

## Color flow doppler ultrasonography in Hashimoto's thyroiditis

Ultrassonografia com doppler colorido em tireoidite de Hashimoto

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### Abstract

**Objective:** To evaluate if the vascularization patterns in the thyroid gland parenchyma by the conventional ultrasound mode B, and color Doppler ultrasonography correlated with the peak systolic velocity (PSV) of the inferior thyroid artery using pulsed Doppler in patients with Hashimoto's thyroiditis (HT) in various stages. **Methods:** Patients with diagnosis of HT were enrolled in this prospective study in the period two years. Thyroid glands of all patients were evaluated with conventional ultrasound mode B, color-flow Doppler ultrasonography, and peak systolic velocity (PSV) of the inferior thyroid artery. Data were analyzed applying variance (ANOVA) and Pearson's or Spearman's correlation. **Results:** A hundred twenty patients (10 men and 110 women) were included in the study. Highly elevated PSV were associated with very lower thyroid echogenicity and heterogeneous pattern thyroid gland ( $p=0.01$ ) and intrathyroidal blood flow ( $p=0.004$ ). **Conclusions:** We conclude that evaluation the vascularization patterns of the thyroid gland parenchyma in patients with HT when compared to conventional ultrasound mode B, and with the PSV of the inferior thyroid artery by pulsed Doppler showed a high correlation. Probably this method could be recommend as a measure of thyroid blood flow as an essential part of evaluating ultrasonography in the HT.

**Keywords:** Thyroid gland. Hashimoto's thyroiditis. Color flow Doppler sonography. Inferior thyroid artery.

### RESUMO

**Objetivo:** Avaliar os padrões de vascularização do parênquima da glândula tireóide, correlacionando-se a ultrassonografia modo B convencional e a ultrassonografia com Doppler colorido com o pico de velocidade sistólica (PVS) da artéria tireoidiana inferior pelo Doppler pulsátil em pacientes nas diversas fases da TH. **Métodos:** Estudo prospectivo de pacientes com diagnóstico de TH, no período de 2007 a 2009. A tireóide dos pacientes foi avaliada através da ultrassonografia modo B convencional, Doppler colorido (DC), e pico de velocidade sistólica (PVS) da artéria tireoidiana inferior. Os dados foram analisados pela análise de variância (ANOVA) e correlação de Pearson ou Spearman. **Resultados:** Um total de 120 pacientes consecutivos (10 homens e 110 mulheres) participou do estudo. O PSV elevado apresentou nível de significância elevada quando associado à baixa ecogenicidade tireoidiana ( $p=0,01$ ) e ao fluxo sanguíneo intratireoidiano ( $p=0,004$ ). **Conclusões:** Concluímos que a avaliação dos padrões de vascularização do parênquima da glândula tireoide, em pacientes com TH, quando comparada à da ultrassonografia modo B convencional e ao PSV da artéria tireoidiana inferior pelo Doppler pulsátil, mostrou uma alta correlação, sendo, então, recomendada a avaliação do fluxo sanguíneo tireoidiano como uma parte essencial da avaliação do TH.

**Palavras-chave:** Glândula tireoide. Doença de Hashimoto. Tireoidite. Ultrassonografia. Ultrassonografia Doppler em cores.

### INTRODUCTION

The value of color flow Doppler ultrasonography (CFDU) in thyroiditis continues to be a matter of debate. Hashimoto's thyroiditis (HT) is an autoimmune thyroid disorder, with the diagnosis based on clinical findings, laboratory data and ultrasonography<sup>1</sup>. The ultrasound aspects normally show a diffuse low echogenicity as results of lymphocytic infiltration and disruption of

tissue architecture thyroid<sup>2</sup>. CFDU mapping has added data to diagnosis of HT and is helpful clinically for the differential diagnosis.

CFDU is a noninvasive assessment of vascularity status, reflect both anatomical and physiologic characteristics, and has been successfully applied distinguishing through of the vascularity in benign and malignant thyroid's diseases.<sup>3</sup>

In thyroid disorders, in animals, is accepted that occurs an enlargement of the blood capillaries and an increase in blood flow to this region<sup>4-6</sup>. CFDU is a

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technique of low-cost and easy application, been the major primary diagnostic procedure in suspected autoimmune thyroiditis.<sup>7</sup>

Hodgson et al.<sup>8</sup> reported that thyroid artery blood flow correlated remarkably with the levels of free triiodothyronine, whereas others studies did not find a correlation between CFDU findings and serum thyroid-stimulating hormone (TSH) levels<sup>9</sup>. However, previous studies reported that the thyroid blood flow is increased in some patients with chronic thyroiditis in whom serum TSH is markedly elevated, and the TSH receptor stimulation usually adjusts blood flow in the thyroid gland.<sup>10</sup>

Lagalla et al. showed that the evaluation of systolic flow velocity in the inferior thyroid artery is more reliable than the quantitative analysis of color signals in monitoring treatment response in thyroid disease.<sup>11</sup>

In the present study we evaluated the vascularization patterns of the thyroid gland parenchyma, determining the correlation between the conventional ultrasound mode B, and color Doppler ultrasonography with the peak systolic velocity (PSV) of the inferior thyroid artery by pulsed Doppler in patients with HT in various stages.

## PATIENTS AND METHODS

### Patients

A hundred twenty patients (10 men and 110 women; age range, 27-64 years; mean age, 45 ± 8.05 years) with diagnosis of HT by established laboratory criteria (elevated serum titers of anti-thyroid peroxidase antibody) were enrolled in this study during 2008–2010. Each CFDU examination was performed by the same investigator, who was unaware of the laboratory values at the time of the examination.

The study was approved by the ethical committee of Santa Casa de Itabuna, Bahia, Brazil in accordance to the Declaration of Helsinki.

### Conventional and CFDU of thyroid

All patients was first submitted to gray scale sonography conventional, and subsequently to color flow Doppler using digital ultrasonography equipment (Voluson 730 Pro GE Medical Systems – Kretz Ultrasound) in connection with a 10-MHz linear array transducer and a direct contact technique was applied in all patients by the same investigator.

The conventional sonography images were obtained in the transverse and longitudinal scans and gain was adjusted to a level not associated with relevant artifacts (Figure 1). The thyroid sonographic characters were as follows: enlarged and diffusely hypoechoic thyroid gland, sonographic pattern of multiple focal hypoechoicities, hypoechoic thyroid gland with

single or multiple nodules and scattered hyperechogenic areas, and isoechogenic and small thyroid gland characterized by the presence of numerous hyperechogenic spots and strings.

The CFDU found of the thyroid patterns were based on the criteria of Ralls et al.<sup>12</sup>: absent intraparenchymal vascularity or minimal spots, presence of parenchymal blood flow with patchy uneven distribution, mild increased of color flow Doppler signal with patchy distribution, and markedly increased color flow Doppler signal with diffuse homogeneous distribution including the so-called “thyroid inferno”. The CFDU evaluations were performed using the some standart preset with color gain adjusted to maximum level to allow minimum noise: PRF 2500 Hz with color gain 80%. With this preset usually used for the examination of the carotid arteries the normal thyroid gland, the inferior thyroid artery is always detectable (Figure 2).

The sonography conventional images and CFDU findings were correlated to with the PSV of the inferior thyroid artery.

### Spectral Doppler analysis

The PSV (the Doppler waveform recorded at the point with the highest frequency shift) determinations were performed at the level of inferior thyroid artery by pulsed Doppler, and performed whereby the measurement of three consecutive systolic and diastolic maximum flow velocities followed by the calculation of a mean value. The evaluation of inferior thyroid artery was performed by longitudinal plane in the ascending tract of the artery with a sampling volume of 3 mm. The sample volume was centered in and completely insonated the vessel. The angle of insonation was kept at 60° or less, and the angle-correction cursor was parallel to the direction of flow (Figure 3).

### Statistics

All data were expressed as means ± SD. Results were analyzed by 1-way analysis of variance (ANOVA), 2-sample t test ANOVA for analysis of the differences between parameters, comparison between the values of the parameters was performed by Pearson's or Spearman's correlation. The level of significance was taken as  $p < 0.05$ .

Statistical analyses were performed with software, SPSS® for Windows (version 16.0 - Chicago, IL).

## RESULTS

### Conventional Ultrasound data of the patients

Ultrasound mode B analysis showed the following sonography patterns: atrophy thyroid (7.0%), fine linear echoes within the thyroid parenchyma (32.0%),

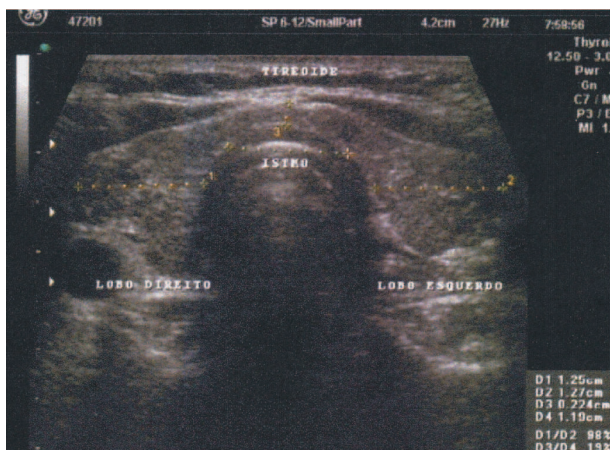


Figure 1 - Ultrasound mode B thyroid – Transverse scan.



Figure 2 - Color flow Doppler ultrasonography thyroid longitudinal scan.

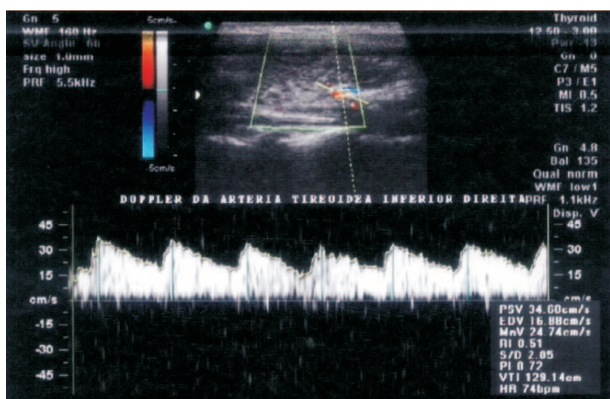


Figure 3 - Spectral Doppler analysis of blood flow in inferior thyroid artery.

hypoechoic with fine linear echoes in thyroid gland (38.0%), significantly lower thyroid echogenicity (15.0%), and heterogeneous pattern (8.0%).

#### Intrathyroidal vascularization

Color flow Doppler ultrasonography analysis demonstrated the following vascularization patterns: a decreased significantly in intrathyroidal blood flow in patients with atrophy thyroid, intrathyroidal blood flow

normal in patients with hypoechoic with fine linear echoes in thyroid gland, a moderate increase in intrathyroidal blood flow in patients with significantly lower thyroid echogenicity, and significantly higher of intrathyroidal blood flow in patients with heterogeneous thyroid gland.

#### PSV of inferior thyroid artery

The PSV determinations analysis showed flow several velocities according to different degrees of increased parenchymal vascularization: in patients with atrophy thyroid the mean PSV of inferior thyroid artery was 17.0 cm/s, fine linear echoes within the thyroid parenchyma the mean PSV was 28.0 cm/s, hypoechoic with fine linear echoes in thyroid gland the mean PSV was 36.0 cm/s, significantly lower thyroid echogenicity the mean PSV was 42.0cm/s, and in patients with heterogeneous thyroid gland the mean PSV was 59.0 cm/s. The results are summarized in Table 1.

Among HT patients no association of thyroid echogenicity to different age ranges or gender was detected.

Highly elevated PSV were associated with significantly lower thyroid echogenicity and heterogeneous pattern thyroid gland as compared to atrophy of thyroid and fine linear echoes within the thyroid parenchyma ( $p=0.01$ ).

Higher PSV values were associated with moderate and significantly higher intrathyroidal blood flow ( $p=0.004$ ).

No significant differences in the size were observed between number of vessels per square centimeter, thyroid blood flow, maximal velocity, and resistive index in the thyroid artery acquired from the two thyroid lobes.

## DISCUSSION

The results of the present study demonstrated that there is a relationship of the HT with higher PSV values and significantly higher intrathyroidal blood flow. Consistent with this notion, a prior report that has showed an increase in thyroidal blood flow in autoimmune thyroid disease.<sup>13</sup>

Study of angiogenesis in the thyroid gland has showed that in the hypothyroid the thyroid gland undergoes hypertrophy with marked enlargement of the capillaries, and increased blood flow restricted to the thyroid vessels due to increased expression of growth factors of the vasculotropins and the tyrosine kinase receptor families, which are then released by thyroid follicular cells and in turn act on endothelial cells.<sup>4,6,14</sup>

Reduced echo levels is a well known phenomenon of the thyroid gland in HT caused either by reduction of colloid content or lymphocytic tissue infiltration<sup>15,16</sup>. Our data reveal significantly higher PSV values in HT with significantly lower thyroid echogenicity and

**Table 1** - Sonography, intrathyroidal blood flow, and PSV of the subjects.

Sonography Pattern	Intrathyroidal blood flow	Mean PSV*	%
<b>Atrophy thyroid</b>	Decreased	17 cm/s	7,0
<b>Fine linear echoes</b>	Normal	28 cm/s	32,0
<b>Fine linear echoe / hypoechoic</b>	Normal	36 cm/s	38,0
<b>Significantly lower thyroid echogenicity</b>	oderate increase	42 cm/s	15,0
<b>heterogeneous pattern</b>	nificantly high	59 cm/s	8,0

\*PSV = peak systolic velocity.

heterogeneous pattern of thyroid gland. Though it has been considered that the echogenic appearance of the thyroid gland varies with the adjustment of the gain<sup>17,18</sup> so that defined conditions are necessary to evaluate exact data, we adjust the of ultrasound power level, brightness gain, depth, depth range, and frame rate within a representative region of thyroid gland on a B-mode image was displayed.

The CFDU gives helpful information about the blood circulation of thyroid gland, and clinical experience with thyroid diseases is essential when using thyroid ultrasonography<sup>19</sup>. All our patients were examined by the same investigator clinical experience with thyroid diseases. Our data showed that the CFDU is a useful tool to investigate intrathyroidal blood flow and clearly demonstrated that thyroid vascularity and blood flow mainly in subjects with lower thyroid echogenicity and heterogeneous pattern of thyroid gland.

The thyroid vessels normally have of PSV of 25 cm/s and volume flow of 6 ml/min per vassel<sup>20</sup>. Our results showed that the mean PSV values were significantly higher in lower thyroid echogenicity and heterogeneous pattern of thyroid gland patients compared to the HT patients with atrophy thyroid and fine linear echoes the thyroid parenchyma.

## CONCLUSIONS

We conclude that the evaluation of the vascularization patterns in the thyroid gland parenchyma in patients with HT when compared to conventional ultrasound mode B, and with the PSV of the inferior thyroid artery by pulsed Doppler showed a high correlation, and could be recommend as a measurement of the thyroid blood flow as an essential part of evaluation ultrasonography in the HT.

**Conflicts of interest:** None declared.

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