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Ambulatory arterial blood pressure monitoring in patients before and after thyroidectomy

Ambulantni monitoring arterijskog krvnog pritiska kod bolesnika pre i posle tireoidektomije

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Abstract

Bacground/Aim. Increased values of thyroid hormones in the clinical syndrome of hyperthyreosis affect blood pressure values and its circadial variation. The aim of this study was to define the influence of hyperthyreosis on the values and circadial variations of arterial blood pressure, as well as to investigate the effect of thyroid surgery on blood pressure values. **Methods.** We compared the 24-hour averages of systolic and diastolic blood pressure, their variations and their reduction during the night between 20 female patients with hyperthyroidism and hypertension *de novo* and 20 healthy females. We compared the values of 24-hour ambulatory monitoring performed before the surgery with the values gathered two weeks after the surgery. **Results.** The 24-hour average systolic and diastolic blood pressure values were higher in the patients with hyperthyroidism than in the control group ($p < 0.001$). In the group of patients, the variations in blood pressure were significantly higher than they were in the group of healthy people ($p < 0.001$). The amplitude of the nocturnal reduction of blood pressure was also significantly lower in the patients with hyperthyroid status and hypertension, in comparison to the healthy persons ($p < 0.001$). Two weeks after the surgery, a significant reduction of blood pressure values (both for systolic and diastolic) appeared. **Conclusion.** The patients with hyperthyroidism-caused hypertension had higher systolic and diastolic blood pressure, higher variations in blood pressure and lower nocturnal reduction of blood pressure than healthy subjects. Thyroid surgery, as a control of thyroid function, optimised blood pressure very rapidly.

Key words:
hyperthyroidism; hypertension; thyroidectomy; treatment outcome.

Apstrakt

Uvod/Cilj. Povećane vrednosti hormona tiroidne žlezde u sklopu hipertireoze imaju uticaj na regulaciju vrednosti i cirkadijalne varijacije arterijskog krvnog pritiska. Cilj rada bio je da se utvrdi uticaj kliničkog sindroma hipertireoze na vrednosti i cirkadijalne varijacije arterijskog krvnog pritiska. Pored toga, ispitivan je efekat kontrole tireoidne funkcije, koja je ostvarena tireoidektomijom, na vrednosti arterijskog krvnog pritiska. **Metode.** Vršeno je upoređivanje prosečne 24-časovne vrednosti sistolnog i dijastolnog pritiska, odstupanja od njih i redukcija njihovih vrednosti u noćnom periodu između grupe od 20 bolesnica sa hipertireozom i novootkrivenom hipertenzijom i 20 zdravih ispitanica. Kod obolelih od hipertireoze i arterijske hipertenzije navedeni parametri dobijeni 24-časovnim ambulantnim monitoringom upoređivani su pre i dve nedelje nakon tireoidektomije. **Rezultati.** Srednje 24-časovne vrednosti sistolnog i dijastolnog pritiska bile su veće u grupi bolesnica sa hipertireozom u odnosu na kontrolnu grupu zdravih ($p < 0,001$). U grupi obolelih postojale su značajnije oscilacije u vrednostima sistolnog i dijastolnog pritiska u odnosu na one nađene u kontrolnoj grupi ($p < 0,001$). Amplituda noćnog pada sistolnog i dijastolnog pritiska bila je značajno niža kod bolesnica sa hipertireozom i hipertenzijom u odnosu na zdrave ispitanice ($p < 0,001$). Dve nedelje nakon tireoidektomije došlo je do značajne redukcije vrednosti sistolnog i dijastolnog pritiska ($p < 0,001$). **Zaključak.** Kod bolesnica sa hipertenzijom koja je bila indukovana hipertireozom postojalo je povećanje vrednosti sistolnog i dijastolnog pritiska, povećaje varijacija arterijskog krvnog pritiska i redukcija pada vrednosti arterijskog pritiska tokom noći u odnosu na zdrave osobe, a kontrola tireoidne funkcije tireoidektomijom dovela je do brze normalizacije vrednosti arterijskog pritiska.

Ključne reči:
hipertireoidizam; hipertenzija; tireoidektomija; lečenje, ishod.

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Introduction

Increased values of thyroid hormones, which are the cause of the clinical syndrome of hyperthyreosis, cause the decrease of systemic vascular resistance, increasing the heart rate, myocardial contractility and blood volume [1, 2]. Systemic vascular resistance is reducted as a result of the direct vasodilatative effects of triiodothyronine. An increase in heart frequency is caused by hyprsensitivity to catecholamines (with their normal or lower values). Increasing myocardial contractility is caused by changes in the expression of contractile proteins and Ca^{++}-regulator proteins under the effect of the thyroid hormones [2]. The higher blood volume is a result of reduced systemic vascular resistance and effective arterial filling, which is a consequence of releasing the renin and the synthesis of angiotensin and aldosterone [1, 2]. The results of these changes are increased in cardiac output from 50–300% [2]. In some patients, these haemodynamic changes could have an effect on blood pressure values.

The aim of this study was to investigate the influence of hyperthyroidism on blood pressure values and circadial variation. We compared medical records from 24-hour ambulance monitoring of the blood pressure in patients with hyperthyroidism and hypertension *de novo*, and in the control group consisting of healthy people. We tried to examine the effect of thyroid function control on the blood pressure regulation achieved by thyroid surgery.

Methods

We retrospectively analyzed two groups of patients. The first group consisted of 20 female patients with the clinical syndrome of hyperthyreosis and hypertension *de novo*. Diagnosis of the clinical syndrome of hyperthyreosis is based on clinical examinations and the serum levels of T3, T4, TSH and TSH antibodies. We used scintigraphy for the diagnosis of multinode goiter. Graves disease was found in 12 female patients and Plummer disease in 8 of them.

None of the patients recieved information about hypertension before their hyperthyreoid status. In examination, female patients were included when 24-hour average blood pressure values were higher than 135/85 mmHg, which was approximaly equal to the values of 140/90 mmHg from conventional measuring [3]. Considering that it was the first grade hypertension, there was no need for drug treatment.

The patients with other rhythm disorders, except these with sinus rhythm tachycardia, heart and kidney failure and acute inflammatory diseases were not included in the examination.

The second, control group, was composed of 20 female subjects with optimal health conditions, with normal functions of the thyroid gland and normal blood pressure values.

The average age of the female patients was 58±9 years and 59±10 years in the control group.

For the patients of the first group, 24-hour blood pressure monitoring was done before and two weeks after the surgery.

Blood pressure monitoring was performed in the dispensary with the Bosch & Sohn (BOSO) model TM 2430 PC from 2005. Determination of blood pressure was performed using the oscillometric method in the range of 40–280 mmHg, with a calculated error of ±3 mmHg.

The 24-hour period was divided into day (6 a.m. – 10 p.m.) and night (10 p.m. – 6 a.m.). Monitoring was performed at 30-minute intervals during the day and 60-minute intervals during the night. We analyzed the values and calculated the averages of systolic and diastolic blood pressure during the 24-hour period and the level of digression. Reduction of blood pressure values during the night was viewed as a percent of the day values decreasing.

Descriptive statistics and Student's *t*-test were used for data analyses.

Results

The average 24-hour systolic pressure values were statistically significantly higher in the patients with hyperthyroidism than in the control group (146.0±5.9 mmHg vs. 118.3±3.9 mmHg, $p < 0.001$) (Table 1). The same was true for the average 24-hour diastolic pressure values (79.28±5.03 vs. 66.5±3.6, $p < 0.001$), which were statistically significantly higher in the patients with hyperthyroidism, too (Table 1).

Table 1

The 24-hour average values of systolic and diastolic blood pressure, blood pressure value variations and blood pressure decrease during the night in patients with hyperthyroidism and in euthyroid subjects

Parameters	Euthyroid subjects (n = 20)	Patients with hyperthyroidism (n = 20)
24-hours average blood pressure (mmHg)		
Systolic pressure	118.3±3.9	146.0±5.9*
Diastolic pressure	66.5±3.6	79.28±5.03*
Blood pressure value variations (mmHg)		
Systolic pressure	12.8±2.8	20.3±3.9*
Diastolic pressure	7.7±1.2	13.2±3.2*
Blood pressure decreasing during the night (%)		
Systolic pressure	19.8±2.4	11.1±3.5*
Diastolic pressure	13.1±3.9	7.8±3.7*

*$p < 0.001$ *vs* euthyroid subjects

The variations in systolic and diastolic blood pressure were statistically significantly higher in the hyperthyroidism patients compared with the subjects from the control group (20.3±3.9 vs. 12.8±2.8 mmHg for systolic pressure, $p < 0.001$ and 13.18±3.2 vs. 7.72±1.2 mmHg for diastolic pressure $p < 0.001$) .

The amplitude of the nocturnal fall in blood pressure was less in the patients with hyperthyroid status than in the subjects from the control group (11.1% vs. 19.85 %, $p < 0.001$ for systolic pressure, and 7.8% vs. 13.1%, $p < 0.001$ for diastolic pressure).

After the surgery, our patients experienced significant blood pressure reduction, both for systolic blood pressure (from 146±5.9 to 131±3.8 mmHg, $p < 0.001$), diastolic blood pressure (from 79.3±5.0 to 75.8±4.9 mmHg, $p < 0.001$) and the variations in the blood pressure values – systolic pressure oscillations decreased from 20.3±3.9 to 14.4±2.6 mmHg ($p < 0.001$) and for diastolic from 13.3±3.2 mmHg to 10.6±2.0 mmHg ($p < 0.001$).

After the surgery, the mean nocturnal fall of systolic pressure significantly increased (from 11±3.5 mmHg to 15.4±5.1 mmHg) as did diastolic blood pressure (from 7.8±3.7 mmHg to 11.9±3.5 mmHg) as can be seen in Table 2.

Kuchel et al. suggested that hypertension is caused by increased cardiac output [6]. Increase in cardiac output is thought to result from the hypersensitivity of cardiac beta-adrenergic receptors. One of the links in the mechanism strings leading to increased blood pressure values is the direct vasodilatative effect of T3 on arteriolas. This results in a reduction of systemic vascular resistance. The decline in systemic vascular resistance stimulates renin release and sodium reabsorption, resulting in an expansion of blood volume [7]. The role of angiotensin II is not important in increasing blood pressure values [8].

It is common for hyperthyreosis increase activity of nitric oxide (NO) synthase and production of NO which has a protective role for increasing blood pressure. Conversely, decreased production of NO leads to an increased *pro* hypertension effect of the thyroid hormones [9].

The results of the increased level of atrial natriuretic peptides (ANP), brain natriuretic peptides (BNP), vasopressin, endothelin 1 and vasodilatative peptide adrenomeduline in patients with hypertension induced by hyperthyreosis, confirm the role of the activity of system renin-angiontensin-aldosterone in its creation in different ways [4].

The increase of blood pressure in patients with hyperthyroidism is related to the lack of adaptation of peripheral vessels to the profoundly enhanced cardiac output [4].

Table 2

Differences in the average values of systolic and diastolic blood pressure, oscillations in the values of systolic and diastolic blood pressure and the amplitude of decreasing values during the night before and after thyroidetomy

Parameters	Before thyroid surgery (n=20)	After thyroid surgery (n=20)
24-Hours average blood pressure (mmHg)		
Systolic pressure	146.0±5.9	131±3.8*
Diastolic pressure	79.28±5.03	75.8±4.9*
Blood pressure values variations (mmHg)		
Systolic pressure	20.3±3.9	14.4±2.6*
Diastolic pressure	13.2±3.2	10.6±2.0*
Blood pressure decreasing during the night (%)		
Systolic pressure	11.1±3.5	15.4±5.1*
Diastolic pressure	7.8±3.7	11.9±3.5*

*$p < 0.001$ *vs* before thyroid surgery

Discussion

The prevalence of arterial hypertension in patients suffering from hyperthyreosis is not minor. It could be found in as much as 20–30% of patients [4]. In 1931, a study of 458 hyperthyroid patients observed a prevalence of 26% based on systolic blood pressure being higher than 150 mmHg [5].

It is hard to determine the true frequency of arterial hypertension in patients suffering from hyperthyreosis today, due to the significantly increasing of number of patients with arterial hypertension and the heavier exclusion of other causes of hypertension. It is one of the reasons why we included a smaller group of patients in this research.

It is assumed that blood pressure is regulated in patients with hyperthyroidism using several different mechanisms.

A number of examinations have been dedicated to examining the influence of hyperthyreosis on blood pressure values. Most of them were dedicated to the examination of the connection between hyperthyreosis and increased blood pressure values at the normal range [10–13], and a very few to the role of hyperthyreosis in the evolution of hypertension [6, 8]. The unique result is that it is common for hyperthyreosis to increase systolic blood pressure, whether it is a high-normal value of hypertension or real hypertension values.

In the female patients examined, the average 24-hour values of systolic pressure were increased and referred to the 1st grade hypertension. These were much higher than the values of the female control group. This result is the same as that of the other examinations [4, 6, 8, 10–13].

Initially, it was suggested that hyperthyreosis may be associated with increased systemic vascular resistance and lead to the reduction of diastolic blood pressure. However,

only Marciz et al. found significantly lower values of diastolic blood pressure in a group of 51 normotensive patients with hyperthyreosis in comparison to the control group [11]. The results of other examinations showed that there were no differences between normotensive patients with hyperthyreosis and the control group [12–14]. In our examination, in the group of patients with hyperthyreosis and arterial hypertension, the average 24-hour values of diastolic pressure were still normal, but higher than the ones found in the control group. This result could be explained by the fact that female patients with hyperthyreosis and arterial hypertension were included in the examination.

Oscillations in the values of systolic and diastolic blood pressure were more significant in the group of the patients than in the control one. Under normal conditions, variations in blood pressure values are influenced by the sympathetic activity during awake time**.** The **s**ympathetic tone is influenced by physical activity and the metabolic condition. It is common for hyperthyreosis to have a condition of higher metabolism and that partially explains the increased variation in blood pressure values that were found. Based on the proof of the accumulation of thyroid hormones in the parts of the central nervous system responsible for autonomous regulation, it is assumed that thyroid hormones directly influence sympathetic activity [15]. A part in the increasing oscillations in blood pressure in patients with hyperthyreosis also belongs to the sensitivity to catecholamines already mentioned. Klein and Levey [16] found a correlation between the level of T3 and the daily variations in systolic pressure and explained it with the influence of hormones on the heart.

In the group of patients a less reduction was found in the nocturnal blood pressure values than in the control group. Under normal circumstances, bradycardia and reduction of blood pressure during the first hours of sleeping were conditioned by the increased activity of the parasympathetic system. The reduction of systolic and diastolic pressure values found in the group of patients compared to the control group is explained by sympathetic-vagal dysbalance, with increased sympathetic and reduced vagal modulation values of arterial pressure during the night.

The same result of amplitude reduction in night-reduced blood pressure in the patients with hyperthyreosis was seen by Minami et al, [13] thanks to examinations on a sample of 21 normotensive patients with Graves disease, as well as in the examination by Middeke et al, [17] of 14 patients with hyperthyreosis-influenced secondary arterial hypertension. In comparison, Iglesias et al, [14] did not find any difference between the reduction of the nocturnal blood pressure values in a group of 20 patients with hyperthyreosis and in the control group of 15 subjects.

The first who has determined the role of the control of the thyroid function in the regulation of blood pressure values was Hurxthal [5] in 1931 and Bisgard [18] 10 years later. They showed that surgical treatment of hyperthyreoisis brings an immediate reduction in the systolic and diastolic blood pressure values, reducing them to normal or almost normal values. Marciz et al, [11] found that normalization of heart rate values, volume and systolic pressure comes after a short-term treatment, but before the exceeding of normal metabolic conditions and that the normalization (increasing) of diastolic values and systemic vascular resistance comes after a long-term treatment.

In the examined female patients with hyperthyreosis and hypertension, two weeks after the thyroidectomy, the reduction and normalization of systolic and diastolic values were achieved, which indicated that hyperthyreosis was responsible for the reversible increasing of arterial tension.

Interest in the correlation between hyperthyreosis and hypertension dates back to the first half of 20th century. In spite of that, there has been a very small number of examinations published. Also, the more recent examinations, by default, included a minor number of patients. Due to this, there are different premises about the influence of hyperthyreosis on blood pressure values and circadian variety.

The results of this research show that hyperthyreosis was responsible for hypertension development, increased variation in arterial blood pressure and the lower reduction in nocturnal blood pressure. It also show that the control of the thyroid function after thyroidectomy brought faster normalization of blood pressiure values.

Conclusion

The patients with hyperthyroidism-caused hypertension had higher systolic and diastolic blood pressure, higher variations in blood pressure and lower nocturnal reduction of blood pressure than healthy subjects. Thyroid surgery, as a control of thyroid function optimised blood pressure very rapidly.

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