تأثير مكملات المغنيزيوم في وظيفة هرمونات الغدة الدرقية

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الملخص:

المغنيزيوم هو عنصر أساسي يعمل كمساعد للعديد من التفاعلات الأنزيمية. يلعب دوراً مهماً في الفسفرة التأكسدية في المتقدرات واصطناع ATP. وهو ضروري لتوازن الإستروجين والقدرة على تقليل الأدرينالين والكورتيزول. كهرمون مهدئ، يساعد المغنيزيوم على تقليل فرط نشاط محور الغدة النخامية – الغدة الكظرية (HPA) وقد يساعد في تحويل هرمون الغدة الدرقية T4 الأقل فعالية إلى هرمون T3 الأكثر فعالية.

تلعب هرمونات الغدة الدرقية دوراً مهماً في تنظيم معدل الاستقلاب الأساسي وتكوين السعرات الحرارية. يعزى التحكم في السعرات الحرارية بواسطة الغدة الدرقية إلى تحسين التمثيل الغذائي للمتقدرات. حيث يؤدي هذا إلى تحفيز عملية التنفس والفسفرة التأكسدية، وبالتالي تأثير المغنيزيوم في تنظيم وظائف هرمون الغدة الدرقية .

وقد لوحظ أن المغنيزيوم يؤثر على عملية إزالة اليود. حيث إن إنزيمات اليودوثيرونين ديودنيز وإنزيمات ديوديناز يودوتيروزين أثناء عملية إزالة اليود تتطلب الفلافين أحادي نيوكليوتيد (FMN) والمغنيزيوم كتميم انزيمي للمساعدة في عملية الاختزال التي تتضمن سلسلة نقل الإلكترون.

تناولت 80 امرأة (تتمتع بصحة جيدة ومتوسط العمر 40–50 سنة) لاكتات المغنيزيوم 470 ملغ / يوم لمدة 90 يوم.

تمت معايرة المعايير الحيوية التالية (T3, T4, , المغيزيوم, الكالسيوم) في عينات الدم لجميع المرضى قبل تناول مكملات المغنيزيوم و مباشرة بعد انتهاء المدة المذكورة.

وقد أظهرت نتائج القياس وجود علاقة موثوقة احصائيا مباشرة بين ارتفاع تركيز المغنيزيوم في الدم و زيادة فعالية هرمونات الغدة الدرقية.
ارتغعت فعالية الهرمون المحفز الغدة الدرقية بدلالة إحصائية بين الحالات التي تناولت مكملات المغنيزيوم (0.44±2.68) مقارنة مع المجموعة نفسها قبل تناول المكملات (0.33±1.85)
ارتفع تركيز المغنيزيوم بين الحالات التي تناولت مكملات المغنيزيوم (0.55±2.4) مقارنة مع المجموعة نفسها قبل تناول المكملات (1.04±1.55) و كانت ذات دلالة إحصائية .
ارتغعت فعالية T4 بين الحالات التي تناولت مكملات المغنيزيوم (0.88±3.98) مقارنة مع المجموعة نفسها قبل تناول المكملات (1.07±2.46 2) وهي ذات دلالة إحصائية .
ارتفعت فعالية T3 بين الحالات التي تناولت مكملات المغنيزيوم (0.04±1.54) مقارنة مع المجموعة نفسها قبل تناول المكملات (0.09±1.02) وكانت ذات دلالة إحصائية .
ارتفع تركيز الكالسيوم بين الحالات التي تناولت مكملات المغنيزيوم (0.72±10.08) مقارنة مع المجموعة نفسها قبل تناول المكملات (0.27±8.84) وكانت ذات دلالة إحصائية .

الكلمات المفتاحية: ثلاثي يودوثيرونين (T3) ورباعي يودوثيرونين (T4) ، تراكيز الهرمون المحفز للغدة الدرقية (TSH) ، الكالسيوم.

"Effect of Magnesium Supplementation on Thyroid Hormone Function"

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Abstract:

Magnesium is an essential macro element that functions as a cofactor for many enzymatic reactions. It plays a critical role in mitochondrial oxidative phosphorylation and ATP synthesis.

Magnesium is necessary for Estrogen balance and ability to reduce Adrenalin and Cortisol; As a calming hormone, magnesium helps to reduce over-reactivity in your Hypothalamic-Pituitary-Adrenal (HPA) axis and may help convert the less active T4 thyroid hormone to the more active T3.

Thyroid hormones play an important role in regulating the basal metabolic rate and calorigenesis. The calorigenic control by the thyroid gland is attributed to enhanced mitochondrial metabolism. This causes stimulation of mitochondrial respiration and oxidative phosphorylation, thereby influencing the magnesium to regulate the thyroid hormone functions.

Mg has been noted to influence the deiodination process. During the deiodination process, the iodothyronine deiodinase and the iodotyrosine deiodinase enzymes require Flavin mononucleotide

(FMN) as a coenzyme and Mg to help the reduction process involving electron transport chain.
80 healthy women, average age 40-50 years have taken Magnesium Lactate 470 mg/day for 90 days.
The activities of the were statistically significant raised among the cases after supplementation of Magnesium lactate 2.68±0.44 and 1.85±0.33 in the group before supplementation.
among the cases after supplementation (2.41±0.55) and the group before supplementation (1.55±1.04) were statistically significant.
The activities of the T4 among the cases after supplementation (3.98±0.88) and the group before supplementation (2.46±1.07) were statistically significant.
The activities of the T3 among the cases after supplementation of Mg were (1.54±0.41) and before supplementation (1.01±0.09) were statistically significant .
The concentration of the Ca among the cases after supplementation of Mg were (10.08±0,72) and before supplementation (8.84±0.27) were statistically significant .

Key words: Magnesium; tri-iodothyronine(T_3) and tetra-iodothyronine(T_4), thyroid stimulating hormone concentrations (TSH), , calcium.

1. introduction:

Magnesium is the fourth most abundant essential mineral in the human body after sodium, potassium, and calcium, and is a cofactor for more than 300 enzymes that regulate a variety of biochemical processes, such as DNA/RNA synthesis, protein synthesis, oxidative phosphorylation, and glycolysis [1,2]. Magnesium is mainly absorbed through the diet, and high-magnesium foods include nuts, seeds, whole grains, and leafy greens. Epidemiological surveys show that C deficiency exists in many regions worldwide [3].

Thyroid hormones play an important role in regulating the basal metabolic rate and calorigenesis. The calorigenic control by the thyroid gland is attributed to enhanced mitochondrial metabolism [4]. This causes stimulation of mitochondrial respiration and oxidative phosphorylation, thereby influencing the (Mg) to regulate the thyroid hormone functions. Mg is a mineral involved in energy-dependent reactions or ATP (adenosine triphosphate) generating reactions. Because of this, Mg is directly or indirectly involved in the regulation of more than 300 enzymatic reactions. The role of Mg in thyroid hormone synthesis could be indirect, i.e., it acts at the iodide uptake step and the deiodination step during the thyroid hormone synthesis [4].

Trace elements, such as iodine and selenium, are closely related to autoimmune thyroiditis and thyroid function. Low serum Mg is associated with several chronic diseases; however, its associations with autoimmune thyroiditis and thyroid function are unclear [5].

Mg in the human body is mostly located in the cells and bone tissues; only 1% of total body Mg is located in extracellular fluids, and only 0.3% of total body Mg is present in serum [2]. However,

the detection of intracellular Mg ions is difficult, while the detection of serum Mg ions is simple and convenient [2,3]. Hypermagnesaemia and Mg poisoning are rare in clinical practice, and only occur in patients with severe renal failure. [4,5].

Calcium and vitamin D are vital for strong bones, but they need Mg to be metabolized properly. Mg also helps with the mineralization of bones and reducing bone loss, so a lack of magnesium can be bad for bone health [6,7].

Mg helps to convert an amino acid called tryptophan into the important mood-boosting hormone, serotonin. Serotonin also makes melatonin, which is needed for good quality sleep. Mg also helps regulate calcium ion flow in calcium channels in the brain. So when it is deficient, neuronal issues may reduce brain function and trigger depression [7,8].

Mg is so helpful for lowering blood sugar that some experts call it 'natural metformin' – in reference to the drug used to stabilize blood sugars in people with diabetes Type 2 [8].

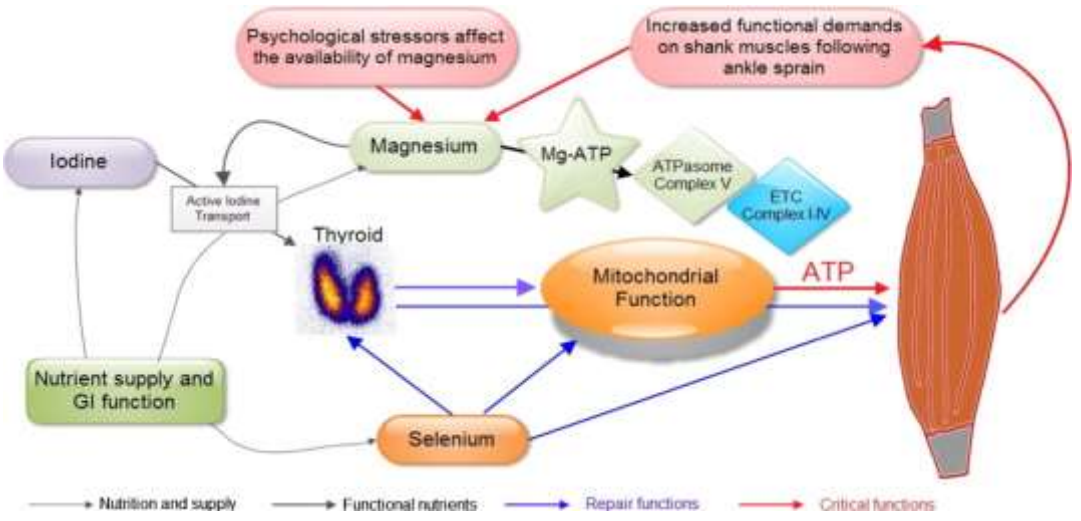

Figure 1. The rule of Magnesium on Iodine transport [6].

Magnesium and calcium metabolism are closely related. The intestinal absorption and the renal excretion of the two ions are interdependent [7]. The most frequent causes of hypomagnesemia in children are reduced intake, impaired intestinal absorption, renal loss and genetic diseases. Hypomagnesemia is reflected clinically in the nervous system, and there are neurophysiological and metabolic changes [7]. In vitro studies have demonstrated that Mg can modulate parathyroid hormone (PTH) secretion in a similar way to calcium. An acute decrease in Mg concentration stimulates PTH secretion, and an acute increase in concentration decreases secretion [7,8,9]. Mg is likely to play an important role in vitamin D metabolism. Some patients with hypocalcemia and magnesium deficiency are resistant to pharmacological doses of vitamin D or may have a form of magnesium-dependent vitamin D-resistant rickets [7,10,11].

Mg is involved in many of the biochemical reactions that take place in the cell, and particularly in processes involving the formation and utilization of ATP. Thus, at the cellular level, Mg plays a key role in ionic transport processes [7,8,12].

The activities of Mg may, therefore, appear significant in the normal functioning of various hormones that include the thyroid hormones, the sex hormones (estrogen, progesterone), the stress hormone/steroid hormone (cortisol), and the neurobiological hormones (HPA-axis hormones) [8]. Also, the Mg acts as a co-factor for various energy-dependent reactions, functions as a detoxicant by carrying out the conjugation of estrogen, participates in tryptophan metabolism that generates serotonin, and melatonin, and helps in the synthesis of GABA, the inhibitory neurotransmitter of the human brain [8]. A schematic representation of the role of Mg in different human biological activities is shown in Figure2 [8].

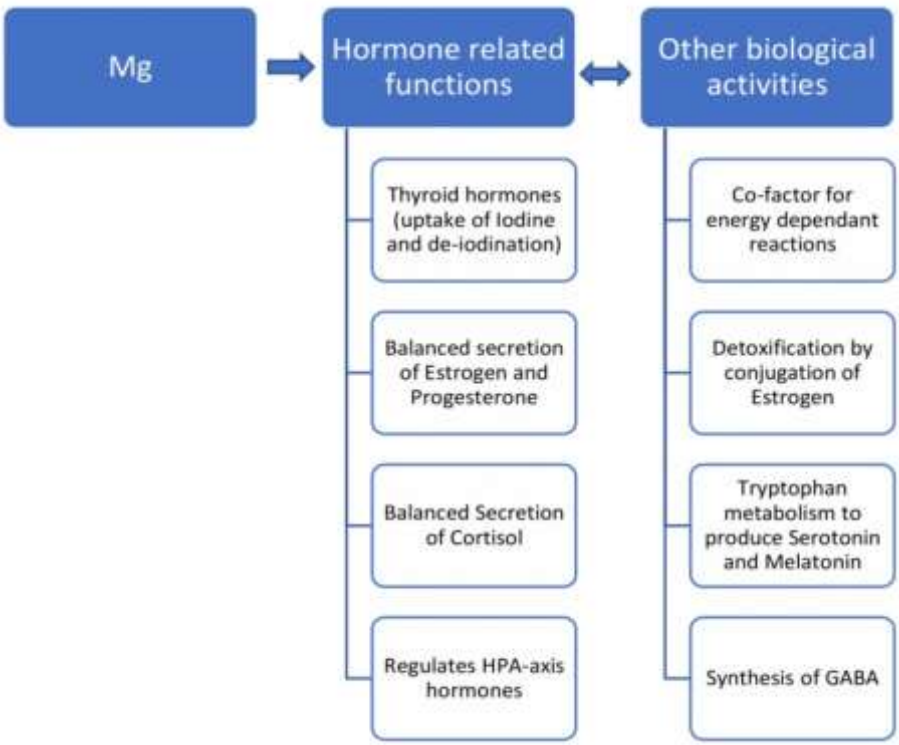

Figure 2 :The schematic representation of the role of Mg in different human biological activities

Mg- Magnesium; HPA-axis, hypothalamic pituitary adrenal-axis; GABA, gamma-aminobutyric acid

Mg is involved in energy production and plays a role in exercise performance. One study aimed to explore the effects of Mg on the dynamic changes in glucose and lactate levels in the muscle, blood and brain of exercising rats using a combination of auto-blood sampling and microdialysis [13]. The results indicated that Mg enhanced glucose availability in the peripheral and central systems, and increased lactate clearance in the muscle during exercise [13].

The purpose of this investigation was to assess the effects of Magnesium supplementation on plasma total triiodothyronine (T_3) and thyroxine (T_4), serum free T_3 and T_4, thyroid-stimulating hormone concentrations, plasma fasting glucose and calcium.

2. Methods and Materials:

2.1. Subjects: We investigated the relationships between low serum magnesium and thyroid functions in 80 Syrian participants.

Our study includes 80 healthy women, average age 40-50 years.

They have taken Magnesium Lactate 470 mg/day for 90 days.

Human ethics: Academic Research Committee confirm requirement that: takes magnesium is into account the legal and ethical conditions and the safety of the patients.

2.2. Laboratory Measurements:

The parameters were measured using standard methods in the routine laboratory at Al-Hawash Private University- in (Farzat Ayoub Hospital) Homs/ Syria, before taking Mg and as soon as they finished program.

2.3. Statistical analysis: Value are reported as mean ±SD. Comparison between results before and after program were made by Student،s-test. Calculations were performed using a standard statistical package.

3. Results:

were statistically significant raised among the cases after supplementation of magnesium lactate 2.68±0.44 and 1.85±0.33 in the group before supplementation. among the cases after supplementation (2.41±0.55) and the group before supplementation

(1.55±1.04) were statistically significant.The activities of the T4 among the cases after supplementation (3.98±0.88) and the group before supplementation (2.46±1.07) were statistically significant.

The activities of the T3 among the cases after supplementation of Mg were (1.54±0.41) and before supplementation (1.01±0.09) were statistically significant.

The concentration of the Ca among the cases after supplementation of Mg were (10.08±0,72) and before supplementation (8.84±0.27) were statistically significant .

The activities of thyroid hormones, thyroxine stimulating hormone and magnesium after taking magnesium lactate for three months are shown in Table *1*.

Table 1: The serum activities of Magnesium and the thyroid hormones among the cases and the control group after three months of taking magnesium lactate (470 mg/day).

Parameter	**Cases (n = 80) Before taking Mg**	**Controls (n = 80) After taking Mg**	**p-value**
Mg Normal Value: 1.5-2.3 (mg/dL)	1.55±1.04	2.41±0.55	<0.05*
TSH Normal Value: 0.6-4.5 (µIU/L)	1.85±0.33	2.68±0.44	<0.05*
T4 Normal Value: 4.6-12.0 (µg/dL)	2.46±1.07	3.98±0.88	<0.05*

T3 Normal Value: 0.6-1.52 (ng/mL)	1.01±0.09	1.54±0.41	<0.05*
Ca Normal Value: 10 (mg/ dl)	8.84±0.27	10.08±0,72	

TSH, thyroid-stimulating hormone; T_3, tri-iodothyronine; T_4: tetra-iodothyronine; Mg, magnesium; *: statistically significant.

4. Discussion and Conclusion:

Women have been noted to suffer from thyroid dysfunction at various stages of their lives. The incidences of thyroid dysfunctions were also associated with age and menopause, as noted by increased incidences of thyroid dysfunction in post-menopausal women [8].

Mg is a mineral involved in energy-dependent reactions or ATP (adenosine triphosphate) generating reactions. Because of this, Mg is directly or indirectly involved in the regulation of more than 300 enzymatic reactions. The role of Mg in thyroid hormone synthesis could be indirect, i.e., it acts at the iodide uptake step and the deiodination step during the thyroid hormone synthesis [8,9].

Among the basic elements, the dietary iodine is involved in the synthesis of thyroid hormone. The dietary iodide is oxidized at or near the thyroid gland membrane into more reactive iodine, the free radical of iodine ($l^{-\cdot}$). Later the $l^{-\cdot}$ binds to the tyrosine molecules and then to thyroglobulin (thyroid protein) to form monoiodothyronine with the help of the thyroperoxidase enzyme. This process also involves sodium-iodide symporter, which in turn requires energy derived from the hydrolysis of ATP, thereby involving Mg, an essential cofactor for ATP generation [8,9].

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