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Thiamine Blood Level and Erythrocyte Transketolase Activity in Continuous Ambulatory Peritoneal Dialysis and Intermittent Peritoneal Dialysis Patients

Zawartość tiaminy we krwi i aktywność transketolazy w erytrocytach u chorych ze schyłkową niewydolnością nerek leczonych ciągłą ambulatoryjną dializą otrzewnową i przerywaną dializą otrzewnową

INTRODUCTION

The survival length of uremic patients depends mostly upon their biological comfort which, in turn, is the result of a positive nutritional balance in the face of an adequate dialysis treatment. This positive balance is bounded predominantly with proteins, particularly albumins. There are, on the other hand, increasing arguments underlining the beneficial impact of the treatment with vitamins of group B on the metabolism of uremics.

Since several years we have been investigating this problem which, we consider, was generally underestimated. As to witamin B_1 (thiamine) we were able to show its concentration in blood and erythrocyte transketolase activity (ETKA) in dialyzed and pre-dialyzed uremics (15, 16, 17, 18).

In this paper we want to present our data concerning thiamine concentration in blood and ETKA derived from patients treated with intermittent peritoneal dialysis (IPD) as well as from those having continuous ambulatory peritoneal dialysis (CAPD). The rationale for this comparison of our data is the well known fact that CAPD patients have better general condition than those on IPD. It is interesting whether this difference reflects the content of blood thiamine and the ETKA.

It is believed that low weight molecular substances (< 500 Daltons) accumulated in plasma of uremics inhibit normal ETKA (1, 4, 9, 11, 13). This is regarded as one of the factors contributing to the development of uremic polyneuropathy.

Transketolase is an essential enzyme in the pentose shunt and in indispensable for the myelin sheath maintenance, Its cofactor is thiamine pyrophosphate, thus thiamine deficiency causes the depression in ETKA (6).

AIM OF STUDY

The purpose of our study was to compare the impact of CAPD versus IPD treatment on thiamine in plasma (PTh) and erythrocytes (RBC Th) as well as ETKA. We were able to differentiate the total and free form of thiamine — TTh and FTh respectively. By this differentiation we wanted to have an insight concerning the binding with phosphates which reflects the activity of thiamine. The results of this comparison were faced with the plasma creatinine (Pcr) and blood urea (Bur) levels. With this study we also wanted to check whether during CAPD more thiamine is removed from the body than with IPD in the same time, resulting in difference of plasma and RBC level of this vitamin. Our further aim was to check the widely discussed relationship of creatinine and urea levels with the general condition of the patients treated with CAPD or IPD.

PATIENTS AND METHODS

General description of persons studied is presented in Table 1. There were no signs of vitamin B_1 deficiency in these patients. They had no dietary restrictions and daily intake of 1.0—1.5 g/kg body weight of protein was recommended to them.

The TTh and FTh level in plasma and RBC was determined using fluorimetric method by Blum and Merkel (3). The TTh comprises FTh and Th bounded with phosphates. After separation of the nonsoluble impurities, the released FTh is oxidized in alkalic solution with potassium hexacyanoferrate into tiochrome, which is then extracted from the aqueous solution using isobutanol. Parallelly, for the separation of Th from the phosphate rest we added takadiastase (10%) to get FTh. The sum of the two fractions of FTh represents TTh.

ETKA was determined in red cells hemolysate using the photocolorimetric method according to Dische (8) and Bruns (7). It is based on the reaction of transferring glycoaldehyde from D-xylulose-5-phosphate on the D-ribose-5-phosphate. This reaction, results in sedoheptulose-7--phosphate, the rate of its generation in a measure of ETKA.

Plasma creatinine (Pcr) and blood urea (Bur) levels were estimated using enzymatic methods. Statistical analysis was performed with Student's *t*-test and the analysis of variance.

RESULTS

Mean plasma total thiamine (PTTh) and plasma free thiamine (PFTh) levels (μMol/l) in CAPD (0.222 ± 0.018, 0.136 ± 0.017) and in IPD patients

Table 1. General description of persons studied, mean $\pm SD$

Persons studied	Number of persons	Age (years)	Diagnosis		Duration of therapy (months)
			GN	PyN	
Normals	20	40.05 $\pm$7.96	—	—	—
CAPD	12	41.54 $\pm$7.45	8	4	13.50 $\pm$2.01
IPD	8	45.43 $\pm$7.21	6	2	17.81 $\pm$3.44

Explanation: GN — *Glomerulonephritis*, PyN — *Pyelonephritis*.

(0.235 $\pm$ 0.048, 0.128 $\pm$ 0.023) were found to be lower than those of normals (0.279 $\pm$ 0.123, 0.156 $\pm$ 0.065). The differences were statistically significant between PTTh in CAPD patients and normals ($p < 0.05$) and between PFTh in IPD patients and normals ($p < 0.05$) — Figure 1.

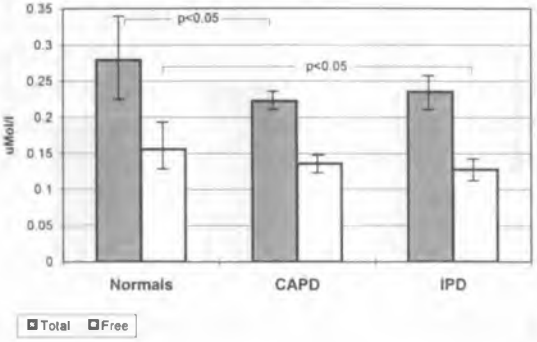

Fig. 1. Total and free thiamine level in plasma; mean $\pm SD$

Mean red blood cells total thiamine (RBC TTh), as well as free thiamine (RBC FTh) levels (0.129 $\pm$ 0.019, 0.085 $\pm$ 0.022 levels (µMol/l) in CAPD patients did not differ significantly from normals (0.139 $\pm$ 0.056, 0.092 $\pm$ 0.042). On the other hand, in IPD patients, mean level of RBC TTh (0.114 $\pm$ 0.017) and RBC FTh level (0.064 $\pm$ 0.017) was found significantly lower ($p < 0.05$) than in normals (Fig. 2).

CAPD and IPD patients had distinctly lower ETKA levels (µMol/dl/ /min). In CAPD (2.04 $\pm$ 0.37) and IPD (1.55 $\pm$ 0.31) patients ETKA was significantly ($p < 0.001$) lower than in normals (2.59). Nevertheless, ETKA in CAPD patients was significantly higher ($p < 0.05$) than that in IPD (Fig. 3).

Mean plasma creatinine levels (Pcr mg/dl) in CAPD (11.75) and in IPD (11.12) patients did not differ significantly contrasting with mean blood urea level (Bur). Mean Bur level (mg/dl) was found lower (145.42) in CAPD than in IPD patients (210.50) and showed statistical difference ($p < 0.001$) — Table 2.

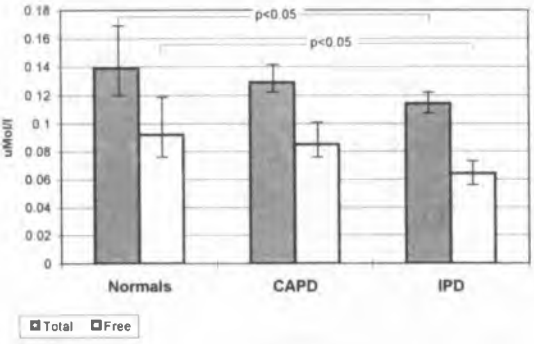

Fig. 2. Total and free thiamine level in RBC; mean $\pm SD$

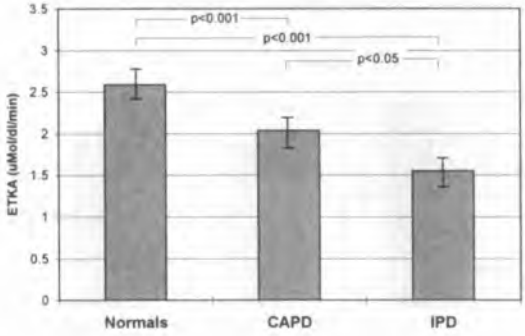

Fig. 3. Erythrocytes transketolase activity; mean $\pm SD$

Table 2. Plasma creatinine (Pcr) and blood urea (Bur). Mean $\pm SD$

Persons studied	Pcr	Bur
	mg/dl	
Normals $n=20$	0.91 $\pm$0.13	34.10 $\pm$3.62
CAPD $n=12$	11.75 $\pm$0.84	145.42** $\pm$45.01
IPD $n=8$	11.12 $\pm$0.80	210.50 $\pm$18.95

DISCUSSION

Peritoneal dialysis — both, IPD and CAPD, leads to increased removal of solutes with molecular weight of 300—5000 Daltons (2). Uremic toxins of such range of molecular weight as well as thiamine (331) are expected to be removed from the body more efficiently with CAPD than with IPD treatment. This is

because CAPD is performed continuously, everyday, whereas IPD every second or third day i. e. 50—60 hrs weekly. Additionally, chronic renal failure *per se* may reduce the serum and tissue levels of thiamine.

The results of some authors indicate that deficiency of thiamine is present in 11—64% of CAPD patients (5). However, there are also reports on normal level of blood thiamine in patients treated either with CAPD or IPD (12, 10).

Looking at our results it turns out, that the total thiamine in plasma of CAPD patients appeared to be lower than that of IPD patients. On the other hand, the free thiamine in plasma of CAPD patients was higher than that in IPD patients. This may explain in this way, that with good detoxification, followed by better food ingestion and subsequent amelioration in general condition of the CAPD patients, they were able to compensate their losses of thiamine. Additionally, improvement of intestinal absorption of thiamine can be also postulated in CAPD patients. However, we have to take into account the above mentioned general improvement of CAPD patients, bounded with the fact, that they are ingesting, among others, also more thiamine. This improved thiamine supply may compensate the greater loss of thiamine with dialysate while on CAPD.

Considering that CAPD patients are losing more thiamine with dialysate than IPD patients did, these differences in plasma total and free thiamine levels should be regarded as supporting the above mentioned speculations. The almost normal levels of RBC TTh and RBC FTh in CAPD patients can be interpreted as the beneficial impact of the factors bounded with this modality of peritoneal dialysis, with concomitant increase in thiamine input to the red blood cells. In contrast, the RBC TTh and RBC FTh in IPD patients being significantly lower than that in normals, should be regarded as the inability of this form of peritoneal dialysis to restore these values to normal range.

ETKA closely corresponded with the values of RBC TTh and RBC FTh confirming the above mentioned arguments, as to the improved ability of thiamine to penetrate the cellular membrane. In this way, we strongly support the view of the other authors (6, 14).

CAPD patients presented higher RBC TTh, RBC FTh and higher ETKA than IPD patients did, corresponding with the inverse relation as to the Bur levels. In contrast, Pcr levels did not differ significantly between CAPD and IPD group of studied patients. High levels of Bur in IPD patients contrasted strikingly with their relatively low Pcr levels and simultaneously — low Bur in CAPD patients. This is just, we want to underline in face of the fairly good condition of CAPD patients.

We feel justified to say, that higher values of RBC TTh and RBC FTh, as well as ETKA in CAPD than in IPD patients, indicate that the first PD modality, has more beneficial effect on the erythrocytes metabolism, than the second one. These findings reflect the metabolic and clinical condition, which is better in CAPD, than in IPD patients.

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STRESZCZENIE

Badano wpływ leczenia CADO i PDO na zawartość tiaminy w osoczu i erytrocytach oraz na aktywność transketolazy w erytrocytach. Uzyskane wyniki porównano ze stężeniem kreatyniny

w osoczu (Pcr) i mocznika we krwi (Bur). Przebadano 12 chorych leczonych CADO i 8 leczonych PDO oraz 20 zdrowych ochotników. Zawartość tiaminy wolnej i całkowitej w osoczu i erytrocytach oceniano przy użyciu metody fluorymetrycznej; aktywność transketolazy w erytrocytach badano metodą fotokolorymetryczną. Stężenia Pcr i Bur były oznaczane przy użyciu metod enzymatycznych.

Średnie stężenie (μMol/l) tiaminy całkowitej (PTTh) i tiaminy wolnej w osoczu (PFTh) chorych leczonych CADO (0,222, 0,136) oraz leczonych PDO (0,235, 0,128) było niższe niż w normie (0,279, 0,156). Średnie stężenie PTTh u chorych leczonych CADO oraz stężenie PFTh u leczonych PDO było statystycznie istotnie niższe ($p<0,05$) niż w normie. Średnie stężenie tiaminy całkowitej (RBC TTh) i tiaminy wolnej w erytrocytach (RBC FTh) (0,129, 0,085) u leczonych CADO nie różniło się statystycznie od wartości u zdrowych (0,139, 0,092). Natomiast u chorych leczonych PDO średnie stężenie RBC TTh oraz RBC FTh (0,114, 0,064) było statystycznie istotnie niższe ($p<0,05$) niż odpowiednie wartości u zdrowych (0,139, 0,092). ETKA (μMol/dl/min) u chorych CADO (2,04) i PDO (1,55) było statystycznie istotnie niższe ($p<0,001$) niż u zdrowych (2,59). Jednak u leczonych CADO średnia wartość ETKA była statystycznie wyższa niż u leczonych PDO ($p<0,05$). Stężenie Pcr (mg/dl) u leczonych CADO (11,75) i u chorych PDO (11, 12) nie różniło się statystycznie istotnie. Stężenie Bur (mg/dl) w grupie leczonych CADO (145,42) było statystycznie istotnie niższe ($p<0,001$) od stężenia Bur u leczonych PDO (210,50). Chorzy leczeni CADO prezentowali wyższe wartości RBC TTh, RBC FTh i ETKA niż leczeni PDO, co pozostawało w odwrotnej relacji do stężenia Bur u tych pacjentów. Natomiast stężenie Pcr nie różniło się statystycznie istotnie pomiędzy grupą CADO i PDO. Wyniki te mogą wskazywać na lepszą kondycję metaboliczną i kliniczną chorych leczonych CADO niż PDO.

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