Ventilator Function Improvement in Patients Undergoing Regular Hemodialysis: Relation to Sex Differences

Peđa Kovačević[1]*, Amela Matavulj[1], Slavimir Veljković[2], Zvezdana Rajkovača[1], Nenad Ponorac[1], Jasminko Huskić[3]

1. Department of Physiology, Faculty of Medicine, University of Banja Luka, Save Mrkalja 14, 78000 Banja Luka, Bosnia and Herzegovina
2. Institute of Physiology, Faculty of Medicine, University of Niš, Bulevar Dr Zorana Đinđića 81, 18000 Niš, Serbia - Montenegro.
3. Institute of Physiology and Biochemistry, Faculty of Medicine, University of Sarajevo, Čekaluša 90, 71000 Sarajevo, Bosnia and Herzegovina.

* Corresponding author

Abstract

Uremic lung is different entity then oedema present in cardiovascular diseases or in adult respiratory distress syndrome as well. This state is one of the possible complications in patients with chronic renal failure (CRF) receiving regular hemodialysis (HD). There are several studies suggesting that in these patients in 30-40% cases pulmonary hypertension was developed. It is known that patients with primary pulmonary hypertension have peripheral airway obstruction The data also showed that primary as well secondary pulmonary hypertension are more often developed in females; even real reason is still unknown. The aim of the study was to estimate the ventilator function improvement in patients with CRF receiving regular HD related to sex differences. The study population consisted in 39 patients with CRF, with no cardiac and pulmonary diseases. These patients were treated by regular hemodialysis using bicarbonate or acetate mode, respectively. They were divided into two groups according to the sex. Spirometry parameters before and after onset of hemodialysis were recorded. The results were analyzed using Student t-test and presented as mean ±SD. All p values <0,05 were considered significant. The result showed that ventilatory function in male patients is significantly improved, especially VC and FEV1, whereas in female patients improvement had not statistical significance. It can be concluded that one of the possible reasons for slight improvement of ventilator function in female patients is pulmonary hypertension.

KEY WORDS: chronic renal failure, pulmonary dysfunction

Introduction

Cardiovascular complications are major causes of mortality in patients with chronic renal failure (CRF) receiving regular hemodialysis. Many complications on respiratory system have been described in patients with chronic renal failure, while, and much less are known about the haemodialysis effects and other therapeutic procedures on lungs (1, 2). The most frequently described complications on lungs in these patients are: uraemic lung, pulmonary infections, uraemic pleurisy and uraemic calcifications (3, 4). Uraemic lung is a pulmonary oedema that differs from pulmonary oedema of cardiac origin or oedema occurring in acute respiratory distress syndrome in adults (ARDS). As a complication, it appears in chronic renal failure and in patients treated with repeated haemodialysis. In these patients, liquid is accumulated in lung interstice that is removed at time of each haemodialysis (3,5). This hypothesis is proved by determining of water in lungs by means of indocyanine green diluting method and after haemodialysis (6). Symptoms of the uraemic lung are mild in comparison with x-ray finding, and very often are completely absent; therefore, it is called sub-clinical pulmonary oedema. From radiological point of view, uraemic lung is seen as a butterfly-shaped picture with perihylus trunk localisation and radial wings exposition. The reasons for such distribution of the liquid have not been completely known (7).

PATHOPHYSIOLOGY OF UREMIC LUNG

Many authors described uremic lung like accumulation of oedematous liquid in lung. Imbalance between hydrostatic and colloid-osmotic pressure in pulmonary capillaries and interstitial space is major causes in uremic lung (8, 9). Almost 40% of patients undergoing long-term haemodialysis via an arteriovenous access had unexplained pulmonary hypertension (high hydrostatic pressure in pulmonary capillaries). Women had higher incidence of primary and secondary (in CRF) pulmonary hypertension. The reasons for these facts have not been completely known (1, 10, 11). Pulmonary hypertension can take role in pathophysiology of uremic lung. This pathophysiology process can lead to disfunction and obstruction in small airways (12-15) The aim of this study was to determine the potential differences (in improving) ventilatory function related to the sex in patients receiving hemodialysis.

Patients and Methods

The study included 39 patients suffering from end-stage renal failure who were treated with repeated haemodialysis at Centre for Haemodialysis, Clinical Centre of Banja Luka. The mean duration of haemodialysis in all the patients was from 180 to 240 minutes (individual approach), three times a week. The dialysers used were produced by Gambro and Frezenius companies with controlled ultrafiltration, acetate and bicarbonate modul were applied. Haemodialysis was performed on the following dialysers: E4H, F6, F60, F60s. Heparinisation was continuous with 4000-5000 i.u. of heparin per patient. No patients had primary pulmonary disease nor had haemodynamic instability during haemodialysis. Out of the total, 20 of examined patients were female, while 19 were male. The average age was 52 (25 - 75 years of age). The average period of haemodialysis duration in all the patients was 52 months (from 9 – 89 months). During the process of result evaluation, two groups of patients have been established:

1. males patients
2. females patients

All the patients had spirometry (Jaeger) done, both before and after haemodialysis.

The following parameters were determined:

1. Vital capacity (VC)
2. Forced vital capacity (FVC)
3. Forced expiratory volume in the first second (FEV1)

The results were processes by standard statistical method (Student's t-test for small dependent samples, "difference method") and shown as mean ± standard mean error (X ± SX). Significance in difference between the mean in the observed groups before and after haemodialysis was tested, aimed at monitoring changes of pulmonary function parameters. Values with $p < 0,05$ are considered statistically significant.

Results

Figure 1 shows results of vital capacity (VC) measurements. There are vital capacity means (X) measured before (A) and after haemodialysis (B) in male patients (1) and female patients (2). Statistic analysis by means of "difference method" showed that there was a high statistically significant difference ($p<0,05$) between vital capacity values before and after haemodialysis in group 1, while in the group 2, it was determined that

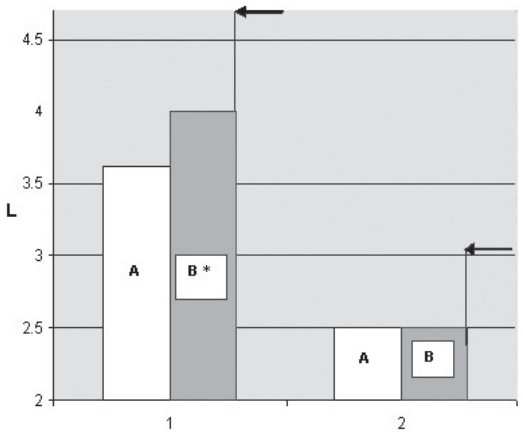

FIGURE 1. Influence of haemodialysis on vital capacity values.
1. males patients
2. females patients
A. vital capacity means before haemodialysis
B. vital capacity means after haemodialysis
← referral vital capacity values (mean value); * p<0,05

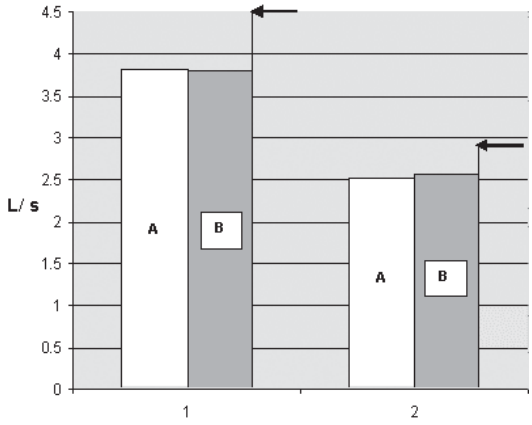

FIGURE 2. Influence of haemodialysis on forced vital capacity values.
1. males patients
2. females patients
A. vital capacity means before haemodialysis
B. vital capacity means after haemodialysis
← referral forced vital capacity values (mean value)

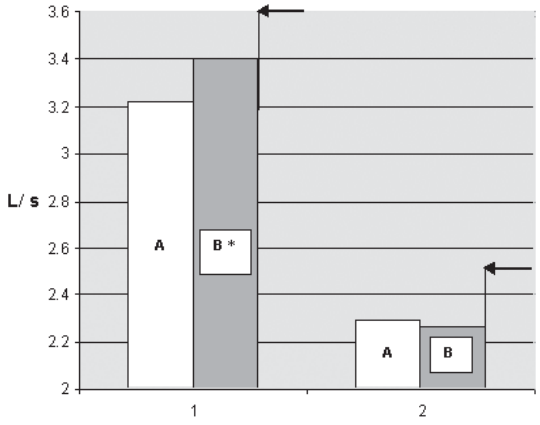

FIGURE 3. Influence of haemodialysis on forced expiratory volume in one second values.
1. males patients
2. females patients
A. forced expiratory volume in one second means before haemodialysis
B. forced expiratory volume in one second means after haemodialysis; * p<0,05
← Referral forced expiratory volume in one second values (mean value)

there was no statistically significant difference (p>0,05) between measuring before and after haemodialysis. Figure 2 shows results of forced vital capacity (FVC) measurements. There are vital capacity means (X) measured before (A) and after haemodialysis (B) in male patients (1) and female patients (2). Statistic analysis by means of "difference method" showed that there were not statistically significant differences (p>0,05) between forced vital capacity before and after haemodialysis in both groups. Figure 3. shows results of forced expiratory volume in one second (FEV1) measurements. There are vital capacity means (X) measured before (A) and after haemodialysis (B) in male patients (1) and female patients (2). Statistic analysis by means of "difference method" showed that there was a high statistically significant difference (p<0,05) between forced expiratory volume in one second values before and after haemodialysis in group 1, while in the group 2, it was determined that there was no statistically significant difference (p>0,05) between measuring before and after haemodialysis.

Discussion

During the research, we observed parameters of ventilating function: vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in the one second (FEV1). Chronic renal failure is a progressive and irreversible impairment of renal function. Such condition disturbs functions of almost all organs and organic systems. The disturbed electrolyte and liquid status, as well as acid-base unbalance are the findings that follow chronic renal failure in its end-stage – uraemia (1, 2). In these patients, liquid is accumulated in all tissues, as well as lung interstice that is removed at time of each haemodialysis. Apart from direct influence of the illness alone on the lungs, therapeutic procedures and haemodialysis, also show their negative effect at respiratory system. Haemodialysis removes the excess liquid and increases ventilation of basal lungs areas, and a positive effect is seen in reducing of airways obstruction. The obtained results are in compliance with the results obtained by other authors that observed the stated parameter (9, 10, 13, 14). VC and FEV1 after haemodialysis, shows a change toward recovery, which is statistically significance (p<0,05) in group with males patients (group 1). These parame-

ters shows tendency for recovery in group patients with females (group 2), but is of no statistical significance (p>0,05). One of the reasons, for such results could be higher incidence of primary and secondary pulmonary hypertension (high hydrostatic pressure in pulmonary capillaries) in female's patients. It is known that patients with primary pulmonary hypertension have peripheral airway obstruction (13, 14). As these patients had no cardiac or pulmonary diseases, we assumed that pulmonary hypertension and peripheral obstruction was related to the CRF and/or tolong-term hemodialysis therapy via arteriovenous access (1, 10). There are several potential explanations for the development of pulmonary hypertension and peripheral airway obstruction patients with CRF. From a physiologic point of view, this may result from increased pulmonary vascular resistance or diminished vasodilatory response to the increased cardiac output. One of the reasons, for such results could be imbalance of levels of vasoactive substances (endothelin-1 and nitric oxide). It is known that women have a higher incidence of primary pulmonary hypertension (1, 10, 14, 15). Whether this observation also applies for pulmonary hypertension and peripheral airway obstruction complicating CRF is to be determined by further studies.

Conclusion

We can conclude that Haemodialysis has a positive effect on ventilating function in patients suffering from CRF (VC, FEV1). This recovery is significant in males patients than in females patients.

References

(1) Amin M., Fawzy A., Hamid M.A., Elhendy A. Pulmonary hypertension in patients with chronic renal failure. Chest 2003;124:2093–2097.

(2) Locatelli F., Bommer J., London G.M., Martin-Malo A., Wanner C., Yaqoob M., Zoccali C. Cardiovascular disease determinants in chronic renal failure: approach and treatment. Nephrol. Dial. Transplant. 2001;16:459–468.

(3) Morris E.P., Bernard R.G. Pulmonary complication of uremia. In: Massary SR (ed)., Textbook of Nephrology. Kluwez.,1994:1364-1367.

(4) Govelli G. Thoracic complication in uraemic patients and patients undergoing dialytic treatment. Eur. Radiol. 1997;7:708-717.

(5) Đorđević V. Changes and complications in some systems - lungs. In: Đorđević V., et al. (ur)., Haemodialysis. Niš: Education-Niš, 1997;213-218.

(6) Wallin C.J., Jacobson S.H., Leksell L.G. Subclinical pulmonary oedema and intermittent haemodialysis. Nephrol. Dial. Transplant. 1996;2269-2275.

(7) Coskun M., Boyvat F., Bozkurt B., Agildere A.M., Niron E.A. Thoracic CT findings in long-term hemodialysis patients. Acta Radiol. 1999;40:181-186.

(8) Duraković Z., Gasparović V., Ivanović D., Gjurasin M. Bubrezna insuficijencija (zatajivanje bubrega). U: Gamulin S., Marušić M., Krvavica S., ur. Patofiziologija. Zagreb: Jugoslovenska medicinska naklada 1988:932-942.

(9) Chen W.B. The uremic lung. Zhonughua Jie He 1989; 12:262-264.

(10) Yigla M., Nakhoul F., Sabag A., Tov N., Gorevich B., Abassi Z., Reisner S.A. Pulmonary hypertension in patiensts with end – stage renal disease. Chest 2003;123:1577-1582.

(11) Galie N., Manes A., Uguccioni L., Serafini F., De Rosa M., Branzi A., Magnani B. Primary pulmonary hypertension: insights into pathogenesis from epidemiology. Chest 1998;114 (3suppl):184s –194s.

(12) Giaid A., Yanagisawa M., Langleben D., Michel R.P., Levy R., Shennib H., Kimura S., Masaki T., Duguid W.P., Stewart D.J. Expression of endothelin – 1 in the lungs of patients with primary pulmonary hypertension. N. Engl. J. Med. 1993;328:1732-1739.

(13) Kovačević P., Matavulj A., Veljković S., Đekić – Čađo M., Rajkovača Z., Ponorac N. Hemodialysis efects on respiratory function. Acta Fac. Med. Naiss 2004;21:119-126.

(14) Meyer F. J., Ewert R., Olschewski H., et al. Peripheral airway obstruction in primary pulmonary hypertension. Thorax 2002;57:473-476.

(15) Stojanović R., Todorović Z., Vučković S., Nešić Z., Prostran M. Azot - monoksid i plućne bolesti. Med. Pregl. 2003; LVI (Suppl 1):13-17.