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ORIGINAL ARTICLE

The Role of Chest Ultrasound in the Detection of Pulmonary Congestion in Hemodialysis patients in Aswan University Hospital

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ABSTRACT

Keywords: CRF, Hemodialysis, pulmonary congestion, B-Kerley's lines, IVC.

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Background; Pulmonary congestion can be existing and frequently symptomless among dialysis cases, but its outcome is unknown. Early detection of pulmonary congestion is an essential aim for the avoidance of congestive heart failure in high-risky cases. **Aim and objectives;** To assess the role of chest ultrasound in the detection of lung congestion in patients with chronic renal failure under regular hemodialysis. **Subjects and methods:** A cross-sectional study was conducted at the nephrology department, Aswan university hospital, on 100 patients undergoing regular hemodialysis for at least more than 6 months. Demographic data, echocardiographic, and laboratory investigations were collected. Moreover, chest US was done and IVC diameter was measured pre-dialysis and post- dialysis. **Results**; The study included 100 patients; their mean age was 43.66 ±7.6. 52(52%) patients were male,47(47%) were hypertensive and 37(37%) patients were diabetic. There was a substantial reduction in B-Kerley's lines post dialysis ($p<0.001$) and there was a substantial change in IVC diameter measurements before and after dialysis ($p<0.001$). **Conclusion**; Chest US is a quick bed-side examination and a non-invasive dependable method for the evaluation of pulmonary congestion in in patients with chronic renal failure under regular hemodialysis.

INTRODUCTION

In patients with end-stage renal failure, Hypertension (HTN) between hemodialysis sessions is associated with high mortality.[1] Dry weight is described as the weight at which almost overload of body fluids was eliminated and below which more removal can result in hypotension and muscle cramps. [2] Too low dry weight eventually leads to early dialysis discontinuation, while over hydration causes poor controlling of HTN, cardiac dysfunctions and pulmonic congestion.[1]

Dry weight was measured clinically using trial and error techniques.[2]Clinical technique is imprecise and often unreliable.[3] There are many techniques to determine dry weight (bioimpedance technology, ultrasound of inferior vena cava (IVC), chest ultrasonography, [4] natriuretic peptides, isotope dilutions and neutron activations analyzing

methods).[5] Isotope dilution and neutron activation analysis methods have been regarded as the gold standard for assessing body fluid compartments.[5] Bio-impedance technology is a dependable tool for the evaluation of volume status.[1] However, this is limited by cost and bedside availability.

Chest ultrasonography (US) is a new line for assessment of lung congestion in dialysis patients.[6] It is beneficial for the noninvasive evaluation of extra-vascular lung water in chronic hemodialysis cases and give the enhance ability to detect lung congestion compared with the traditional physical examination. [7,8]

Ultrasonography evaluation of the inferior vena cava (IVC) could measure the vessel's diameter and collapsibility index, these measures can reflect the volume state.[1] *The objective of the present study* was to assess the role of chest US in detection of lung congestion among hemodialysis patients in Aswan University Hospital.

Methodology

Study setting and design:

A cross-sectional study was performed at nephrology department, Aswan university hospital, Aswan, Egypt. From December 2019 to December 2020.

Participants:

The current study included 100 patients with chronic renal failure on regular dialysis.

Inclusion criteria: the patients were included if above 18 year and has been on regular hemodialysis for more than 6 months.

Exclusion criteria*:* Cardiac patients and patients with chronic chest disease.

All patients were exposed to

1- Full history taking and full clinical examination.
2- **Lab Tests t**hat were done including (CBC, blood urea, serum creatinine, serum sodium, serum potassium, serum calcium, serum phosphorus, serum uric Acid, serum albumin and estimated (GFR).
3- **Chest ultrasonography:**

Chest ultrasound was accomplished using GE ULTRASOUND (LOGIQ C5 Premium, GE MEDICAL SYSTEMS (CHINA) CO, LTD), a portable ultrasound machine with 1.7 cm curved probe 1 to 5-M Hz, 2.1 cm phase array) was used. Scanning of the frontal and posterior chest has been done on the two sides as follow; Anteriorly; at fourth inter costal space (ICS) on mid clavicular line (MCL), anterior axillary line (AAL) and mid axillary line (MAL), and posteriorly; at the eighth ICS on posterior axillary line (PAL) and scapular line (SL). Lung comets had been described as a hyper-echoic US bundle; these comets arise from the pleural line. The summation of lung comets gives a score mirroring the degree of lungs water accumulations. According to this score, there were three categories of patients (mild: less than 14 comets, moderate: 14 to 30 comets and severe: more than 30 comets) as shown in **(Figure 1).**

4- **Measurment of IVC diameter**:

The IVC diameters was measured in the subxiphoid window in its sagittal view, it's diameters were mesaured at non forced end expiratory and end inspiratory phases within 1 cm from the junction between the IVC and suprahepatic veins as shown in **(Figure 2)**

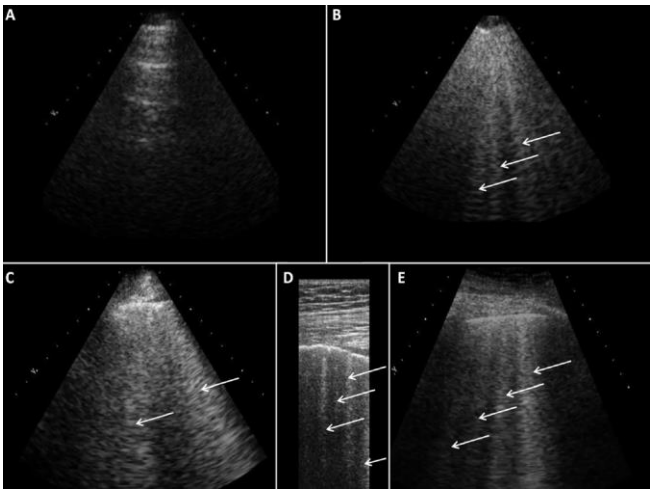

Figure1. Sonographic appearance of lung (A) an aerated (normal) lung scan, (B, D, E) multiple B lines, and (C) confluent B lines (arrows)

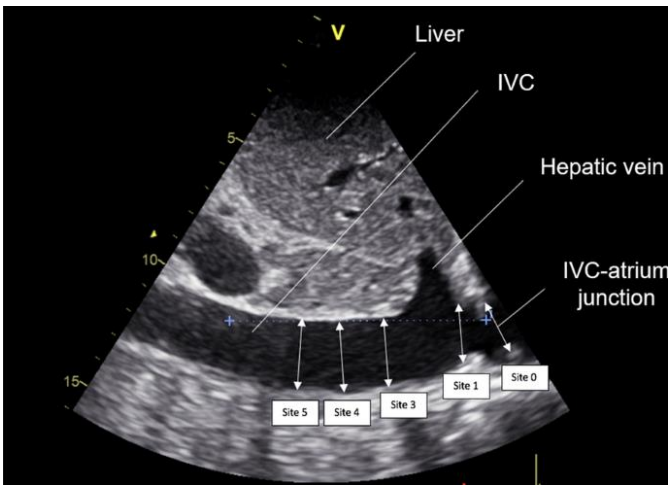

Figure 2. Measurement of the IVC. The diameter is measured with M-mode 2−3 cm distal to the confluence of the hepatic vein and IVC.

Ethical considerations

The Ethics Review Committee of Aswan Faculty of Medicine approved the study. Informed consent was obtained from all the patients after being informed about the aim and the benefits of the study.

Statistical analysis:

Statistical analysis was performed via IBM SPSS software (SPSS for Windows, version 20.0, SPSS Inc., Chicago, IL, USA). A p-value of less than 0.05 was deliberated statistically significant.

RESULTS

The study included 100 patients; their mean age was 43.66 ±7.6. 52(52%) patients were male. the mean BMI 24.93±1.84. 38(38%)patients were smokers. Nearly two thirds of them 63(63%) were from rural areas. Forty seven percent of them(47%) were hypertensive,37(37%) diabetic and the rest of demographic data were illustrated in **Table (1)**. **Table (2)** demonstrated the main of laboratory investigations of the study population. Echocardiographic results were shown in **Table (3)**. There was a substantial reduction in

B-Kerley's lines post dialysis ($p<0.001$) and there was a significant change in IVC diameter measurements before and after dialysis ($p<0.001$) as illustrated in **Table (4)**

Table (1): Demographic data of the study patients (n = 100)

Demographic data	**No.**	**%**
Age		
30 – 39	33	33.0
40 – 49	38	38.0
50+	29	29.0
Mean ± SD.	43.66 ± 7.60	
Gender		
Male	52	52.0
Female	48	48.0
BMI (kg/m2)		
Normal	49	49.0
Overweight	51	51.0
Mean ± SD.	24.93 ± 1.84	
Smoking status		
Nonsmoker	56	56.0
Smoker	38	38.0
Ex-smoker	6	6.0
Residence		
Urban	37	37.0
Rural	63	63.0
Comorbid diseases		
Hypertension	47	47.0
Diabetes	63	63.0
Anemia	100	100.0

Table (2): Laboratory investigations of the study population (n = 100)

Laboratory investigations	**Mean ± SD.**
HB (g/dl)	8.50 ± 1.17
Serum urea (mg/dl)	164.37 ± 59.07
Serum creatinine (mg/dl)	10.65 ± 3.18
Serum sodium (meql/l)	133.81 ± 5.41
Serum potassium (meql/l)	5.32 ± 0.73
Serum calcium (mg/dl)	8.10 ± 0.88
Serum albumin (g/dl)	3.64 ± 0.49
(eGFR) (ml/min/1.73m2)	12.28 ± 1.36

HB: Hemoglobin level, *eGFR: Estimated glomerular filtration rate*

Table (3): Echocardiographic findings of the study population (n =100)

Echocardiographic Data	**Mean ± SD.**
LVMI	76.64 ± 18.85
Left ventricular end-diastolic volume	115.17 ± 34.93
Left atrial volume	14.44 ± 3.84
Early left ventricular filling velocity	0.77 ± 0.24
E/E ratio	8.93 ± 4.29
Ejection fraction	56.74 ± 9.67
Pulmonary pressure	21.88 ± 9.97

LVMI: Left ventricular mass index (LVMI), E/E ratio: the ratio between early mitral inflow velocity and mitral annular early diastolic velocity.

Table (4): Comparison of B-Kerley's lines and IVC diameter pre- and post-dialysis in the study group

Chest ultrasound	**Pre-dialysis (n = 100)**		**Post-dialysis (n = 100)**		**P value**
	No.	**%**	**No.**	**%**	
B-Kerley's lines					
Normal	0	0.0	23	23.0	<0.001*
Mild	29	29.0	46	46.0	
Moderate	36	36.0	23	23.0	
Severe	35	35.0	8	8.0	
IVC diameter					
Mean ± SD.	2.08 ± 0.58		1.39 ± 0.36		<0.001*

DISCUSSION

Pulmonary congestions can be existing and frequently symptomless among hemodialysis cases. Lung US is a new method that was utilized to evaluate lung water in dialysis patients. In the presence of lung congestion, the beam of US was mirrored by thickened interlobular septa, named lung comets [9].

This study aimed to assess the role of chest US in detection of lung congestion in hemodialysis patients and we summarized that there was a significant reduction in B-Kerley's lines post dialysis (p<0.001) and there was a significant change in IVC diameter measurements before and after dialysis (p<0.001).

On the harmony with our study, **Vitturi et al.,**[10] reported that a significant decrease was found in the number of B-lines and in the IVC diameters throughout dialysis and a substantial link was found among B-lines predialysis and postdialysis (r=0.829, p=0.005). Similarly**, Trezzi et al.,** [11] revealed that there was a significant decrease in the overall number of B-lines post-dialysis (p= 0.001). Moreover, in the study of **Koraa et al.,** [12] regarding chest US, there was highly significant reduction in chest US Kerley's B-

lines (P<0.001) after dialysis. Furthermore, **Zoccali et al.** [13] summarized that lung's comets score was mild (<14) in 28 patients, moderate (14–30) in 26 cases, and severe (>30) in 21 cases. Around 60% had moderately to severely lung congestion pre-dialysis and that score marked reduced post-dialysis session (P<0.001).

In the contrary to our study, **Annamalai et al.,** [14], revealed that there was no significant association among absolute decrease in IVC diameter with variations in B-line, and ultra-filtration volume can be clarified by the fact that the 2 methods assess dissimilar fluids compartments. Whereas IVC diameter mirrors the volume of intra-vascular water, B-lines representing the size of extra-vascular water. As re equilibration of fluids from the interstitial to intra-vascular compartments consumes time, the best time to accomplish IVC diameter measurements at the termination of HD isn't obviously defined and still one of the limitations of this technique.

The limitations of this study included a relatively small sample size, lack of clinical information on longer periods due to weak cooperation of some patients, the study may be subjected to inter observer bias. Moreover, the main limitation of our study that ultrasonography was operator dependable technique with several ultrasound limitations such as the existence of pneumothorax as well as the morbid obesity.

CONCLUSION

Chest US is a quick bed-side examination and a non-invasive dependable method for the evaluation of pulmonary congestion in hemodialysis cases.

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