Comparison of pulmonary functions in ٤- and ٨-h dialysis sessions in thrice weekly hemodialysis

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Abstract

Background:

Longer dialysis sessions may improve outcome in hemodialysis (HD) patients. We compared the spirometry parameters in ٨- and ٤-h thrice-weekly HD.

Materials and Methods:

A total of ٣١ patients on chronic regular hemodialysis from Fayoum University hospital Kidney Center, all patients were end stage renal disease of various etiologies. Regular conventional hemodialysis was initiated since ٢ years for all patients. The study continued for ٦ months. They were all older than ١٨ years old. None of the patients was a current or recent smoker, and none of them had a history of respiratory diseases, current or recent respiratory infections, musculoskeletal disorders or tuberculosis. All of the patients underwent Spirometry Test pre and post conventional dialysis session (٣×٤ hours/week), all these patients were subjected to ٣ month long dialysis (٣×٨ hours/week). Thereafter, pulmonary functions were repeated pre and post hemodialysis session for each patient after the end of the ٣ month duration. The forced expiratory volume in the first second (FEV١), forced vital capacity (FVC), FEV١/FVC ratio and peak expiratory flow (PEF) were measured.

Results:

FVC is significantly different when compared pre conventional and pre long dialysis. Also, FVC was significantly different when compared post conventional and post long dialysis.

Conclusion:

Eight-hour thrice-weekly in-centre long dialysis has a better effect on the outcome of pulmonary functions than conventional dialysis especially in the FVC.

Key words: Spirometry, renal failure, conventional dialysis, long dialysis.

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Introduction:

Lung and kidney function are intimately related in both health and disease. Respiratory changes help to mitigate the systemic effects of renal acid-base disturbances, and the reverse is also true, although renal compensation occurs more slowly than its respiratory counterpart (1). End stage renal disease (ESRD) is an irreversible pathological condition characterized by loss of the kidneys' ability to maintain homeostasis. The kidneys regulate the body's vital functions such as water, acid-base and electrolyte balance, and participate in hormonal functions and blood pressure regulation. Patients with chronic kidney diseases (CKD)-ESRD require renal replacement therapy in the form of hemodialysis or peritoneal dialysis for survival, because these can partially replace the impaired kidney function while the patient awaits a definitive solution through kidney transplant, if possible (2). Patients with CKD-ESRD undergoing dialysis can develop dysfunction in multiple systems such as the musculoskeletal, cardiovascular, metabolic and respiratory systems. The musculoskeletal system is seriously affected, and there are several interrelated causal factors in the development of muscle problems in patients with CKD-ESRD. Among these, are decreased protein-calorie intake, muscle atrophy through disuse and muscle protein imbalance, which mostly affect type II muscle fibers; reduction of the vascular and capillary bed; presence of intravascular calcification and decreased local blood flow. These results are part of the pathogenesis of uremic myopathy and are commonly described in the literature in relation to skeletal muscles such as the deltoid, quadriceps and abdominal muscles (3).

The muscles responsible for respiratory function, such as the diaphragm and intercostals, among others, are classified as skeletal muscles and may show decreases in muscle strength and endurance properties resulting from uremic myopathy. Some authors (4) who have studied the involvement of uremia in the diaphragm have concluded that loss of strength occurs through severe uremia. The ventilatory deficit due to this impairment in respiratory muscles, combined with other lung tissue impairments, compromises the functioning of this system, thereby contributing towards decreased lung capacity (5)

Other complications in lung tissue are found in patients with CKD, such as pulmonary edema, pleural effusion (mainly in terminal patients with CKD), pulmonary and pleural fibrosis and calcification, pulmonary hypertension, decreased pulmonary capillary blood flow and hypoxemia (6).

Material and methods:

Subjects:

This study involved ٣١ patients from Fayoum University Hospital Kidney Center who agreed to participate in the study, both genders were involved, age were above ١٨. All of them initiated thrice weekly ٤ hour maintenance bicarbonate HD since ٢ years through AV fistula. The study was done during the period between January ٢٠١٠ and June ٢٠١٠ in which spirometry function was performed for these patients pre and post conventional dialysis session (٣×٤ hours/week), all these patients were subjected to ٣ month duration of long dialysis (٣×٨ hours/week). Thereafter, pulmonary functions were repeated pre and post dialysis sessions after the end of the ٣ month duration. Exclusion criteria included smokers and patient with history of smoking, patient with history of respiratory diseases, current or recent respiratory infection, musculoskeletal disorders or tuberculosis. Dialysis Machines used were Fresenius ٤٠٠٨S, Filters was low flux polysulphone Fresenius F٧ with effective surface area ١.٦ ($m^٢$). In four-hour dialysis session, blood flow rate was ٣٠٠-٤٠٠ ml/min while in eight-hour dialysis session, blood flow rate ٢٠٠-٢٥٠ ml/min.

Spirometry was done just before the patient start his /her regular session of dialysis and repeated again post dialysis session. The same procedure was repeated after end of ٣ month duration of long dialysis, using Cosmed MicroQuark spirometry.

Statistical Analysis

Statistical analysis was done on paired samples using T-test. Thirty one patients on regular dialysis were subjected to this study with measurement of PFTS pre & post conventional dialysis. The PFTS were repeated after use of long ٨ hours dialysis ٣ times /wk for duration of ٣ months. The study duration was ٦ months. All patients were on regular thrice weekly conventional bicarbonate dialysis. The mean duration of initiation of hemodialysis was ٢ years.

Results:

Table ١: **Mean, standard deviation (SD) of FVC pre and post long dialysis**

	FVC pre long dialysis	FVC post long dialysis
Mean	١٠٣.٧	١٠٥.٠٦
± SD	١١.٩٧	١٢.٧٦
P value	٠.٢٥ not significant	

Table ٢: **Mean, standard deviation (SD) of FVC pre and post conventional dialysis**

	FVC pre conventional dialysis	FVC post conventional dialysis
Mean	٩١.٩٦	٩٢.٩
± SD	٦.٦٩	٧.٧٤
P	p = ٠.٢ not significant	

Table ٣: **Mean, standard deviation (SD) of FVC pre conventional and pre long dialysis**

	FVC pre conventional dialysis	FVC PRE long dialysis
Mean	٩١.٩٦	١٠٣.٧
± SD	٦.٦٩	١١.٩٧
P	**P < ٠.٠٠١ Highly Significant**	

Table ٤: **Mean, standard deviation (SD) of FVC post conventional and long dialysis**

	FVC post conventional dialysis	FVC post long dialysis
Mean	٩٢.٩	١٠٥.٠٦
± SD	٧.٧٤	١٢.٧٦
P	**P < ٠.٠٠١ Highly Significant**	

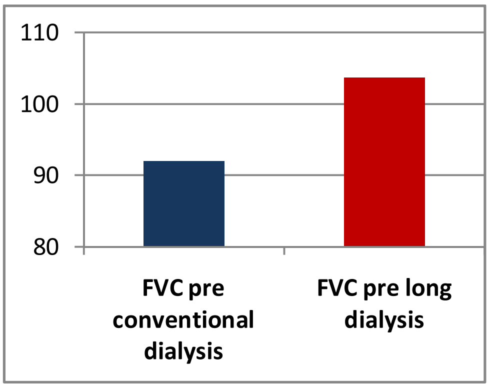

Figure ١: shows Fvc pre conventional and pre long diaylasis which is highly significant

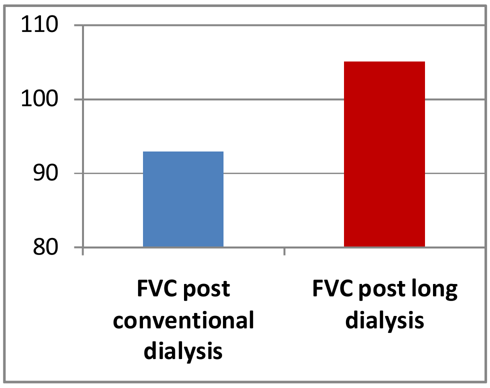

Figure ٢: shows FVC post conventional and psot long dialysis which is highly signficiant.

Table ٥: **Mean and standard deviation (SD) of FEV١ pre and post conventional dialysis**

	FEV١ pre conventional dialysis	FEV١ post conventional dialysis
MEAN	٩٠.٨٧	٩١.٢٩
± ± SD	٩.٠٤	٦.٩٥
P	**P =٠.٦٩٢ Not Significant**	

Table ٦: **Mean and standard deviation (SD) of FEV١ pre and post long dialysis**

	FEV ١ pre long dialysis	FEV١ post long dialysis
MEAN	٩٧.٢٩	١٠١.٤٥
± ± SD	١٨.٩٥	٩.٦١
P	**P = ٠.٢٢٢ Not Significant**	

Table V: **Mean and standard deviation (SD) of FEV١ pre conventional and pre long dialysis**

	FEV١ pre conventional dialysis	FEV١ pre long dialysis
MEAN	٩٠.٨٧	٩٧.٢٩
± SD	٩.٠٤	١٨.٩٥
P	**P = ٠.١٠٥ Not Significant**	

Table ٨: **Mean and standard deviation (SD) of FEV١ post conventional and long dialysis**

	FEV١ post conventional dialysis	FEV١ post long dialysis
MEAN	٩١.٢٩	١٠١.٤٥
± SD	٦.٩٥	٩.٦١

P	P < ٠.٠٠١ highly Significant

Table ٩: **Mean and standard deviation (SD) of FEV١ /FVC pre and post long dialysis**

	FEV١ /FVC pre long dialysis	FEV١/ FVC post long dialysis
Mean	٨٠.٨٣	٨١.٨٣
± SD	١٠.٣٥	٨.٩٦
P	P < ٠.٠٧٥ not Significant	

Table ١٠: **Mean and standard deviation (SD) of FEV١ /FVC pre and post conventional dialysis**

	FEV١/ FVC pre conventional dialysis	FEV١ /FVC post conventional dialysis
Mean	٨٢.٩٦	٨٣.٦٤
± SD	٩.٣٧	٩.٣٤
P	P = ٠.٤٤٢ NOT SIGNIFICANT	

Table ١١: **Mean and standard deviation (SD) of FEV١ /FVC pre conventional and long dialysis**

	FEV١/ FVC pre conventional dialysis	FEV١/ FVC pre long dialysis
Mean	٨٢.٩٦	٨٠.٨٣
± SD	٩.٣٧	١٠.٣٥
P	P = ٠.٣٢٤ NOT SIGNIFICANT	

Table ١٢: **Mean and standard deviation (SD) of FEV١ /FVC post conventional and long dialysis**

	FEV١/ FVC post conventional dialysis	FEV١/ FVC post long DIALYSIS
Mean	٨٣.٦٤	٨١.٨٣
± SD	٩.٣٤	٨.٩٦
P	P = ٠.٦٥٧ NOT SIGNIFICANT	

Table ١٣: **Mean and standard deviation (SD) of PEF pre and post conventional dialysis**

	PEF pre conventional dialysis	PEF post conventional dialysis
MEAN	٩١.٠٣	٩٢.٨
± SD	١٩.٩٨	٢٠.٥٤
P	P = ٠.٤٢٨ NOT SIGNIFICANT	

Table ١٤: : **Mean and standard deviation (SD) of PEF pre and post long dialysis**

	PEF pre long dialysis	PEF post long dialysis
MEAN	٩١.٨٧	٩٣.٠٩
± SD	١٦.٩٥	١٤.٦٤
P	P = ٠.٥ Not Significant	

Table ١٥: : **Mean and standard deviation (SD) of PEF pre conventional and long dialysis**

	PEF pre conventional dialysis	PEF pre long dialysis
MEAN	٩١.٠٣	٩١.٨٧
± SD	١٩.٩٨	١٦.٩٥
P	P = ٠.٨٣٦ NOT SIGNIFICANT	

Table ١٦: : **Mean and standard deviation (SD) of PEF post conventional and long dialysis**

	PEF post conventional dialysis	PEF post long dialysis
MEAN	٩٢.٨	٩٣.٠٩
± ± SD	٢٠.٥٤	١٤.٦٤
P	P = ٠.٩٤٣ NOT SIGNIFICANT	

Discussion:

We studied 31 patients with chronic renal failure; all were excluded to have any past history or current clinical evidence of pulmonary diseases. To our knowledge this is the first study to evaluate the difference in spirometry parameters between hemodialysis patients on conventional and long dialysis forms. Patients on long dialysis exhibited more improvement on their FVC after spending ٣ month duration of long dialysis sessions. Previous studied compared conventional to long dialysis concluded that long dialysis has a better outcome for morbidity and mortality (٧,٢٠). Eight-hour thrice-weekly in-centre nocturnal dialysis provided morbidity and possibly mortality benefits when compared to conventional ٤-hours hemodialysis (٨, ١٩, ٢٠).

Pulmonary congestion in patients with chronic renal failure is associated with a restrictive pattern on pulmonary function testing, and reduced airflow can also be observed on spirometry. These abnormalities have been demonstrated to improve or resolve with hemodialysis (9,10,11). This observation would seem to strengthen the argument that increased lung water results primarily from overall hypervolemia in the presence of low serum albumin levels in this condition, and accounts for the symptoms and signs traditionally associated with "uremic lung" (12).

Table 1,2,3,4 showed that there was no statistical difference in FVC pre and post regular conventional dialysis, and also no statistical difference in FVC pre and post long dialysis. However, there was a significant statistical difference when FVC was compared pre conventional dialysis to pre long dialysis and also there was a significant statistical difference when FVC was compared post conventional dialysis to post long. Observational data suggest that long dialysis provides better blood pressure control than conventional dialysis and leads to improvements in left ventricular hypertrophy (20). This may be due to multiple factors, independent of volume control, and suggest that the prolonged and slow flows of long dialysis treatments may lead to improved haemodynamic physiology. But other researchers have shown the role of removing extracellular volume in reduction of blood pressure and resolution of LVH in short daily treatments and long dialysis, and this may be the case in long dialysis as well (13,14,19,20). This may be the same for the FVC.

While in table 5,6,7,8 the FEV1 showed that there a no statistical difference in FEV1 pre and post conventional dialysis, and there is no difference FEV1 pre and post long dialysis. However, there was no statistical difference when FEV1 was compared pre conventional to pre long. However, there was a statistically significant difference of FEV1 when compared post conventional to post long dialysis.

In table 9,10,11,12 the FEV1/FVC was showed that there was no statistical difference in FEV1/FVC pre and post conventional dialysis. Also, there is no difference in FEV1/FVC pre and post long dialysis, no difference of FEV1/FVC when compared pre conventional to pre long dialysis or FEV1/FVC when compared post regular conventional to post long dialysis.

Also in table 13,14,15,16 PEF shows that there was no statistical difference in PEF pre and post conventional dialysis. Also, no statistical difference in PEF pre and post long dialysis. No difference when PEF was compared pre conventional to pre long dialysis and also no difference when PEF was compared post conventional to post long dialysis.

Cross-sectional evaluation of patients who were on long dialysis exhibited excellent quality indicators with improved fluid balance and slightly lower blood pressure, better survival, and lower hospitalization rates relative to conventional dialysis patients. As in daylong hemodialysis treatments, improved fluid management leading to more effective blood pressure control has also been reported as a major benefit of long-duration HD (15,16,20).

Higher heart rates and impaired vagal and augmented sympathetic heart rate modulation during sleep in ESRD patients are normalized by nocturnal hemodialysis. Potential mechanisms for these observations include attenuation of surges in sympathetic outflow elicited by apnea and hypoxia during sleep, normalization of nocturnal breathing patterns that influence HRV, and removal, by increased dialysis, of a sympatho-excitatory stimulus of renal origin (١٧). Daily nocturnal hemodialysis has been proposed as a valuable strategy to improve outcomes for patients on conventional hemodialysis, but it is burdened by high costs and logistic issues. Thrice weekly long dialysis might represent a more affordable approach to improve hemodialysis patient outcome (٧). Thrice weekly ٨ h HD has a better effect on blood pressure control & reduction in use of anti-hypertensive drugs, serum phosphate level, and weight gain (١٨) and in our study also FVC.

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