence among dialysis patients. Lung comets score was mild (<14) in 28 cases, moderate (14–30) in 26 cases, and severe (>30) in 21 cases. Around 60% had moderate to severe lung congestion predialysis and that score marked reduced postdialysis session ($P<0.001$).

Several recent studies coincide with our results, regarding the degree of lung congestion among haemodialysis patients, and the significant reduction ($P<0.001$) of lung comets score postdialysis, like the one carried out by Enia *et al.* [15] and more recently the study conducted by Donadio *et al.* [16].

Conclusion

Chest US is a quick bedside test and a noninvasive reliable technique for the assessment of pulmonary congestion in hemodialysis patients.

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Conflicts of interest

There are no conflicts of interest.

References

1 Mees EJ. Volaemia and blood pressure in renal failure: have old truths been forgotten?. *Nephrol Dial Transplant* 1995; **10**:1297–1298.

2 Wizemann V, Wabel P, Chamney P, Zaluska W, Moissl U, Rode C, *et al.* The mortality risk of overhydration in haemodialysis patients. *Nephrol Dial Transplant* 2009; **24**:1574–1579.

3 Charra B. Fluid balance, dry weight, and blood pressure in dialysis. *Hemodial Int* 2007; **11**:21–31.

4 Picano E, Gargani L, Gheorghiade M. Why, when and how to assess pulmonary congestion in heart failure: pathophysiological, clinical, and methodological implications. *Heart Fail Rev* 2010; **15**:63–72.

5 Picano E, Frassi F, Agricola E, Gligorova S, Gargani L, Mottola G. Ultrasound lung comets: a clinically useful sign of extravascular lung water. *J Am Soc Echocardiogr* 2006; **19**:356–363.

6 Mallamaci F, Benedetto FA, Tripepi R, Rastelli S, Castellino P, Tripepi G, *et al.* Detection of pulmonary congestion by chest ultrasound in dialysis patients. *JACC Cardiovasc Imaging* 2010; **3**:586–594.

7 Frassi F, Gargani L, Tesorio P, Raciti M, Mottola G, Picano E. Prognostic value of extravascular lung water assessed with ultrasound lung comets by chest sonography in patients with dyspnea and/or chest pain. *J Card Fail* 2007; **13**:830–835.

8 Kalantar-Zadeh K, Regidor DL, Kovesdy CP, Kovesdy CP, van Wyck D, Bunnapradist S, *et al.* Fluid retention is associated with cardiovascular mortality in patients undergoing long term hemodialysis. *Circulation* 2009; **119**:671–679.

9 Panuccio V, Enia G, Tripepi R, Torino C, Garozzo M, Battaglia GG, *et al.* Chest ultrasound and hidden lung congestionin peritoneal dialysis patients. *Nephrol Dial Transplant* 2012; **27**:3601–3605.

10 Halle MP, Hertig A, Kengne AP, Ashuntantang G, Rondeau E, Ridel C. Acute pulmonary oedema in chronic dialysis patients admitted into an intensive care unit. *Nephrol Dial Transplant* 2012; **27**:603–607.

11 David S, Kumpers P, Seidler V, Biertz F, Haller H, Fliser D. Diagnostic value of N terminal pro-B-type natriuretic peptide (NT-proBNP) for left ventricular dysfunction in patients with chronic kidney disease stage 5 on hemodialysis. *Nephrol Dial Transplant* 2008; **23**:1370–1377.

12 Volpicelli G, Caramello V, Cardinale L, Mussa A, Bar F, Mauro F. Bedside ultrasound of the lung for the monitoring of acute decompensated heart failure. *Am J Emerg Med* 2008; **26**:585–591.

13 Adamson PB, Magalski A, Braunschweig F. Ongoing right ventricular hemodynamics in heart failure: clinical value of measurements derived from an implantable monitoring system. *J Am Coll Cardiol* 2003; **41**:565–571.

14 Zoccali C, Benedetto FA, Mallamaci F. Prognostic value of chocardiographic indicators of left ventricular systolic function in asymptomatic dialysis patients. *J Am Soc Nephrol* 2004; **15**:1029–1037.

15 Enia G, Tripepi R, Panuccio V, Tripepi R, Postorino M, Aliotta R, *et al.* Pulmonary congestion and physical functioning in peritoneal dialysis patients. *Perit Dial Int* 2012; **32**:531–536.

16 Donadio C, Bozzoli L, Colombini E, Pisanu G, Ricchiuti G, Picano E, *et al.* Effective and timely evaluation of pulmonary congestion: qualitative comparison between lung ultrasound and thoracic bioelectrical impedance in maintenance hemodialysis patients. *Medicine (Baltimore)* 2015; **94**:473–475.