Original Article

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TANAFFOS

Effects of High-Flux versus Low-Flux Membranes on Pulmonary Function Tests in Hemodialysis Patients

Ali Momeni [1], Hamid Rouhi [1], Glareh Kiani [2], Masoud Amiri [3]

[1] Department of Internal Medicine, Shahrekord University of Medical Sciences, [2] Kashan University of Medical Sciences, [3] Social Health Determinants Research Center and Department of Epidemiology and Biostatistics, School of Health, Shahrekord University of Medical Sciences, Shahrekord, Iran.

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Correspondence to: Rouhi H
Address: Department of Internal Medicine, Shahrekord University of Medical Sciences, Shahrekord, Iran.
Email address: hammfer@yahoo.com

Background: Several studies have been carried out to evaluate the effects of dialysis on pulmonary function tests (PFT). Dialysis procedure may reduce lung volumes and capacities or cause hypoxia; however, to the best of our knowledge, there is no previous study evaluating the effects of membrane type (high flux vs. low flux) on PFT in these patients. The aim of this study was the evaluation of this relationship.

Materials and Methods: In this cross-sectional study, 43 hemodialysis patients without pulmonary disease were enrolled. In these patients dialysis was conducted by low- and high-flux membranes and before and after the procedure, spirometry was done and the results were evaluated by t-test and chi square test.

Results: The mean age of patients was 56.34 years. Twenty-three of them were female (53.5%). Type of membrane (high flux vs. low flux) had no effect on spirometry results of patients despite the significant decrease in the body weight during the dialysis session.

Conclusion: High flux membrane had no advantage over low flux membrane in terms of improvement in spirometry findings; thus, we could not offer these expensive membranes for this purpose.

Key words: Hemodialysis, High flux membrane, Pulmonary function tests, Spirometry

INTRODUCTION

Hemodialysis can be done by low flux or high flux membrane. High-flux dialysis is defined as a β2-microglobulin clearance of over 20 ml/min (1, 2). High flux membranes compared to low flux have larger pores and allow diffusion of greater amounts of uremic toxins and middle molecules such as β2 microglobuline and therefore they may decrease the risk of dialysis-related amyloidosis (3, 4). In addition, these membranes have other advantages like increasing patients' survival (5, 6), reduced admission and morbidity (7, 8), less activation of coagulation pathway and complement system, less leukocytosis and activation of inflammatory system and cytokines secretion, removing more endotoxins, better lipid profile (9), reduced infection risk, aluminum toxicity and better preserved renal function (10-12). Many studies have been done on dialysis patients taking into account their pulmonary function tests. Hemodialysis may change some of the pulmonary function tests and can decrease forced vital capacity (FVC) and forced expiratory volume in one second (FEV1). The exact cause of spirometry changes in these patients is not completely clear and it may be due to the accumulation of WBCs in lung capillaries.

There are a few studies about PFT in hemodialysis patients. High flux membranes compared to low flux ones, are more permeable to middle molecules, remove more serum endotoxins, activate inflammatory system less frequently and cause less leukocytosis and probably less sequestration of leukocytes in pulmonary capillaries, which may be responsible for the changes in pulmonary function tests. Thus, the present study was conducted to compare the acute effects of membrane type on spirometry results.

MATERIALS AND METHODS

Patients:

In this cross-sectional study, 43 hemodialysis patients presenting to Hajar University Hospital in Shahrekord, Iran were evaluated. The inclusion criteria were age more than 18 years, duration of dialysis for more than 6 months, normal chest wall and breath sounds in physical exam and ability of patient to perform PFT. Poor compliance, history of pulmonary disease, thoracic deformity such as kyphoscoliosis, need for oxygen during dialysis and previous thoracic surgery were the exclusion criteria.

Dialysis:

The patents were on dialysis 3 times a week each time for 4 hours with Fresenius (Medical care 4008-B, Germany) and Gambro (AK 95 S, Swiss) machine. While the patients' blood flow range (QB) was variable from 280 to 350 ml/min, dialysate flow was constant (500 ml/min). High flux dialysis was done by R60 membrane and low flux by R6 membrane, both manufactured by Fresenius, Germany. Ultrafiltration coefficient of high and low flux membranes was 40 and 5.5 cc/hour/mmHg, respectively. Dialysis was done by bicarbonate buffer in all sessions. Intra-dialysis ultrafiltration was based on patients' condition. Patient's body weight was also measured before and after dialysis.

Spirometry:

Hemodialysis was performed by low flux membrane and pulmonary function tests (PFT) were done 20 minutes before the initiation of dialysis with and without bronchodilator (2 puffs of β2 agonist inhaler of salbutamol). After dialysis session, PFT was repeated with and without bronchodilator in the same patients. In the next session, hemodialysis was performed for the same 43 patients with high flux membrane and PFT was also done before and after dialysis as described above. The measured spirometry parameters were: forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), FEV1/FVC ratio, and maximal mid-expiratory flow rate (FEF 25%-75%). Spirometry was done by Winspiro PRO 2.3, prediction: Crapo and Bass/ Knudson, manufactured in Italy.

Statistical analysis:

Student's t test was used to compare the PFT values. Pearson's correlation was applied for determination of correlations. Data were analyzed using SPSS software (version 19). *P* values less than 0.05 were considered statistically significant.

RESULTS

Twenty-three patients were women (53.5%). The causes of renal failure were diabetes mellitus, hypertension, hereditary kidney disease and proteinuria in 23, 14, 3, and 3 patients, respectively. Ischemic heart disease was seen in 23 patients and three cases had congestive heart failure. The mean age of patients was 56.34 years (range 23 to 84 yrs.). There were no differences in PFT results (FEV1, FVC and FEV1/FVC) before and after dialysis with low flux membranes. No differences were found in PFT results before and after dialysis with high flux membranes either (Table 1). After comparison of results, spirometry data with high flux membranes were similar to that of low flux membranes before and after dialysis ($P>0.05$). Compared to baseline values before the dialysis session, body weight of the patients significantly decreased after dialysis due to ultrafiltration during the dialysis ($P = 0.001$).

Table 1. Comparison of the characteristics of patients and spirometry results in high and low flux membrane groups.

Characteristics	Time	High Flux Membrane		Low Flux Membrane		High Flux versus Low Flux
		Mean± Standard Deviation	P	Mean± Standard Deviation	P	P
Body Weight (kg)	Before HD*	61.9±12.5	0.001	62.5±12.3	0.001	0.9
	After HD	59.5±12.1		59.8±12.1		
Systolic Blood Pressure (mm Hg)	Before HD	129.5±19.3	0.3	125.5±16.9	0.1	0.5
	After HD	119±19.8		121.3±16.7		
Diastolic Blood Pressure (mm Hg)	Before HD	75.9±8	0.3	73.2±9.1	0.6	0.7
	After HD	73.2±9.1		73.9±9		
FEV1[without bronchodilator] (lit)	Before HD	1.66±0.7	0.5	1.7±0.8	0.1	0.9
	After HD	1.70±0.6		1.8±0.8		
FEV1(lit) [with bronchodilator]	Before HD	1.61±0.7	0.4	1.7±0.8	0.5	0.4
	After HD	1.71±0.6		1.8±0.8		
FVC (lit) [without bronchodilator]	Before HD	1.98±0.9	0.8	2±0.86	0.07	0.5
	After HD	1.97±0.7		2.1±0.9		
FVC (lit) [with bronchodilator]	Before HD	1.96±0.8	0.5	2±0.9	0.4	0.5
	After HD	1.91±0.7		2±0.9		
FEV1/FVC (%) [without bronchodilator]	Before HD	84.7±13.2	0.4	81.1±21.6	0.2	0.9
	After HD	86.5±12.1		85.9±11.5		
FEV1/FVC (%) [with bronchodilator]	Before HD	86.1±13.3	0.2	85.8±11.6	0.7	0.4
	After HD	88.5±9.8		86.9±15.8		
FEF 25-75 (lit) [without bronchodilator]	Before HD	2.1±1	0.8	2.1±1.3	0.9	0.4
	After HD	2.1±1.1		2.1±1.2		
FEF 25-75 (lit) [with bronchodilator]	Before HD	2.1±1.1	0.7	2±1.2	0.01	0.6
	After HD	2.1±1		2.3±1.1		

*HD=Hemodialysis

DISCUSSION

To the best of our knowledge, there is no previous study on the relationship between PFT and type of membrane. Our results showed that the type of hemodialysis membrane has no influence on PFT results. There were no significant differences between spirometry findings of the two patient groups before and after dialysis despite significant ultrafiltration and reduction of body weight.

Several studies have been conducted on the effects of hemodialysis on lung volumes and capacities, including Hekmat's study which showed that in hemodialysis patients, pulmonary capacities and volumes are less than normal population (13). In some studies the correlation of weigh reduction and spirometry findings has been evaluated; for example, in a study by Alves et al., 61 dialysis patients were evaluated and spirometry was done before and after the dialysis. Improvement of FEV1 and FVC after dialysis was correlated with weight loss of patients (14). They also concluded that decreased volume overload after dialysis is an important factor in improvement of PFT findings. Conversely, Langs et al. did not find any correlation between lung function parameters and intra-dialytic weight loss with cellulose or high flux membrane in 14 hemodialysis patients (15). Our results are similar to their study, but the number of our cases was three-times higher and we used highly efficient biocompatible membrane (R6) instead of cellulose membrane.

In another study conducted by Ferrer et al., comparison of spirometry data in patients after dialysis and in normal population did not show any significant differences (16).

Navari et al. in a study on 50 hemodialysis patients compared two types of hemodialysis buffer (bicarbonate versus acetate) and found that spirometry characteristics after dialysis with bicarbonate were higher than acetate in male hemodialysis patients independent of intradialytic weight reduction (17). Kovacević et al. in a study on 21 hemodialysis patients reported that only forced expiratory flow (FEF50) decreased after 5 years of follow up; however, spirometry findings were similar before and after dialysis (18). Similarly, Herrero et al. in 5 years follow up of 43 patients on hemodialysis with bioincompatible membrane showed a significant decline in pulmonary diffusing capacity possibly due to chronic pulmonary fibrosis (19).

CONCLUSION

Based on our results, dialysis procedure does not have any positive or negative effect on PFT results, despite the significant reduction in patients' weight. In addition, high flux membrane had no advantage over low flux membrane in terms of improvement of spirometry findings. Thus, we could not offer these expensive membranes for this purpose.

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