Effect of Hemodialysis on Spirometric Measurement in Patients with Chronic Kidney Disease

تأثير غسيل الكلى على قياس وظائف الرئة في المرضى الذين يعانون من مرض الكلى المزمن

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الخلاصة:
خلفية الدراسة :ان القصور في وظيفة الكلى يمكن أن يؤثر سلبا على وظائف الجهاز التنفسي وديناميكيته عبر آليات مختلفة ناتجة عن تراكم مخلفات الايض مما يؤدي لاحتياج المرضى الذين يعانون من قصور وظائف الكلى الى غسيل الكلى الدموي للبقاء على قيد الحياة.
الهدف: تهدف الدراسة الى بحث التأثير الحاد لغسيل الكلى الدموي على فحص وظائف الرئة في المرضى الذين يعانون من قصور في وظائف الكلى.
المنهجية :شارك في هذه الدراسة مئة مريض (50٪ ذكور، مع معدل اعمار 43.2 ± 15 عاما) ممن لديهم قصور مزمن في وظائف الكلى من الذين يخضعون لغسيل الكلى بشكل منتظم في مركز غسيل الكلى في مستشفى الصدر التعليمي للفترة من بداية شهر كانون الثاني 2015 الى بداية شهر ايلول 2015 حيث تم اجراء فحص وظائف الرئة لكل مريض وافق على المشاركة في الدراسة قبل عملية غسيل الكلى وخلال نصف ساعة بعد اكمال عملية الغسل الكلوي. تم استخدام نظام الحزمة الإحصائية للعلوم الاجتماعية (SPSS) الكومبيوتري لتحليل النتائج احصائيا.
النتائج :أظهرت النتائج وجود تحسن ملموس إحصائيا في قيم فحص وظائف الرئة بعد غسيل الكلى وكان هذا التحسن ملحوظا بشكل اكبر مع الزيادة في ساعات ومرات جلسات الغسيل الكلوي.
الاستنتاج : كانت هناك زيادة مهمة في معلمات فحص وظائف الرئة بعد غسيل الكلى للمرضى الذين يعانون من قصور مزمن في وظائف الكلى.
التوصيات : اوصت نتائج الدراسة بالمزيد من الدراسات لتأكيد النتائج التي توصلنا إليها لغرض معرفة التأثير المزمن لغسيل الكلى على وظائف الرئة للمرضى المصابين بقصور مزمن في وظائف الكلى.

Abstract:
Background: Chronic kidney disease (CKD) can adversely affect the respiratory systems functions and dynamics via different mechanisms resulting from toxic metabolites. Patients with CKD require hemodialysis for survival and prior studies have been showed a controversial effects of hemodialysis on respiratory function

Objectives: The aim of the study was to investigate the acute impact of hemodialysis on spirometric parameters in patients with CKD undergoing maintenance hemodialysis

Patients and methods: One hundred patients (50% male, mean age 43.2± 15 years) with CKD who underwent regular hemodialysis at the hemodialysis center at Al-Sader Teaching Hospital between January and September 2015were enrolled in the study. Forced expiratory volume in the first second (FEV1), forced vital capacity (FVC) and the FEV1/FVC ratio (FEV1%) were performed for each patient who consented to participate in the study; before the hemodialysis session and within half hour after it. SPSS was used for the statistical analysis.

Results: FEV1 and FVC were showed a statistically significant improvement in their values after hemodialysis($P<0.05$) while FEV1% showed no significant changes and improvement after hemodialysis($P>0.05$). FEV1 and FVC were showed a significant change and increment with increased of the frequency of hemodialysis sessions ($P <0.05$).

Conclusion: There was a significant increase in spirometric parameters after hemodialysis for patients with CKD.

Recommendations: A further studies with follow ups are required to confirm our findings and establish the chronic effect of hemodialysis on pulmonary function test

Keywords: Kidney ; hemodialysis ;spirometry

Abbreviations: FEV1(Forced expiratory volume in the first second),FVC(forced vital capacity),CKD(chronic kidney disease),Hb(hemoglobin),GFR(glomerular filtration rate).

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INTRODUCTION

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[1].Chronic kidney disease (CKD) is a is an irreversible pathological condition characterized by loss of the kidneys' ability to maintain body homeostasis that is often undiagnosed until the most advanced stages [2,3].

The incidence of CKD is increasing due to aging of the population and higher incidence of hypertension and diabetes mellitus [3].Patients with CKD require dialysis 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 [4].

The impact of CKD on respiratory function and mechanics becomes evident through intravascular and extravascular volume overload with a varying degrees of left-sided heart failure when the blood level of urea nitrogen exceeds a distinguishing threshold. These adverse effects include acute complications such as acute pulmonary edema, pleural effusion, acute respiratory distress syndrome ,and chronic effects such as calcification of the lung tissue and the vascular intima and impaired cardiorespiratory system [5,6].

Furthermore, toxic effects of uremic metabolites on the endothelium of the pulmonary capillaries lead to raised permeability of the pulmonary capillary, leading to edema and increased resistance in the small airways and alveoli with a further deterioration in the respiratory function [5].

The muscles responsible for respiratory function, such as the diaphragm and intercostals, may show decreases in muscle strength and endurance properties resulting from decreased protein-calorie intake, muscle atrophy through disuse and muscle protein imbalance, which mostly affect type II muscle fibers (uremic myopathy) [1,7].Spirometry is a simple and quick tool that is most commonly performed to measure the lung function by asking the patient to take a maximal inspiration and then to forcefully expel air for as long and as quickly as possible [8].

The most common spirometric parameters are Vital capacity (VC), Forced vital capacity (FVC), Forced expiratory volume in first second (FEV1) [8].Several studies evaluated the effect of hemodialysis on spirometric parameters in patients with CKD on regular hemodialysis showed inconsistent results. Navari et al study performed on 41 patients with CKD on regular hemodialysis showed a significant improvement in spirometric parameters (FEV1 and FVC) except for the FEV1% after hemodialysis while Cury JL et al in their study reported that patients undergoing dialysis showed a lower levels of spirometric parameters than general population resulting from impairment of muscle and lung function that were not completely reverted in the kidney transplant patients [1,5].

The aim of our study was to study the acute impact of hemodialysis on spirometric parameters in patients with CKD undergoing maintenance hemodialysis.

PATIENTS AND METHODS

This cross-sectional study was carried out at the hemodialysis center at Al-Sader Teaching Hospital between January and September 2015.One hundred thirty patients with CKD who underwent regular hemodialysis were included in this study. Of these, 100 patients (50% male, mean age 43.2± 15 years) were enrolled in the study. Verbal or written consent were obtained from each patient. Exclusion criteria for enrollment in the study were patients with acute chest infection , heart failure ,history of lung TB , lung cancer and neuromuscular disease. A detailed history was obtained from each patient at the time of spirometric test including age, sex ,duration of CKD, duration of hemodialysis sessions(in months), frequency of hemodialysis sessions per week and time of diagnosis of CKD (in months) .Full clinical examination by physician to exclude heart failure, acute chest infection ,pleural effusion and chest deformity.

Physical measurement of body weight and height were measured by digital weight and height scale (JookooCo. Ltd. Japan). BMI was calculate according to following equation: BMI= weight(Kg) /height(m^2)[9].For each patient, the following investigations were recorded: blood urea, serum creatinine, GFR, serum K, serum Ca, Hb and abdominal ultrasound and chest X ray to exclude significant ascetics and chest infection. All spirometric parameters were measured by SpirolabIII (new 3rd generation) a computerized diagnostic spirometer made via del Maggiolono, Italy. (SN.A23-035.02415).Spirometric test was performed for each patient who consented to participate in the study; before the hemodialysis session and within half hour after it. All spirometric tests were done by the same person .

The parameters to be measured before and after dialysis are forced expiratory volume in the first second (FEV1), forced vital capacity (FVC) and the FEV1/FVC ratio (FEV1%).

STATISTICAL ANALYSIS

Data are presented as mean ± standard deviation or as numbers with percentages, as appropriate. Continuous variables are presented as mean ± standard deviation and were compared using the Student’s t-test or analysis of variance, as appropriate. A P-value of less than 0.05 was considered statistically significant. SPSS ver. 13.0 (SPSS Inc., Chicago, IL, USA) was used for the statistical analysis.

RESULTS:

Table (1): Anthropometric data

Parameters	No. % or mean ±SD
Age (years)	43.2±15
Gender male/female	50/50
Diabetes mellitus	22
BMI (Kg/m^2)	25±5
Frequency of dialysis(per week)	
Once /week	10
Twice /week	48

Thrice /week	42
Duration of dialysis session (hours)	
3 hours	73
4 hours	27
Hb(g/dl)	8.5±1.7
Blood urea(mg/dl)	170±42
Serum creatinine(mg/dl)	6.8±2.4
GFR (ml/min)	15±8

Table 1 showed that the mean age of our patients was 43.2 and 50% of the sample was male. The prevalence of diabetes mellitus was 22%.The BMI mean was 25. The mean of frequency of dialysis (per week) was as following: 10% for once/week,48% for twice /week and 42% for thrice /week. The duration of dialysis session (hours) was 3 hours(73%) and 4 hours(27%). The mean of Hb, blood urea, serum creatinine and GFR were 8.5 g/dl,170 mg/dl,6.8 mg/dl and 15 ml/min respectively.

Table (2) :The effect of hemodialysis on FEV1,FVC and FEV1% in patients with CKD on hemodialysis.

Parameter	Before hemodialysis(mean±SD)	After hemodialysis(mean±SD)	P value
FEV1	1.6± 0.8	1.87± 0.75	0.014
FVC	2± 0.9	2.2± 0.9	0.017
FEV1%	80.1± 3	79.8± 3	0.4

FEV1 and FVC were showed a statistically significant improvement in their values after hemodialysis while FEV1% showed no significant changes and improvement after hemodialysis

Table (3): The effect of the length of hemodialysis session and frequency of hemodialysis session per week on FEV1 in patients with CKD on hemodialysis.

Variables	FEV1 before hemodialysis(mean±SD)	FEV1 after hemodialysis(mean±SD)	Total	P value
Duration of dialysis session(hours)				
3hours	1.7±0.85	1.9±0.77	73	0.3

4hours	1.2±0.46	1.6±0.67	27	0.01
Frequency of dialysis session/week				
Once/week	1.6±0.53	1.7±0.73	10	0.6
Twice/week	1.4±0.72	1.8±0.76	48	0.01
Thrice/week	1.7±0.88	2.1±0.76	42	0.03

FEV1 had been showed a significant change and increment with increased length of hemodialysis session (P < 0.05).Also,FEV1 showed a significant change and increment with increased of the frequency of hemodialysis sessions (P <0.05)

Table (4): The effect of the length of hemodialysis session and frequency of hemodialysis session on FVC in patients with CKD on hemodialysis.

Variables	FVC before hemodialysis(mean±SD)	FVC after hemodialysis(mean±SD)	Total	P value
Duration of dialysis session(hours)				
3hours	2 ± 0.9	2.3± 0.9	73	0.07
4 hours	1.6± 0.74	2 ± 0.77	27	0.06
Frequency of dialysis / week				
Once/week	1.8±0.72	1.9±0.76	10	0.7
Twice/week	1.6±0.85	2.1±0.95	48	0.01
Thrice/week	2.1±0.99	2.4±0.91	42	0.04

FVC showed a significant change and increment with increased of the frequency of hemodialysis sessions (P <0.05) while no significant effect had been observed for the length of hemodialysis session and on FVC level (P > 0.05)

DISCUSION

The current study ,which involved 100 patients with CKD on hemodialysis, reveals a significant increase in FEV1 and FVC levels after hemodialysis ($P < 0.05$) while there was no statistically significant change in FEV1% after hemodialysis($P > 0.05$).

The results are in agreement with several studies that have been showed a significant improvement in FEV1 and FVC levels after hemodialysis[10,11,12]. There are several hypotheses that may explain the lung damage in patients with CKD and significant increment in spirometric parameters levels after hemodialysis. In patients with CKD, pulmonary dysfunction may be the direct consequence of circulating uremic toxins or may result indirectly from volume overload, low hemoglobin, immune suppression, extra-osseous calcification, small airways resistance, malnutrition, electrolyte disorders, and/or acid-base imbalances [12].Improvement in above factors by hemodialysis through removing of excessive water from the body could be the possible explanation for the changes in spirometric parameters after hemodialysis [13].CKD may adversely affect both inspiratory and expiratory muscle strength through a decreases in muscle mass , decreases in oxidative metabolism, decreases in muscle protein synthesis and decreases in calcium plasmatic concentration which may compromise the respiratory function and causing muscle fatigue or weakness [1]. The inspiratory muscle performance was investigated in 21 patients with CKD undergoing regular hemodialysis. Following dialysis, Both the inspiratory muscle strength and endurance significantly increased following hemodialysis in most of the subjects suggesting that the hemodialysis-induced changes in biochemical parameters may exert an important effects on inspiratory muscle performance leading to the overall improvement of chest mechanics after the hemodialysis session [14].

In our study,FEV1 and FVC were showed a significant change and increment with increased of the frequency of hemodialysis sessions ($P < 0.05$) while only FEV1 had been showed a significant change and increment with increased length of hemodialysis session ($P < 0.05$).

In patients with CKD, a progressive decline in pulmonary function correlates with declining in GFR and the impairment of spirometric function in patients with renal insufficiency is continual with reduction of GFR [15].The progressive decline in kidney function assessed by GFR suggests some decline in pulmonary function associated with deteriorating kidney function that could explain the significant improvement in FEV1 levels after hemodialysis through improvement in small airways edema associated with CKD [16].

There were inconsistent agreements among literatures regarding the effect of the length and frequency of hemodialysis session on spirometric parameters changes.Several studies which assessed the effect of hemodialysis on the lung have been showed that spirometric parameters and lung volume are less than normal population while other studies have not been shows any significant differences in spirometric parameters between patients after dialysis and in normal population [17] .

Lang SM et al reported no correlation between lung function parameters and interdialytic changes in body weight or duration on hemodialysis while a study conducted in Egypt found that an increment in frequency and duration of dialysis sessions were associated with a significant improvement in FEV1 and FVC after hemodialysis [18,19].

Differences in the type of the study, patients selection, setting of the study, hemodialysis procedure characteristics, size and duration of dialysis could be associated with these contradictory results [5].

CONCLUSIONS

There was a significant increase in FEV1 and FVC levels after hemodialysis for patients with CKD. Increased length and frequency of hemodialysis sessions were associated with a significant increase in FEV1 after hemodialysis.

RECOMMENDATIONS:

1. Hemodialysis, as a mode of renal replacement therapy, has a beneficial effect on respiratory function in patients with CKD.
2. A more frequent hemodialysis and increasing length of the session duration could promote a significant improvement in respiratory function.
3. A further studies with follow ups are required to confirm our findings and establish the chronic effect of hemodialysis on pulmonary function test.

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