THE ROLE OF DIALYSIS MEMBRANES ON INTRADIALYTIC SELENIUM EXCRETION AND SELENIUM STATUS IN CHRONIC HEMODIALYSIS PATIENTS

Makrouhi Sonikian[1], Artemisia Dona[2], Jacob Skarakis[3], Theodora Miha[4], Sophia Trompouki[5], Ioannis Karatzas[6], Chara Spiliopoulou[2]

[1]Nephrology Department, Konstantopoulion General Hospital, Athens, Greece; [2]Forensic Medicine and Toxicology, Medical School, Kapodistriakon University, Athens, Greece; [3]Pathology, Medical School, Kapodistriakon University, Athens, Greece; [4]BIONEPHROS Renal Unit, Athens, Greece; [5]IASO GENERAL Renal Unit, Athens, Greece; [6]Biochemistry Department, Sismanoglion-A. Fleming General Hospital, Athens, Greece

INTRODUCTION

Dialysis membrane has been implicated in selenium deficiency in chronic hemodialysis (HD) patients [1-2].

AIM OF THE STUDY

We investigated selenium excretion through different membranes during dialysis session and the role of intradialytic element loss on selenium status in HD.

SUBJECTS & METHODS

- Forty one patients were studied (table 1).
  - Group A included 19 patients on standard hemodialysis (SHD) with low flux polysulfone membrane
  - Group B included 10 patients on SHD with ethylenvinylalcool (EVAL) membrane
  - Group C 12 patients on hemodiafiltration (HDF) with polyamide/polyarylether sulfone/polyvinylpyrrolidone membrane.
  - A control group D consisted of 16 age and gender-matched healthy subjects.
- SE was measured by atomic absorption spectrophotometry in
  - blood drawn from "arterial lines" of the extracorporeal circuit at the beginning and the end of dialysis session (sSE)
  - effluent solution collected at the beginning, the end and every hour during sessions (dSE).
  - in affluent dialysate, in concentrated dialysate and in replacement solution used for hemodiafiltration.
  - SE mass loss in dialysis fluid was calculated.
- Hematolology and biochemistry parameters were also determined.

Table 1. Patient characteristics

Gender (Male / Female)	27 / 14
Age (years)	67 (25-85)
Time on HD (months)	62 (16-307)
Primary nephropathy	
- chronic glomerulonephritis (n)	12
- chronic interstitial nephritis (n)	4
- polycystic kidney disease (n)	4
- diabetic nephropathy (n)	8
- nephrangiosclerosis (n)	9
- unknown (n)	4
Kt/V	1,4 ± 0,06

RESULTS

Table 2. Serum and effluent solution SE levels in all patients and in patient groups separately

	All patients n=41	Group A (PS) n=19	Group B (EVAL) n=10	Group C (HDF) n=12	Healthy subjects n=16
Pre-dialysis sSE (µg/L)	101,9±43,9[a,d]	95,3±41,7[b]	89,7±43,0[c]	122,0±65,4[e]	129,9±46,2[a,b,c]
Post-dialysis sSE (µg/L)	91,7±27,6[d]	90,3±26,9	81,7±24,5	101,4±30,1[e]	
Effluent dSE (µg/L)	51,5±22,4	47,8±18,6	48±31,2	60,5±20,7	
SE mass in dialysis fluid (µg)	93,9456	71,1±45,8[f] 78,7±56,3[g]	94,952	128,6±71,2[f,g]	

[a,e]: p=0,04 [b,f,g]: p=0,03 [c]: p=0,05 [d]: p=0,05

Table 3. Laboratory parameters in patient groups

Parameter	Group A (PS)	Group B (EVAL)	Group C (HDF)
Age (years)	68 (35-85)	69 (52-81)	65 (25-79)
Time on HD (months)	47 (16-242) [a]	39 (18-259) [b]	142 (28-307) [a,b]
Hematocrit [Ht] (%)	36,7±3,5	35,3±2,1	37,8±2,4
Hemoglobin (g/dl)	11,6±1,3	11,3±0,7	12,1±0,8
Platelets (x 103/µl)	247±104	258,5±80,8	210,5±64,3
Iron (µg/dl)	64,5±26,4	74,9±20,9	87,8±27,2
Potassium (mmol/L)	5,1±0,8	5,4±1,0	4,9±0,6
Sodium (mmol/l)	137,6±3,2	136,8±3,6	136,9±1,8
Calcium (mg/dl)	9,04±0,6	9,1±0,5	9,3±0,6
Phosphate [P] (mg/dl)	3,9±1,2	4,3±0,7	4,1±1,2
Magnesium [Mg] (mg/dl)	2,2±0,4	1,9±0,5 [c]	2,5±0,5 [c]
Glucose (mg/dl)	109,6±58,7	143,4±76 [d]	73,8±19,1 [d]
Urea (mg/dl)	121,8±32,4	123,3±45,8	132,8±20,3
Creatinine [CR] (mg/dl)	6,9±1,8	7,4±2,7	8,1±1,8
ALP (U/L)	221,8±57,6	218,7±45,9	206,2±52,2
AST (U/L)	15,9±6,1	21,6±6,3	15,7±8,6
ALT (U/L)	17,7±7,2	23,3±9,2	15,3±8,2
γGT (UL)	38,3±23,9	38,3±29	29,0±19,3
Protein [Prot] (g/dl)	6,9±0,4	6,9±0,6	7,0±0,4
Albumin [Alb] (g/dl)	3,5±0,3 [e]	3,5±0,3 [f]	3,9±0,2 [e, f]
Cholesterol (mg/dl)	172,6±52,4	187,6±53,8	161,3±32,1
Triglycerides (mg/dl)	154,3±89,1	225,3±113	165,2±122,9
HDL-chol (mg/dl)	44,7±27,2	34,5±6,6	37,4±7,1
LDL-chol (mg/dl)	83,2±34,6	82,4±33,4	72,3±24,01
pH	7,4±0,05	7,4±0,03	7,3±0,1
Bicarbonate (mmol/L)	23,0±2,8	22,4±2,5	22,8±2,1
iPTH (pg/ml)	285,4±231,4	279,7±222,4	206,9±168,4
AFP (ng/ml)	1,7±1,3	1,9±0,9	2,3±1,7
CRP (mg/L)	2,7±1,2	3,1±1,1	2,9±1,3
β_2M (mg/L)	29,2±10,6	24,72±8,5	24,5±2,9

[a]: p=0,007 [b,c]: p=0,01 [d]: p=0,003 [e,f]: p=0,04

Table 4. Significant correlations of pre-dialysis sSE levels and SE mass in effluent dialysate with other parameters

Pre-dialysis sSE			Effluent solution SE mass		
PARAMETER	**Spearman R**	**p**	**PARAMETER**	**Spearman R**	**p**
Ht	0,349	0,03	Time on HD	0,370	0,02
Serum urea	0,354	0,03	Serum Prot	0,360	0,03
Serum CR	0,329	0,04	Serum Mg	0,610	<0,001
Serum Alb	0,300	0,05	Serum P	0,42	0,01
Serum Mg	0,678	<0,001	Serum urea	0,54	<0,001
Serum glucose	-0,380	0,03	Serum CR	0,38	0,02
			pH	-0,35	0,03
			Pre-dialysis sSE	0,40	0,01

❖ In the total of patients, pre-dialysis sSE levels were lower than those in healthy controls and post-dialysis sSE levels were marginally reduced (table 2).

❖ sSE levels decreased significantly at the session end only in HDF and remained unchanged in SHD patients despite hemoconcentration, findings compatible with SE loss during dialysis treatment (table 2).

❖ No SE was detected in concentrated and affluent dialysates and in HDF replacement fluid.

❖ The excreted SE mass into effluent dialysate was greater in HDF compared to SHD patients, with significant difference only between C and A groups and no difference between A and B groups (table 2).

❖ Compared to group A and B patients on SHD, HDF patients were on renal replacement therapy for more time, had higher serum Alb and Mg levels and lower serum glucose levels (table 3).

❖ In the total of patients direct correlations of pre-dialysis sSE levels were found with Ht, serum urea, CR, Alb and Mg levels and a negative correlation with serum glucose levels. Direct correlations of effluent solution SE mass were observed with serum Prot, Mg, P, urea, CR, pre-dialysis sSE and time on HD and negative correlations with pH (table 4).

CONCLUSIONS

A net SE loss in dialysis fluid was found with all three membrane types[1-4]
- directly according to SE measurements and also
- indirectly by unchanged or reduced post-dialysis serum SE levels in spite of hemoconcentration[1].

SE loss during session was
- related with high sSE levels, metabolic acidosis and long time on HD
- was similar in standard HD with polysulfone and EVAL membranes but greater in HDF[3].

Low sSE levels observed in HD patients[1, 5-6] were
- related to diabetes and low values of hematocrit, serum urea, albumin[6-7] and magnesium
- observed only in SHD and not in HDF patients.

It seems that intradialytic SE loss could contribute to SE deficiency only in SHD and strangely not in HDF patients[3-4].

The direct correlations of pre-dialysis sSE levels with indices of general condition/nutrition and the negative correlation with serum glucose levels could reflect the significant role of additional factors on SE status in HD patients, such as a worse nutritional status and diabetes.

Further investigation is needed to show directly the roles of these factors on SE status in HD patients as well as if SE supplementation could be beneficial in selected patient groups[8].

REFERENCES

1. Yavuz O, Bicik Z, Cinar Y,Guney Y, Guler S. The effect of different dialysis membranes on oxidative stress and selenium status. Clin Chem Acta 2004;346:153-160
2. Bogye G, Tompos G, Alfthan G. Selenium depletion in hemodialysis patients treated with polysulfone membranes. Nephron 2000;84:119-123
3. Cross J, Davenport A. Does online HDF lead to reduction in trace elements and vitamins? Hemodial Int 2011;15(4):509-514
4. Prodanchuk M, Makarov O, Pisarev E et al. Disturbances of trace element metabolism in ESRD patients receiving hemodialysis and HDF. Cent European J Urol 2014;66(4):472-476.
5. Fujishima Y, Ohsawa M, Itai K et al. Serum selenium levels in hemodialysis patients are significantly lower than those in healthy controls. Blood Purif 2011; 32(1): 43-47
6. Zachara BA, Koterska D, Manitius J et al. Selenium supplementation on plasma glutathione peroxidase activity in patients with end-stage chronic renal failure. Biol Trace Element Res 2004; 97: 15-30
7. Veighey K, Booth J, Davenport A. Does the choice of phosphate binder affect trace element levels in chronic kidney disease patients treated by regular haemodialysis? Nephrol Dial Transplant. 2011;26(3):1006-1010
8. Salehi M, Sohrabi Z, Ekramzadeh M et al. Selenium supple-mentation improves the nutritional status of hemodialysis patients: a randomized, double-blind, placebo-controlled trial. Nephrol Dial Transplant. 2013;28(3):716-723

DOI: 10.3252/pso.eu.52era.2015