e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(2); 694-701

Original Research Article

Role of Doppler Ultrasonography in the Evaluation of Hashimoto's Thyroiditis

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Received: 25-12-2022 / Revised: 24-01-2023 / Accepted: 04-02-2023

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Conflict of interest: Nil

Abstract

Aim: To evaluate the utility of color doppler ultrasonography along with quantitative spectral doppler parameters in the assessment of Hashimoto's thyroiditis.

Methods: The study was conducted at Department of Radiology, Patna Medical College, Patna, Bihar, India for one year and 100 patients were included in the study. All patients were well informed regarding the study and their consent was obtained. Patients were divided into four groups such as group A (normal); group B (early untreated thyroiditis); group C (chronic thyroiditis under treatment/ follow-up); group D (nodular hyperplasia with thyroiditis) based on grey-scale ultrasound findings, thyroid function test and auto-antibody levels. Following grey scale examination, Doppler study was performed, and the vascularity of both lobes was assessed. Quantitative spectral doppler parameters including resistivity index (RI) and acceleration time (AT) were recorded. RI and AT values were obtained by measuring automatically from proximal segment of the first main parenchymal branch of the inferior thyroid artery.

Results: 100 cases were evaluated with age ranging from 27 years to 55 years with the maximum number of cases in the age group of 41 to 50 years (44%). 32 cases were males and 66 were females, 2 patients identified themselves in other gender category. On assessment of the colour doppler pattern, 36 patients had Pattern 0, 37 patients had Pattern I, 24 patients had Pattern II, and 3 patients had Pattern III. Pattern I was the most common pattern overall (37%) and in category B (48%) and C (50%) patients; pattern 0 was more common in category A(66%); pattern 2 was the commonest pattern in category D patients (46%). On assessment of spectral doppler parameters, mean RI in category A, B, C, D were 0.54, 0.40, 0.47 and 0.48 respectively. Mean AT value in category A, B, C, D were 26.3, 71.5, 47.1, 45.3 respectively. RI values of category B (Early untreated thyroiditis) were significantly lower than category A (Normal). AT values of category B, C and D were significantly longer than AT compared to category A.

Statistically significant difference was not found in RI values of category A when compared to category C and D. Significant differentiation could not be made between category C and D on either RI or AT values.

Conclusion: Doppler ultrasonography in Hashimoto's thyroiditis is a promising diagnostic imaging modality. Routine use of doppler study in addition to greyscale ultrasound is helpful in diagnosis especially in doubtful cases.

Keywords: Hashimoto's Thyroiditis, Thyroid Gland, Ultrasonography, Doppler.

Introduction

Thyroid disorders are a major health burden worldwide, including our country. Nearly 42 million people in India are thought to be affected by various thyroid conditions, based on projections from numerous studies on thyroid diseases[1].

A wide spectrum of diffuse thyroid diseases affect the thyroid gland with the most common being autoimmune thyroid disease. Hashimoto's thyroiditis (HT), also known as chronic lymphocytic thyroiditis or Hashimoto's disease, is a common type of organ-specific autoimmune disease that is mediated by anti-thyroid autoantibodies. Hashimoto's thyroiditis is one of the common causes of hypothyroidism, which may be subclinical. Mild hypothyroidism may be present in 20% of patients when first seen or can develop over several years [2].

The limitations to physical examination of the thyroid gland and recent developments in ultrasound technology have led to an increased use of ultrasonography as a diagnostic tool for thyroid diseases [3].Sonography is a safe and additionally a less expensive imaging modality. The procedure is comfortable for the patient since it is a noninvasive method. No special preparations or discontinuation of medication is required [4]. Conventionally, thyroid sonography is used to evaluate thyroid nodules and perform a fine-needle aspiration biopsy on them. Sonography can be used to precisely measure thyroid lobes and nodules. Thyroid echogenicity and calcifications as well as their patterns are easily detected by this modality [5].

Due to the fact that gray-scale ultrasonography's findings are often quite similar to one another, differential diagnosis of diffuse thyroid diseases such as thyroiditis and nodular thyroid parenchymal disorders in their advanced stages can be quite challenging. Additionally, in clinical setting, nodular changes could be observed concurrently with Hashimoto's thyroiditis.[6]

The aim of this study is to evaluate the utility of color doppler ultrasonography along with quantitative spectral doppler parameters in the assessment of Hashimoto's thyroiditis.

Materials and Methods

The study was conducted at Department of Radiology, Patna Medical College, Patna, Bihar, India for one year and 100 patients were included in the study. All patients were well informed regarding the study and their consent was obtained. Initially clinical examination was performed in all patients and available biochemical parameters (thyroid function test and auto-antibody levels) were recorded. Thereafter, grey scale ultrasound examination was performed using GE LOGIQ P3 ultrasound machine. Patients with normal thyroid greyscale ultrasound findings (homogeneous parenchyma with regular normal echogenicity), normal thyroid function test, and normal auto-antibody levels were included in normal group, while patient with abnormal thyroid grey-scale ultrasound findings (heterogeneity, pseudo-nodular appearance with surrounding echogenic septations), abnormal thyroid function test or elevated

auto- antibodies were accepted as abnormal.

Patients were divided into four groups such as group A (normal); group B (early untreated thyroiditis); group C (chronic thyroiditis under treatment/ follow-up)); group D (nodular hyperplasia with thyroiditis).

Following grey scale examination, Doppler study was performed by adjusting the pulse repetition frequency (PRF) and colour gain setting to appropriate level (the maximum gain and lowest PRF at which no aliasing in the internal jugular vein or carotid artery could be seen). According to the previously developed classification by Schulz et al., the vascularity of both lobes was assessed [15].

Table 1: Color Doppler classification

Color Doppler Pattern	Description
Pattern 0	Blood flow limited to the peripheral thyroid arteries, while parenchymal flow is absent
Pattern I	Presence of mildly increased parenchymal flow
Pattern II	Clearly increased color flow with a diffuse homogenous distribution
Pattern III	Markedly increased color flow with a homogenous distribution, including the so-called 'thyroid inferno'

Quantitative spectral doppler parameters including resistivity index (RI) and acceleration time (AT) were recorded. RI and AT values were obtained by measuring automatically from proximal segment of the first main parenchymal branch of the inferior thyroid artery.

Statistical analysis

Results were subjected to statistical analysis for correct inferences. SPSS v. 25 (Statistical Package for Social science) for Windows was used for analyses, and the results were compared, maintaining the level of confidence interval by 95%. P value less than 0.05 was considered significant.

Results

Our study population comprises of cases with age ranging from 27 years to 55 years with the maximum number of cases in the age group of 41 to 50 years (44%). 32 cases were males and 66 were females, 2 patients identified themselves in other gender category.

Table 2: Gender Distribution

Gender	Frequency
Male	32
Female	66
Others	2
Total	**100**

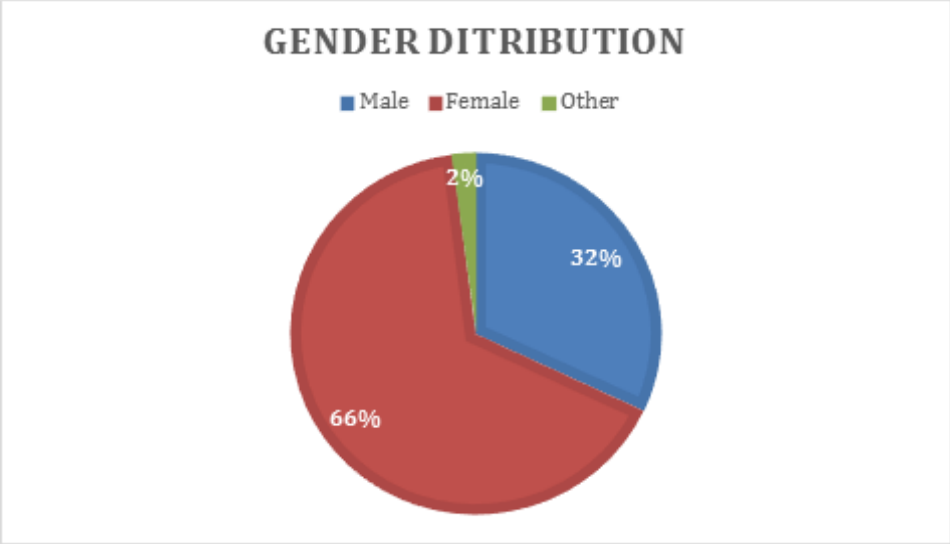


Figure 1: Gender distribution

Table 3: Age distribution

Age range	Frequency
<30	8
31-40	31
41-50	44
>50	17
Total	**100**

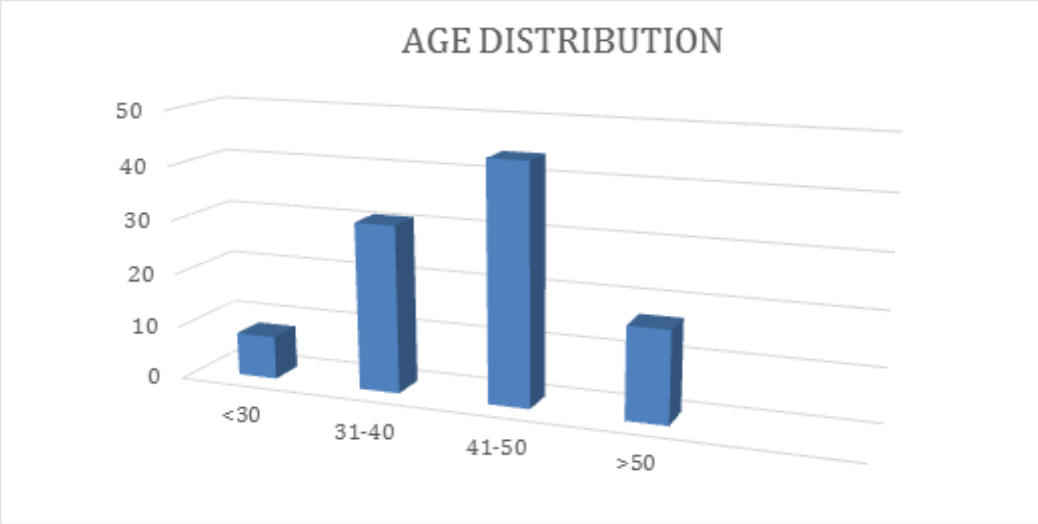


Figure 2: Age distribution

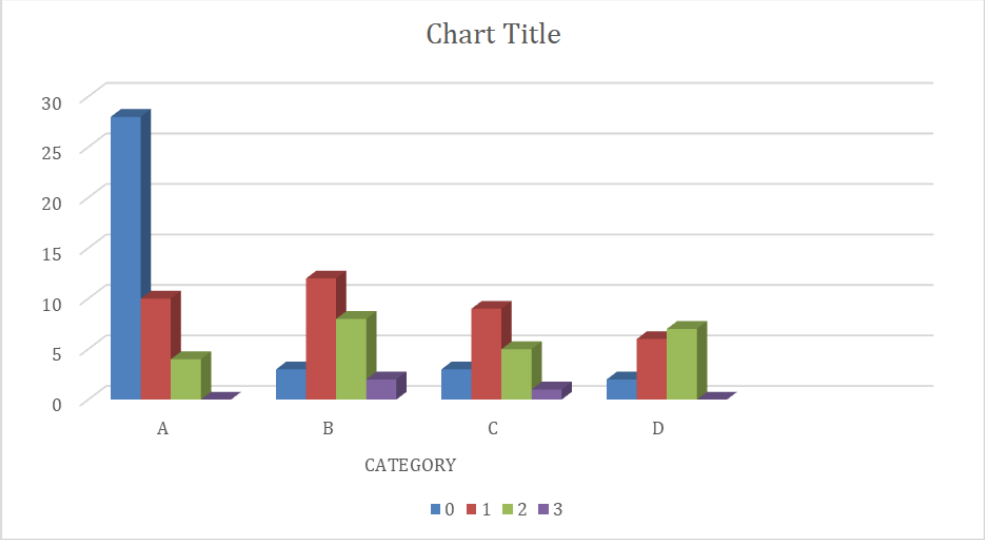
Patients were divided into following four categories based on clinical, radiological and biochemical parameters.

Table 4 : Assessment Categories

Category	A	B	C	D
Diseases	Normal	Early untreated thyroiditis	Chronic thyroiditis under treatment/ follow-up	Nodular hyperplasia with thyroiditis
N	42	25	18	15

Table 5: Colour Doppler Pattern in Assessment Categories

Doppler Pattern	Category				
	A	B	C	D	
0	28	3	3	2	36
1	10	12	9	6	37
2	4	8	5	7	24
3	0	2	1	0	3
	42	25	18	15	100



On assessment of the colour Doppler pattern, 36 patients had Pattern 0, 37 patients had Pattern I, 24 patients had Pattern II, and 3 patients had Pattern III. Pattern I was the most common pattern overall (37%) and in category B (48%) and C (50%) patients; pattern 0 was more common in category A(66%); pattern 2 was the commonest pattern in category D patients (46%).

Table 6: Spectral Doppler Parameters in Assessment Categories

Parameters	Category A	Category B	Category C	Category D	P- value
RI	0.54	0.40	0.47	0.48	0.01
AT	26.3	71.5	47.1	45.3	0.02

Mean RI in category A, B, C, D were 0.54, 0.40, 0.47 and 0.48 respectively. Mean AT value in category A, B, C, D were 26.3, 71.5, 47.1, 45.3 respectively.

Since the variables were in non-normal distribution in four groups of different sample sizes, Kruskal–Wallis H test or one-way ANOVA on ranks was performed.

When RI values were evaluated, category B (Early untreated thyroiditis) had significantly lower values than category A (Normal). On evaluation of AT values, category B (Early untreated thyroiditis) had significantly longer AT compared to category A (Normal). Similarly category C (Chronic thyroiditis under treatment/ follow-up) & D (Nodular hyperplasia with thyroiditis) had significantly longer AT compared to category A.

Statistically significant difference was not found in RI values of category A when compared to category C and D. Significant differentiation could not be made between category C and D on either RI or AT values.

The demographic characteristics of the study group were excluded from the statistical analysis of the data.

Discussion

Thyroid disorders are a major burden health worldwide, including India. In a landmark study on Hashimoto's thyroiditis in India, 6283 schoolgirls from all over India were screened[9]. Among them, 1810 had goitre. Of the 764 of them who underwent a fine-needle aspiration cytology, 58 (or 7.5%) showed signs of juvenile autoimmune thyroiditis, which comprised both focal lymphocytic thyroiditis and Hashimoto's thyroiditis. High prevalence of thyroid diseases may generate certain risks in our population. Furthermore, according to recent literature, seronegative Hashimoto's thyroiditis may affect up to 13% of the population, which raises the risk of papillary thyroid cancer [16]. These results therefore support the idea that Hashimoto's thyroiditis should be distinguished from other chronic parenchymal diseases even during remission [13,14,21].

Several diagnostic criteria exist for Hashimoto's thyroiditis based on clinical and laboratory findings, excluding imaging findings [17]. Thyroid ultrasonography is reliable in the quantitative measurement of thyroid dimensions and volume [8]. The thyroid echogenicity was categorised into groups A and B, as iso-, hypo-, or hyperechoic compared with adjacent muscles, by Hayashi et al. based on ultrasound findings in 53 patients with diffuse thyroid disease who had histological confirmation. The authors emphasised that a hypoechoic gland may be indicative of hypothyroidism and that ultrasonography may be a useful simple and non-invasive tool for identifying Hashimoto's disease because the thyroid gland is likely to be more echogenic than adjacent muscles in normal individuals [10]. In patients with Hashimoto's disease, ultrasound is useful for detecting nodular goitre and for identifying and monitoring these nodules. Additionally, ultrasound provides guidance for fine-needle aspiration biopsy [11,12].

Limited information on the role of colour Doppler ultrasound in diagnosing diffuse thyroid diseases, such as Hashimoto's disease, exists in the literature. Ralls et al. initially described a colour Doppler pattern in Graves' disease that was not observed in normal individuals or in patients with other thyroid diseases and named it the 'thyroid inferno'. This pattern results from continuous multiple intrathyroidal flows during systole and diastole [7].

In our study we evaluated 100 cases, 58 cases of Hashimoto thyroiditis & compared them with 42 control case. We observed that Hashimoto thyroiditis is significantly more common in females.. The thyroid gland vascularity was increased in 64% of the evaluated cases on colour Doppler study, among which 50 (78%) had thyroiditis. Similar findings have been reported in previous studies.

Significantly lower RI values were noted in early untreated Hashimoto thyroiditis compared to normal patients. Similarly, significantly increased AT values were seen in patients with thyroiditis (early untreated, chronic thyroiditis under treatment/ follow-up & nodular hyperplasia with thyroiditis) compared to the control group. However, significant difference in spectral doppler parameters was not observed between, chronic thyroiditis & nodular hyperplasia with thyroiditis.

Yildirim et al [18], in their study evaluated findings of 227 patients (179 females, 48 males) that underwent spectral Doppler ultrasound and acoustic radiation force impulse. Mahmoud et al [19] in their study evaluated 96 pathologically proved cases of Hashimoto's thyroiditis and compared them to 100 control cases. They concluded that can suggest hypothyroidism (high TSH) in cases of grade 2 parenchymal

echogenicity (reduced parenchymal echogenicity, which is less than strap muscles), high vascularity & para-tracheal lymph nodes enlargement. Popoveniuc G, et al [20], in their study assessed of thyroid diseases by ultrasound in 167 patients. The study groups were classified into 9 groups. Authors found that thyroid USG has great role in assessment of thyroid disease and in their follow up. Zhang et al [22] assessed a deep learning model called HTNet for diagnosis of Hashimoto's thyroiditis by training on 106,513 thyroid ultrasound images from 17,934 patients and test its performance on 5051 patients from 2 datasets of static images and 1 dataset of video data. [23]

Our study had certain limitations. The sample size was relatively small and the study was performed at a single centre. Biochemical parameters such as thyroid function test and autoantibody levels, although evaluated were not included in the analysis.

Conclusion

Doppler ultrasonography in Hashimoto's thyroiditis is a promising diagnostic imaging modality. Routine use of doppler study in addition to greyscale ultrasound is helpful in diagnosis especially in doubtful cases such as chronic thyroiditis, autoantibodies negative thyroiditis and nodular hyperplasia with thyroiditis.

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