Short communication

Creatinine, blood urea nitrogen and thyroid hormone levels before and after haemodialysis

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مستويات الكرياتينين ونتروجين يوريا الدم وهرمونات الدرقية قبل الديال الدموي (غسيل الكلى) وبعده

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الخلاصة: أُجريت دراسة على 57 من المرضى بالفشل الكلوي المزمن في مستشفى بمدينة كرمان الإيرانية. وتم أخذ عينات من الدم قبل الديال الدموي وبعده، لقياس مستويات نتروجين يوريا الدم، وكرياتينين المصل، وثلاثي اليودوثيرونين والثيروكسين. وأظهرت النتائج انخفاض مستوى كلٍّ من الثيروكسين في 11 حالة، وثلاثي اليودوثيرونين في 29 حالة، عن المجال الطبيعي، وذلك قبل الديال الدموي. أما بعد إجراء الديال، فكان مستوى الثيروكسين منخفضاً عن المجال الطبيعي في 3 حالات فقط، ومستوى ثلاثي اليودوثيرونين منخفضاً في 15 حالة فقط. وأما سائر الحالات فقد عادت إلى وضعها الطبيعي. ويرى الباحثون أن هناك علاقة ارتجاعية بين مستوى المنتجات التقويضية النهائية الرئيسية (الكرياتينين ونتروجين يوريا الدم) وبين مستوى الهرمون الدرقي في المصل.

ABSTRACT A study was carried out on 57 patients with chronic renal failure in a hospital in Kerman city, Islamic Republic of Iran. Blood samples were taken before and after haemodialysis to measure blood urea nitrogen and serum creatinine, triiodothyronine (T3) and thyroxine (T4) levels. Findings revealed that before dialysis T4 in 11 cases and T3 in 29 cases were lower than the normal range, but after haemodialysis only 3 cases for T4 and 15 cases for T3 were lower than normal levels. The remaining cases reverted to normal state. We suggest that a feedback relationship exists between the major end catabolic products (creatinine and blood urea nitrogen) and thyroid hormone serum levels.

Les taux de créatinine, d'azote uréique sanguin et d'hormones thyroïdiennes avant et après une hémodialyse

RÉSUMÉ Une étude a été réalisée sur 57 patients atteints d'insuffisance rénale chronique dans un hôpital de la ville de Kerman (République islamique d'Iran). On a prélevé des échantillons sanguins avant et après une hémodialyse pour mesurer les taux d'azote uréique sanguin, de créatinine sérique, de triiodothyronine (T3) et de thyroxine (T4). Les résultats ont indiqué que la T4 et la T3 étaient inférieures aux valeurs normales pour 11 cas et 29 cas respectivement avant la dialyse, et que 3 cas pour la T4 et 15 cas pour la T3 seulement avaient des valeurs inférieures à la normale après l'hémodialyse. Les autres cas sont revenus à un état normal. Ceci nous donne à penser qu'une relation de rétroaction existe entre les principaux produits cataboliques finals (créatinine et azote uréique sanguin) et le taux sérique d'hormones thyroïdiennes.

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Introduction

Endocrine abnormalities in patients with chronic renal failure are well documented [*1*]. Previous studies using thyroid function test shows lower thyroid hormone concentrations in haemodialysed patients [*1–6*]. Studies have shown that patients with uraemia may manifest some varie-ties of hormonal abnormality, including decreased serum concentrations of thyroid and gonadal hormones and increased serum levels of growth hormone and prolactin [*5–8*]. Secretion of thyroid hormones and their metabolism in humans are controlled at 2 levels: the hypothalamic–pituitary–thyroid negative feedback axis controls thyroidal secretion, while extra-thyroidal tissues regulate the production of triiodothyronine (T3) and are responsible for thyroid hormone degradation [*5–7*]. The thyroid gland produces thyroxine (T4) but only 20% of the most metabolically active thyroid hormone T3 and 5% to 8% of the calorigenically inactive reverse T3 (RT3) hormone and T4 in tissues such as liver, kidneys and muscles [*8,9*].

Haemodialysis employs the process of diffusion across a semi-permeable membrane to remove excretion products and excess fluids from the blood, while adding desirable components [*2*]. Regular periodic haemodialysis may reverse dynamic thyroid function.

The aim of this study was to compare the serum levels of thyroid hormones T3 and T4 with blood urea nitrogen (BUN) and creatinine serum levels in patients with chronic renal failure, before and after haemodialysis.

Methods

The study took place at Shafa Hospital in Kerman city, Islamic Republic of Iran in February 2002. The initial study group was 67 patients with chronic renal failure who had been receiving weekly haemodialysis for more than 1 year.

A standard form was filled for each patient with age, sex, duration of dialysis, family history and signs of any other disease. Two blood samples was taken from each patient, 1 immediately before and 1 immediately after haemodialysis. The mean time of dialysis was 3 hours.

Standard methods were used to measure serum levels of creatinine, BUN, T3 and T4 by routine biochemical and radioimmunoassay tests (Embee Diagnostics, Delhi). The normal range for T3 levels in our laboratory was 80–200 ng/dL and for T4 levels was 4.5–12.0 µg/dL

This study was planned to have 80% power to detect thyroid hormone serum levels at the 5% significance level. Means and standard deviation (SD) were presented for comparing groups before and after haemodialysis. The data were analysed using *Epi-Info*, version 6. The relationship between creatinine or BUN and thyroid hormone levels was statistically analysed using analysis of variance and Mantel-Haenszel and Fisher Exact tests; the level of significance was $P < 0.05$.

Results

Of the 67 dialysis patients entered in the study, full data were obtained for 57 patients (31 males and 26 females). The mean serum BUN level was 102.8 mg/dL before and 31.4 mg/dL after haemodialysis (Table 1). Mean serum creatinine levels were 11.3 mg/dL and 4.7 mg/dL before and after haemodialysis respectively. Mean serum T3 and T4 hormone levels were 78.0 ng/dL and 6.2 µg/dL before and 102.5 ng/dL and 8.4 µg/dL after haemodialysis respectively.

Our findings showed that before dialysis T4 levels in 11 cases and T3 levels in 29

Table 1 **Relation between blood urea nitrogen (BUN) and serum creatinine, triiodothyronine (T3) and thyroxine (T4) levels in 57 patients with chronic renal failure, before and after haemodialysis**

Variable (normal range)	Before dialysis Mean	SD	After dialysis Mean	SD	Analysis of variance
BUN (10–50 mg/dL)	102.8	49.0	31.4	27.0	$P < 0.05$
Creatinine (0.7–1.4 mg/dL)	11.3	4.2	4.7	2.7	$P < 0.05$
T3 (80–200 ng/dL)	78.0	26.5	102.5	42.0	$P < 0.05$
T4 (4.5–12.0 μg/dL)	6.2	2.1	8.4	2.4	$P < 0.05$

SD = standard deviation.

cases were lower than the normal range (Table 2). After haemodialysis, only 3 cases had T4 lower than the normal range and 15 cases had below normal T3 serum levels. The remaining cases showed reversal of serum levels to normal ranges.

Discussion

The aim of this study was to compare the serum levels of thyroid hormones T3 and T4 with BUN and creatinine levels in patients with chronic renal failure, before and after haemodialysis. Periodic blood dialysis was done in the Shafa Hospital centre by dialysis machine. Uraemia is based on recognition of a constellation of signs and symptoms with or without reduced urine output, but the serum levels of BUN and creatinine are always increased [*7,8*]. Our study showed the mean BUN level before and after haemodialysis was 102.8 mg/dL and 31.4 mg/dL respectively, indicating that our dialysis machines were functioning properly. Injection of urine, urea or other retained toxic metabolites, and nephrectomy, would diminish catabolism and also the basal heat [*6,10*]. Elevation of serum urea nitrogen

Table 2 **Serum levels of thyroxin (T4) and triiodothyronine (T3) in 57 patients with chronic renal failure, before and after dialysis**

Variable (normal range)	Before dialysis No.	After dialysis No.	Mantel–Haenszel test
T4			$\chi^2 = 6.08$, $P = 0.047$
Low (< 4.5 μg/dL)	11	3	
Normal (4.5–12.0 μg/dL)	44	51	
High (> 12.0 μg/dL)	1	3	
Total	56	57	
T3			$\chi^2 = 8.22$, $P = 0.004$
Low (< 80 ng/dL)	29	15	
Normal (80–200 ng/dL)	25	41	
High (> 200 ng/dL)	0	0	
Total	54	56	

and creatinine occurs late in the course of renal failure. Dialysis usually returns body temperature to the normal range [*10*]. In our study, before haemodialysis, T3 and T4 serum levels were 78.0 ng/dL and 6.2 µg/dL, whereas they increased to 102.5 ng/dL and 8.5 µg/dL after haemodialysis, respectively. Increased serum levels of toxic compounds in our dialysis patients caused diminishing serum levels of thyroid hormones following damage to the thyroid gland. Low thyroid secretion can decrease protein catabolism and low BUN stimulates catabolism by secretion of thyroid hormones.

The finding that the sera of patients with uraemia can exert toxic effects in a variety of biologic test systems has motivated a search to identify the responsible toxin. Kokot et al. made a case–control study on the long-term effect of erythropoietin therapy on plasma levels of thyrotropin and thyroxine hormone in haemodialized patients [*1*]. They showed that erythropoietin therapy cannot change plasma concentrations of T3 hormone but is able to induce a significant increase in plasma levels of T4 hormone [*1*]. In our study, 8 out of 11 cases with low T4 hormone serum levels before dialysis had normal T4 levels after haemodialysis, suggesting that haemodialysis activates secretion of thyroid gland and catabolism. Furthermore, 14 out of 29 cases with low serum levels of T3 returned to normal levels after dialysis. A study of 9 haemodialysis patients with iron overload, before and after iron depletion, showed that thyroid abnormalities improved in 8 cases after iron depletion [*11*].

We conclude that haemodialysis may have a positive feedback effect on thyroid gland secretions. The thyroid gland hormones increase catabolic activities resulting an increase in creatinine and BUN levels, which in turn switch off the secretion of thyroid hormones by a feedback mechanism.

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