Journal of
Cardio - Thoracic Medicine

http://jctm.mums.ac.ir

Renal Fractional Excretion of Sodium in Relation to Arterial Blood Gas and Spirometric Parameters in Chronic Obstructive Pulmonary Disease

Fariba Rezaeetalab[1], Abbas Ali Zeraati[2], Sayyed Hosien Mostafania[3]*, Bahareh Basiri[4], Shahrzad M Lari[5]

[1] *Pulmonologist, Chronic Obstructive Pulmonary Disease Research Center, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran*
[2] *Nephrologist, Department of Nephrology , Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran*
[3] *Resident of Internal Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran*
[4] *Resident of Internal Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran*
[5] *Pulmonologist, Cardio-Thoracic Surgery & Transplant Research Center, Emam Reza Hospital, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran*

ARTICLE INFO

Article type:
Original article

Article history:
Received: 24 Feb 2014
Revised: 20 Mar 2014
Accepted: 8 Apr 2014

Keywords:
Arterial Blood Gas
Chronic Obstructive Pulmonary Disease
Fractional Excretion
Hypoxemia
Sodium

ABSTRACT

Introduction: Arterial gas derangement could change urinary sodium excretion in Chronic Obstructive Pulmonary Disease (COPD) patients .There are very few and conflicting data in regards to the measurement of fractional excretion of sodium in COPD patients. The main aim of this study was to assess the relationship between renal fractional excretion of sodium (FeNa) with arterial blood gas and spirometric parameters in COPD.

Materials and Methods: This study was a cross-sectional study performed on 40 consecutive stable COPD outpatients in 2 main general hospitals (Emam Reza, Ghaem) in Mashhad/Iran between 2011 and 2012. We investigated the relationship of renal FeNa with arterial blood gas parameters including HCO_3, PH, $PaCO_2$ and PaO_2, and spirometric parameters. Analysis was done by SPSS v16 with a statistically meaningful p value of less than 0.05.

Results: Mean age was 65.97±10.77 SD years and female to male ratio was 0.26. A renal FeNa of less than 1% was presented in 27% patients. There was a significant, positive relationship between renal FeNa and PaO_2 (P=0.005, r=0.456). The correlations between $PaCO_2$, HCO_3, PH and spirometric parameters were not seen (P>0.05), but there was a significant relationship between Urine Na and PaO_2. Outstanding, it seems likely that kidneys of COPD patients are responsible for sodium retaining state particularly in the presence of hypoxemia.

Conclusion: This study indicates that in COPD patients, PaO_2 but not $PaCO_2$ is related to renal FeNa which shows the probable role of hypoxemia on sodium output in COPD patients. However, some caution is needed for interpretation of the probable role of hypercapnia on sodium retention in COPD.

►*Please cite this paper as:*
Rezaeetalab F, Zeraati AA, Mostafania SH, Basiri B, M Lari SH. Renal Fractional Excretion of Sodium in Relation to Arterial Blood Gas and Spirometric Parameters in Chronic Obstructive Pulmonary Disease. J Cardiothorac Med. 2014;2(2):147-151.

Introduction

Today Chronic Obstructive Pulmonary disease (COPD) is known as a major health problem which is expected to be the third cause of death till 2020 (1). There are increasing evidences that prove we should consider COPD as a systemic disease other than a single pulmonary

**Corresponding author:* Sayyed Hosien Mostafania, Resident of Internal Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. Tel:+985118431252; Fax: +985118431252; Email: mostaFaniah901@mums.ac.ir
© 2014 *mums.ac.ir* All rights reserved.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/3.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Table1. The Mean Spirometric, Gasometric and FeNa in COPD outpatients

Parameters	Value*
Gasometric	
PH	7.40±0.06
PCO2 (mmHg)	47±8
HCO3	31.24±6.95
PO2 (mmHg)	52.29±12.91
Spirometric	
FEV1(%)	44.81±15.15
FEV1/FVC (%)	53.97±10.26
Blood Components	
Sodium	140.07±5.12
Creatinine	1.09±0.27
Urine Components	
Sodium	98.4±29.35
Creatinine	0.59±0.21
FeNa	1.31±0.42

* Mean± SD

one (2). The diagnosis of COPD is based on a typical history of persistent and progressive symptoms on risk factors for COPD and on assessment of physiologic measures of lung function (1-12). The most commonly used test for the evaluation of lung dysfunction is spirometry (10). The severity of the disease is based on spirometric criteria measuring the forced expiratory volume in 1 sec (FEV1) and the ratio of FEV1 to forced vital capacity (FVC) after bronchodilator administration (1). The stage of severity of COPD is determined according to Global initiative for Obstructive Lung Disease (GOLD) guidelines. Therefore, COPD is categorized as mild when FEV1 is ≥80%, moderate when FEV1 is among ≤50–<80%, severe when FEV is ≤30%–50%, and very severe when COPD patients are presented with an FEV1 <30%. Diagnosis also demands FEV1/FVC to be <0.70 (1). A useful feature for confirmation of the diagnosis is that COPD patients' lung functions do not return to normal after bronchodilator administration, in contrast to patients with other breathing disorders. Oxygen-induced natriuresis and diuresis were likely more dependent of changes in the tubular manipulation of sodium. So hypoxemia affects fractional excretion of sodium in kidney (8-10).

There are several studies which demonstrate presence of a decreased renal blood flow in response to hypoxemia but none of them demonstrate the mechanism. Further studies show that correction of hypoxemia with long term oxygen therapy in hypercapneic-hypoxic COPD leads to significant natriuresis and renal function improvement (3). It is hard to say whether mild hypoxemia has an effect on kidneys or not .In other words it is severe hypoxemia which causes renal flow to decrease (4-7). The aim of this study was to assess the relation between renal fractional excretion of sodium and spirometric / arterial blood gas parameters variables.

Materials and Methods

This was a cross-sectional study performed on consecutive 40 stable COPD outpatients in 2 main general hospitals (Emam Reza, Ghaem) in Mashhad/Iran between 2011 and 2012. Inclusion criteria consisted of patients with clinically stable COPD and exclusion criteria included as having another firmly diagnosed pulmonary disease based on history taking, physical examinations, chest radiography; history of renal disease; diuretics consumption or patients with clinically unstable COPD diagnosed by a pulmonologist, serum biochemical profile tests including urea, crea-tinine and sodium were done alongside with gasometry and spirometry. Forced expiratory volume in one second (FEV1), Forced vital capacity (FVC)and forced expiratory volume in one second to forced vital capacity (FEV1/FVC) were obtained three times by an experienced single operator with one spirometry (multifunc-tional Spirometr HI-801; Chest MI Inc, Tokyo, Japan) and maximum measurements were selected. The severity of COPD was evaluated according based on Gold (Global initiative for Chronic Obstructive Lung disease guidelines (1) as following:

Stage 1 (mild): FEV1/FVC<70%, FEV1≥80%
Stage 2 (moderate): FEV1/FVC<70%, 50%≤FEV1<80%
Stage 3 (severe): FEV1/FVC≤70%, 30% <FEV1<50%
Stage 4 (very severe): FEV1/FVC<70%, FEV1<30% or FEV1<%50 with respiratory failure

Renal fractional exertion of sodium calculated by a qualified technician in a single laboratory as below:

U Na * P Creatinine / U Creatinine * P Na

Written informed consent was initially obtained from all patients and the study protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences.

Data Analysis

Findings sort out by descriptive statistical methods including frequency, diagrams and statistical indicators. We used pearson test for normally distributed data to investigate the correlation between sodium excretion fraction and gasometry/spirometry variables. In case of not normal distribution of data, spearman test was used. Analysis was done by SPSS v16 with a statically significant p value of less than 0.05.

Results

The mean age was 65/97±10/77 SD. Female to male (F/M) ratio was 0.26. The mean ±SD of

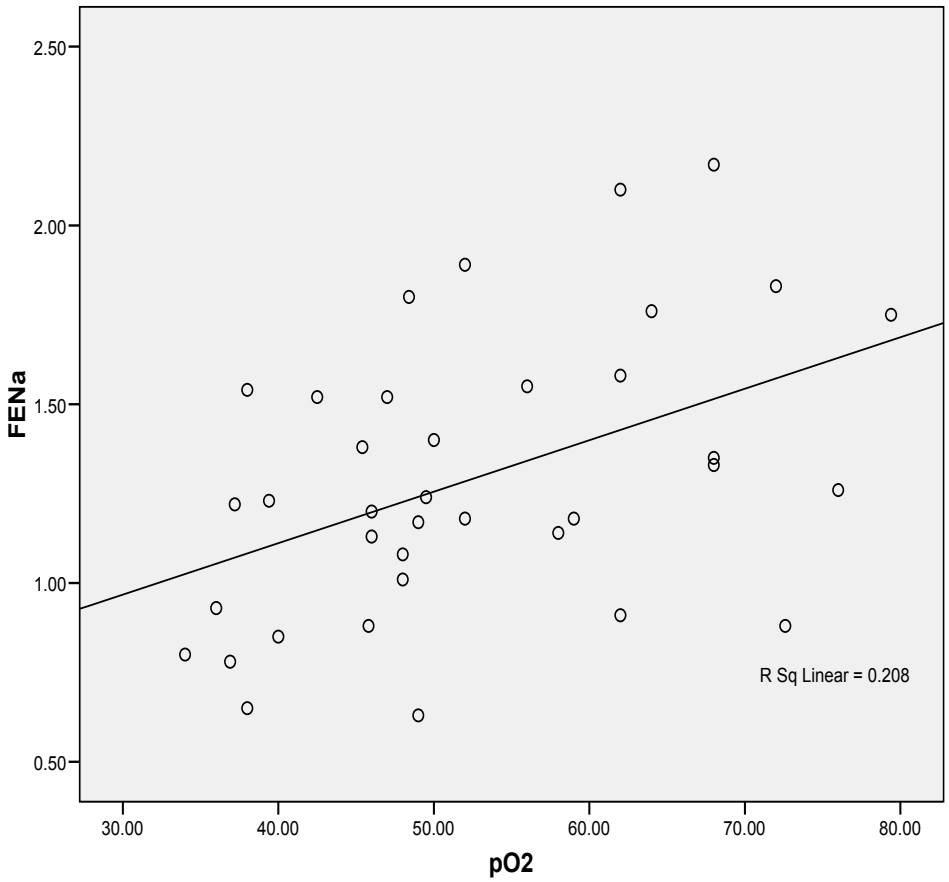

Figure 1. The correlation between FeNa and pao2 (*P*=0.005, r=0.456)

FeNa was 1.31±0.42.Twenty-seven percent of patients were detected with sodium fractional exertion less than %1 .This result was significant (*P*<0.05). In our study, 7 (17.5%) patients were in stage1, 12 (30%) patients in stage 2, 18 (45%) patients in stage 3 and 3 (7.5%) patients in stage 4 of COPD severity. Table 1 illustrates the Mean Spirometric, Gasometric and FeNa in COPD outpatients.

A significant correlation was observed between FeNa and PaO2 (*P*=0.005, r=0.456), but no further relation with PaCO2 (P=0.081), HCO3 (*P*=0.073), pH (*P*=0.086) were found. (Figure 1, 2) while no significant relation was detected amongst FeNa, FVC (*P*=0.068), FEV1 (*P*=0.226), and FEV1/FVC (*P*=0.125).

Discussion

COPD characterized by air flow limitation with incomplete reversible and is a serious problem in public health system (9). This study represented that hypoxemia changes urinary sodium excretion. Changes in renal blood flow followed by creatinine and sodium retention leads to edema (10-14). Hypoxemia with hypercapnia are also responsible for sodium retention in COPD patients (12, 13). Faber *et al* explained not only a dysfunction in sodium and water excretion (which is mostly detectable in stable hypercapneic COPD patients exists) but also the grade of hypercapnia correlated with dysfunction level of sodium excretion (12-13). Although there are few studies which illustrate renal blood flow correlation with FeNa, no single study has been done yet to stand out a probable relation between arterial blood gas parameters variables and renal fractional excretion of sodium .It seems COPD patients suffer from a sodium excretion dysfunction which results in sodium retention (14).

COPD patients have possible problems in sodium excretion (acutely at least) and their kidneys in sodium retention status. This condition is usual when there is a hypercapnia; however, hypoxia may result in mentioned problem too. All the performed studies were done on the basis of renal sodium excretion and almost all of them were established on exacerbated COPD inpatients. Supplemental oxygen therapy may reduce renovascular resistance and improve the flow in normocapneic-hypoxemic patients (8, 9, 15). In the presence of hypercapnia, a progressive fall is expected in renal perfusion and generally a reverse relationship is explained between arterial CO2 pressure and renal blood flow (11, 15).

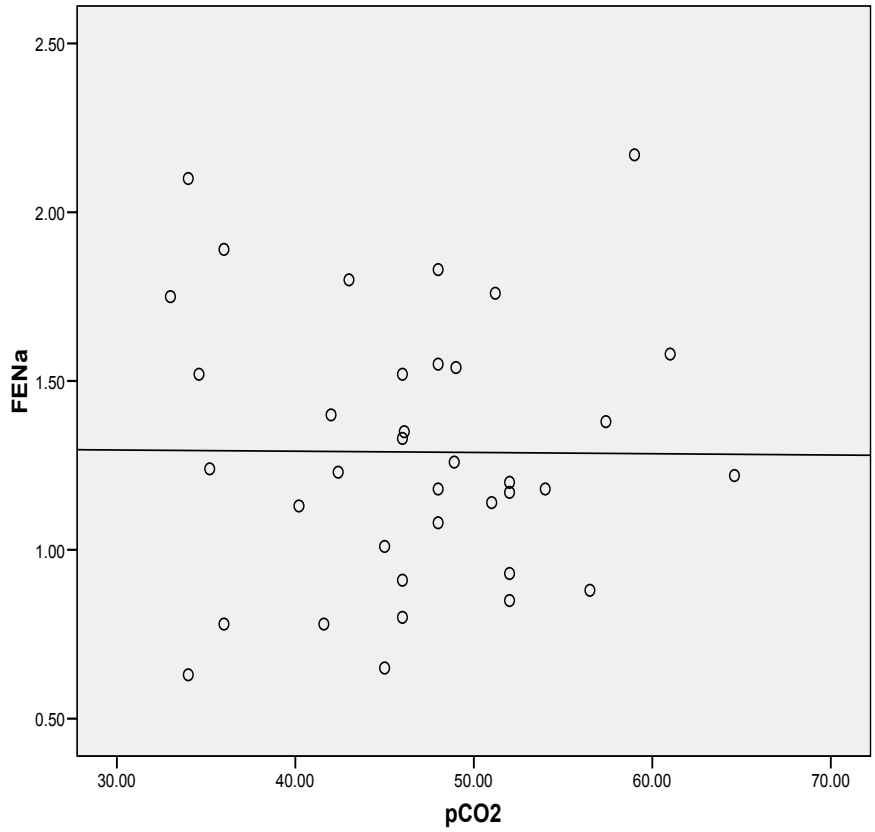

Figure 2. The correlation between FeNa and Paco2 (*P*=0.081, r=0.635)

Our study on the other hand was dependent on sodium fractional excretion and more importantly, obtained data were belonged to out-patients which has possible effects on outcome. This study showed a sodium retention in COPD patients, especially in hypoxemia state, the way our peers explained. But on the contrary of their published, hypercapnia has no role in sodium retention in our obtained results.

Conclusion

This study demonstrated a correlation of PaO2 not PaCO2 with FeNa in COPD patients which shows possible role of hypoxemia in urinal excretion of sodium. Interpretation of hypercapnia effects on sodium retention in COPD patients should be considered cautiously. However our results are in contrast with the fact that hypercapnia contributes to sodium retention in COPD patients.

Our study has some limitations. First, we included only stable COPD. Second, this study was a cross-sectional, that all the biochemical tests provided one time. Third, checking the sodium intake was not done carefully.

Acknowledgement

This study was financially supported by the research Vice Chancellor, Mashhad University of Medical Sciences, Mashhad, Iran. The Code number of this research was 89593.

Conflict of Interest

The authors declare no conflict of interest.

References

1. Global Initiative for Chronic Obstructive Lung disease (GOLD). Global strategy for the diagnosis, management and prevention of COPD. NHLBI/WHO workshop report, Executive summary. 2004; 1-21.
2. Decramer M, Rennard S, Trosters T, Mapel DW, Giardino N, Mannino D. COPD as a lung disease with systemic. Consequences clinical impact, mechanisms, and potential for early intervention. COPD. 2008; 5: 235-56.
3. Mannix ET, Dowdeswell I, Carlone S, Palange P, Aronoff GR, Farber MO. The effect of oxygen on sodium excretion in hypoxemic patients with chronic obstructive lung disease. Chest. 1990; 97: 840-4.
4. De Leeuw PW, Dees A. Fluid homeostasis in chronic obstructive lung disease. Eur Respir J Suppl. 2003; 22:33s-40s.
5. Joaquim G, Esther B, Mauricio OL. Systemic Inflammation in COPD. Clinical Pulmonary Medicine. 2009; 16:233-42.
6. Laghi F, Adiguzel N, Tobin MJ. Endocrinological derangements in COPD. Eur Respir J. 2009; 34: 975-96.

7. Darmon M, Schortgen F, Leon R, Moutereau S, Mayaux J, Di Marco F, et al. Impact of mild hypoxemia on renal function and renal resistive index during mechanical ventilation. Intensive care Med.2009; 35:1031-8.
8. Palange P. Renal and hormonal abnormalities in chronic obstructive pulmonary disease. Thorax. 1998; 53: 989–91.
9. Bratel T, Ljungman S, Runold M, Stenvinkel PS. Renal function in hypoxaemic chronic obstructive pulmonary disease: effects of long-term oxygen treatment. Respir Med. 2003; 97: 308–16.
10. Abraham WT, Schrier RW. Renal sodium excretion, edematous disorders, and diuretic use. Renal and Electrolyte Disorders. 1997; 72:129.
11. Sharkey RA, Mulloy EMT, O'Neill SJ. The acute effects of oxygen and carbon dioxide on renal vascular resistance in patients with acute exacerbation of COPD. Chest. 1999; 115: 1588-92.
12. Farber MO, Roberts LR, Weinberger MH, Robertson GL, Fineberg NS, Manfredi F. Abnormalities of sodium and H2O handling in chronic obstructive lung disease. Arch Intern Med. 1982; 142:1326–30.
13. Farber MO, Weinberger MH, Robertson GL, Fineberg NS, Manfredi F. Hormonal abnormalities affecting sodium and water balance in acute respiratory failure due to chronic obstructive lung disease. Chest. 1984; 85:49–54.
14. Howes TQ, Deane CR, Levin GE, Baudouin SV, Moxham J. The effects of oxygen and dopamine on renal and aortic blood flow in chronic Obstructive Pulmonary disease with Hypoxemia and hypercapnia. Am J Resp Crit. 1995; 151:378-83.
15. Valli G, Fedeli A, Antonucci R, Paoletti P, Palange P. Water and sodium imbalance in COPD patients. Monaldi Arch Chest Dis. 2004; 61:112-6.