Moderate magnesium deficiency in patients with hyperthyreosis

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Zusammenfassung

Die Konzentration von Magnesium wurde im Plasma von 20 gesunden Kontrollpersonen und 16 hyperthyreoten Patienten bestimmt (TSH basal 0,11 ± 0,10 µU/ml, Mittelwerte ± Standardabweichung). Die Plasmamagnesiumkonzentrationen wurden mittels Atomabsorptionsspektroskopie gemessen. Das Plasmamagnesium betrug 1,01 ± 0,09 mmol/l bei den Kontrollen und 0,74 ± 0,08 mmo/l bei den Patienten mit Hyperthyreose. In der Gruppe der Patienten mit Hyperthyreose war das Plasmamagnesium leicht, aber signifikant erniedrigt verglichen mit den gesunden Kontrollpersonen ($p < 0,05$). Der Normwertbereich des Magnesiums liegt zwischen 0,8 und 1,2 mmol/l. Der Grund warum die Plasmamagnesiumspiegel bei Hyperthyreose erniedrigt sind bleibt unklar und es ist die Aufgabe weiterer Studien, eine Antwort darauf zu geben. Unsere Annahmen richten sich auf einen Shift zwischen intra- und extrazellulären Magnesiumspeichern, einen Hyperaldosteronismus und auf eine vermehrte Magnesiumexkretion über den Urin bei erhöhtem Herzminutenvolumen im Rahmen der Hyperthyreose.

Summary

The concentration of magnesium was determined in the plasma of 20 healthy control patients and 16 hyperthyreotic patients (TSH basic 0.11 ± 0.10 µU/ml, mean ± SD). Plasma magnesium concentrations were measured by atomic absorption spectroscopy. Plasma magnesium was 1.01 ± 0.09 mmol/l in controls vs. 0.74 ± 0.08 mmol/l in hyperthyreotic patients. In the hyperthyreotic group plasma magnesium was found to be significantly decreased as compared to the control group ($p < 0.05$). The normal range of plasma magnesium is between 0.8 and 1.2 mmol/l. The reason why in hyperthyreotic patients the plasma magnesium levels are decreased remains unclear and should be investigated in further studies. We speculate a shift between extra- and intracellular magnesium stores, aldosteronism and an increased urinary magnesium loss due to an increased minutely cardiac output (e.g. dependent on an increased frequency) in hyperthyreosis.

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Introduction

Disturbances in the magnesium homeostasis are reported in several diseases. The six main clinical situations related to alterated magnesium concentrations are: renal disease, hypertension, preeclampsia, diabetes mellitus, cardiac disease and the administration of therapeutic drugs. In renal disease mostly moderate hypermagnesiemia is seen [1]. Lowered total intracellular and membrane Mg^{++} concentrations were found in patients with primary hypertension [2]. *Laurant* et al. observed an increased blood pressure and vascular morphological alterations (stiffening of the carotid artery) in Mg-deficient rats (dietary Mg deficiency) [3]. In a further study *Kisters* et al. showed a magnesium deficiency in borderline hypertensive patients with hyperlipidaemia and remarked a slight improvement of the values after Mg supplementation [4]. In addition, an intracellular magnesium deficiency was seen in patients with liver disease in chronic alcoholism. The data presented implicate that the magnesium deficiency depends on the degree of liver disease [5]. In recent investigation a disturbed calcium metabolism and a magnesium deficiency were detected in women with preeclampsia [6]. An inadequate renal Mg loss which correlates with the amount of glucosuria is postulated in insulin-dependent diabetes mellitus. Diabetes mellitus with bad metabolic control leads to a Mg deficiency [7]. In a sample of young, nondiabetic black Americans low dietary magnesium is associated with insulin resistance [8]. Hypomagnesemia, probably related to increased urine magnesium excretion, is an essential feature of heart failure associated with complex ventricular arrhythmias. These arrhythmias can be abolished by magnesium supplementation [9]. Torsades-De-Pointes episodes can be due to a magnesium deficiency [10].

Side-effect of diuretics, aminoglycosides, cisplatin, pentamidine and foscarnet are disturbances of the electrolyte homeostasis, specially in form of hypomagnesemia [11, 12].

Furthermore hypomagnesemia is frequently encountered in hospitalized patients and is seen most often in patients admitted to intensive care units [12].

There are many diseases associated with alterated magnesium metabolism but only sparse data exist concerning patients with dysfunction of the thyroid and magnesium status. For these reasons, we were interested in the relation between plasma magnesium levels and hyperthyreosis.

Subjects and methods

Subjects

36 volunteers were examined. 20 of them with normal thyroid function served as controls (C). The remaining

16 volunteers were patients with hyperthyreosis (TSH basic 0.11 ± 0.10 µU/ml). None of the patients had received antihypertensive, cardiovascular or diuretic treatment for the last 6 weeks prior to the study. The cinical data of the patients and controls are shown in Tab. 1. In each patient plasma magnesium was determined.

Methods

The Mg^{++} concentrations in plasma were measured with an atomic absorption spectroscope according to previously described methodology [13, 14]. Statistical analysis was performed using unpaired Student's T-test. P values were two-tailed and a p value < 0.05 was considered as significant.

Results

Plasma magnesium was 1.01 ± 0.09 mmol/l in controls vs. 0.74 ± 0.08 in hyperthyreotic patients. In the hyperthyreotic group plasma magnesium was found to be significantly decreased as compared to the control group ($p < 0.05$). The normal range of plasma magnesium is between 0.8 and 1.2 mmol/l.

Discussion

The results of the presented study show a slight but significant decrease of plasma magnesium concentrations in hyperthyreotic patients as compared to healthy controls. The pathophysiology of this impairment is still unclear. There are several indications that accentuate the role of a disturbed transmembrane magnesium shift. A Na^+/Mg^{++} exchanger has been discussed to be involved in the regulation of intra- and extracellular Mg concentrations in human platelets. Preincubation of platelets with 10 mol/l ouabain effectively decreased the transmembrane Na^+ gradient and led to a Mg^{++} shift from the extracellular space to the intracellular space resulting in increasing intracellular Mg^{++} concentrations [15]. In vascular smooth muscle cells regulation of magnesium transport is Na^+ dependent. An activation of the Na^+/H^+ exchanger is postulated to be responsible for a Mg^{++} transport modulation [16].

Low serum magnesium levels are also related to increased urine magnesium excretion [9]. Supporting this, *Kisters* et al. measured an increased fractional magnesium excretion in patients with magnesium deficiency and insulin-dependent diabetes mellitus [7]. *Roffi* et al. assess that osmotic diuresis and acidosis increase magnesium excretion [17]. A magnesium depletion in hyperinsulinaemic states, such as hypertension, diabetes mellitus and atherosclerosis may be due to a specific increase in the renal excretion of magnesium [18].

It is evident that hyperaldosteronism is associated with magnesium deficiency. *Delva* et al. underline the hypothesis that in primary hyperaldosteronism the magnesium homeostasis is modificated by an alterated activity of the Na^+/Mg^{++} antiporter [19, 20].

The reason why in hyperthyreotic patients the plasma magnesium levels are decreased remains unclear and should be investigated in further studies. We speculate a shift between extra- and intracellular magnesium stores, aldosteronism and an increased urinary magnesium loss due to an increased minutely cardiac output (e.g. dependent on an increased frequency) in hyperthyreosis. Up to now, no measurements concerning intracellular magnesium status in hyperthyreosis exist, and should be done in further investigations to clarify the nature of hypomagnesemia in hyperthyreosis. In our study no severe forms of hypomagnesemia (e.g. < 0.6 mmol Mg^{++}/l) in hyperthyreotic patients were observed, neither clinical symptoms occured in these patients. In conclusion a moderate hypomagnesemia can be accompanied with a hyperthyreosis due to different pathophysiological mechanisms.

Tab. 1: Clincal data of patients and controls. Data are given as means ± SD

	controls	hyperthyreotic patients
	n = 20	n = 16
sex (male/female)	10/10	8/8
age (years)	47.3 ± 6.4	49.3 ± 5.0
serum creatinine (mg/dl)	0.9 ± 0.1	0.8 ± 0.1
TSH basic (µU/ml)	1.8 ± 0.3	0.11 ± 0.10 *
diabetes mellitus	–	–
hyperlipidemia	–	–
blood pressure (mm Hg, syst./diast.)	119 ± 3 / 85 ± 4	122 ± 6 / 87 ± 4
Na+ (mmol/l)	142 ± 3	140 ± 4
K+ (mmol/l)	4.1 ± 0.3	4.2 ± 0.5

* $p < 0.05$

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