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COMPARISON OF EFFICACY OF SONOGRAPHIC ECHOGENICITY AND COMPUTED TOMOGRAPHY ATTENUATION OF THYROID PARENCHYMA IN DETECTING SUBCLINICAL THYROID DYSFUNCTION

Radiology

Dr. Avisek Nath Ordnance factory hospital, cossipur, Kolkata
Dr. Soham Saha Command hospital (EC), Alipore, Kolkata
Dr. Sourav Bera Indian railway hospital
Dr. Joimala Shaw* West Bengal health service *Corresponding Author
Dr. Debarshi Jana Institute of Post-Graduate Medical Education and Research, A.J.C. Bose Road, Kolkata.

ABSTRACT

Large patient population suffers from non-specific signs and symptoms, thyroid dysfunction often remains an undiagnosed underlying abnormality. Clinically, diagnosing thyroid dysfunction can be extremely challenging since it has diverse manifestations.
Our aim was to compare the efficacy of both the radiological modalities (USG and CT scan) in identifying subclinical thyroid dysfunction as determined by abnormality in serum TSH level.
Present study was conducted in the department of Radiology in Command Hospital (EC), Kolkata, West Bengal. Total 200 patients were selected using above defined criteria. The study period was from Jan 2017 to Aug 2018.
From this statistical analysis, we observed that out of the 16 SHypo cases, thyroid attenuation with NCCT picked up the maximum number of cases. Thyroid echogenicity compared with SMSG determined 10 cases (62.5%) & echogenicity compared with strap muscle can determine only 3 cases(18.7%).
So thyroid echogenicity compared with SMSG has better sensitivity than strap neck muscles, though NCCT evaluation is more efficacious than USG.

KEYWORDS

INTRODUCTION

Hypothyroidism, also called underactive thyroid or low thyroid, is a disorder of the endocrine system in which the thyroid gland does not produce enough thyroid hormone.[1] It can cause a number of symptoms, such as poor ability to tolerate cold, a feeling of tiredness, constipation, depression, and weight gain[1].Occasionally there may be swelling of the front part of the neck due to goitre[2]. Untreated hypothyroidism during pregnancy can lead to delays in growth and intellectual development in the baby or cretinism[3]

Worldwide, too little iodine in the diet is the most common cause of hypothyroidism[4].Salt iodization has prevented hypothyroidism in many populations[5]. Hypothyroidism can be treated with levothyroxine[6]. In countries with enough iodine in the diet, the most common cause of hypothyroidism is the autoimmune condition Hashimoto's thyroiditis[7,8].Hypothyroidism is more common in women than men[7]. People over the age of 60 are more commonly affected [8-10]

Worldwide about one billion people are estimated to be iodine deficient; however, it is unknown how often this results in hypothyroidism.Subclinical hypothyroidism, a milder form of hypothyroidism characterized by normal thyroxine levels and an elevated TSH level, is thought to occur in 4.3–8.5% adult population in the United States[11]. The word "hypothyroidism" is from Greek hypo- meaning "reduced", thyreos for "shield", and eidos for "form."[12]

This is clearly likely to be affected by the TSH range used to define the problem. The prevalence of subclinical hypothyroidism in the United States adult population is 4.3-8.5%.Although this figure increases with age, may differ among ethnic groups and less consistent data is available among men.[10]

The progression to overt hypothyroidism is approximately 2-5% per year. The rate of progression is proportional to baseline TSH concentration and is higher in individuals with antithyroid antibodies.[12-14]

- AIM:Comparison of Efficacy of Sonographic Echogenicity and Computed Tomography Attenuation of Thyroid Parenchyma in detecting Subclinical Thyroid Dysfunction.

MATERIALS AND METHODS

STUDY DESIGN:

Aprospective cohort study to be conducted in the department of Radio diagnosis, Command Hospital (EC), Kolkata. Study population was 200 patients and the study period will be from Jan 2017 to Aug 2018. Informed consent was taken from all the patients and the approval of Ethics committee will be sought.

EXAMINATION TECHNIQUE:

- As a protocol, patients reporting for CECT Neck would have to undergo a serum creatinine test to evaluate renal function prior to contrast administration for CT examination on the appointed day. Serum TSH was also by requisitioned along with the renal function test.
- All CT scans was performed using the standard protocol and parameters on a 16-slice Multislice CT scanner (Philips Brilliance 16) for Neck CT, which includes a Non-contrast CT (NCCT) scan. The thyroid gland would be evaluated for estimation of tissue attenuation by using “region of interest” (ROI) over right & left lobes of the thyroid gland and measuring the Hounsfield units in absolute numbers.
- For the same patients, neck scans was then be performed by standard B-mode Ultrasonography (USG) using a 7.5 - 12 MHz linear transducer probe with Logic E USG machine (Wipro GE). Significant thyroid nodules was excluded. The echogenicity of both lobes of thyroid gland will be compared with the submandibular salivary gland and strap muscles on either side after cofirming that patient does not have complaints or findings in the submadibular salivary glands.

Statistical Analysis:

For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS 24.0. andGraphPadPrism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Without other qualification, 'chi-squared test' often is used as short for Pearson's chi-squared test. Unpaired proportions were compared by Chi-square test or Fischer's exact test, as appropriate.p-value ≤ 0.05 is considered as statistically significant

RESULTS AND ANALYSIS

Our study showed that 200 patients, 4(2.0%) patients were18-20 yrs of age, 22(11.0%) patients were 21-30 yrs of age, 45(22.5%) patients were 31-40 yrs of age, 31(15.5%) patients were 41-50 yrs of age, 49(24.5%) patients were 51-60 yrs of age, 32(16.0%) patients were 61-70 yrs of age and 17(8.5%) patients were 71-80 yrs of age. The mean age (mean±s.d) of patients was 48.4750 ± 15.3547yrs with range

18.0000 - 80.0000 yrs and the median was 49.5000 yrs.

We found that out 200 patients,52(26.0%) patients are female and 148(74.0%) patients are male. Out of 200 cases, taking TSH as a marker of normal thyroid function; 181(90.5%) patients had euthyroidstatus of TSH value, 3(1.5%) patients had hyperthyroidism and 16(8.0%) patients had hypothyroidism. Out of 200 cases, 186(93.0%) patients had hyperattenuation thyroid parenchyma on CT and 14(7.0%) patients had hypoattenuation thyroid parenchyma.

It was found that out of 200 cases, 177(88.5%) patients had hyperechoic thyroid on USG (cf.SMSG) and 23(11.5%) patients had hypoechoic thyroid. Of the 200 cases, 193(96.5%) patients had hyperechoic thyroid on USG (cf. Strap muscle) and 7(3.5%) patients had hypoechoic gland.In group of NCCT hyperattenuating thyroid gland, 179(96.2%) patients had Euthyroid status, 3(1.6%) patients had Hyperthyroidism and 4(2.2%) patients had Hypothyroidism. In group of hypoattenuating gland, 2(14.3%) patients had Euthyroid status and 12(85.7%) patients had Hypothyroidism. Association of serum TSH vs. CT finding was statistically significant (p<0.0001).

Our study showed that group of 186 hyperattenuating thyroid parenchyma on NCCT scan, 171(91.9%) patients had hyperechoic and 15(8.1%) patients had hypoechoic thyroid gland on USG whe compared to SMSG.In group of 14 hypoattenuating thyroid parenchyma on CT scan, 6(42.9%) patients had hyperechoic and 8(57.1%) patients had hypoechoic thyroid gland on USG.Association of USG finding (cf.SMSG) vs. CT finding was statistically significant (p<0.0001). In groupof total 186 hyperattenuatedthyroid gland on NCCT, 182(97.8%) patients had shown hyperechoicgland on USG (cf. strap muscle) and 4(2.2%) patients had hypoechoic gland.In group of a total of 14 hypoattenuatedthyroid gland on NCCT, 11(78.6%) patients had shown hyperechogenecity of thyroid parenchyma on USG (cf. strap muscle) and 3(21.4%) patients had hypoechoic thyroid gland.Association of USG findings of thyroid parenchyma (cf. strap muscle)vs. CT finding was statistically significant (p=0.00015).Association of age vs. CT finding of thyroid gland was not statistically significant (p=0.3627).

We found that in group of 186 total patients with hyperattenuating thyroid parenchyma on CT, 46(24.7%) patients were female and 140(75.3%) patients were male. Of the grouphavinghypoattenuation of thyroid gland on NCCT; 6(42.9%) patients were female and eight(57.1%) patients wereof male gender. In group of hyperattenuated thyroid gland on NCCT scan, 31(67.4%) patients werepost-menopausalstate and 15(32.6%) patients were premenopausalstate. In hypoattenuated group, 5(83.3%) patients waspostmenopausaland 1(16.7%) patients werein premenopausalstate. Association of menstrual historyvs. CT attenuation of thyroid gland was not statistically significant (p=0.4261).

Our study showed that in group of hyperechoic patients on sonography of thyroid gland,the mean of TSH (in USG finding cf. vs. SMSG) (mean±s.d.) of patients was 2.6840 ± 2.7864 uIU/mLwith range 0.0100 - 29.0000 uIU/ml and the median was 2.2000 uIU/mL.In group of hypoechoic thyroid gland,the mean of TSH (in USG finding cf. vs. SMSG) (mean±s.d.) of patients was 5.6961 ± 3.5257 uIU/ml with range 1.0100 - 13.2500 uIU/mL and the median was 5.9000 uIU/mL.Association of serum TSH& USG finding (cf. vs. SMSG) was statistically significant (p<0.0001). In group of hyperechoic thyroid gland, the mean of TSH (in USG finding cf. strap muscle) (mean±s.d.) of patients was 2.9077 ± 2.9380 uIU/mLwith range 0.0100 - 29.0000 uIU/mL and the median was 2.3000 uIU/mL.In hypoechoicgroup of thyroid gland, the mean of TSH (in USG finding cf. strap muscle) (mean±s.d.) of patients was 6.4771 ± 3.7136 uIU/mLwith range 1.9000 - 12.0000 uIU/mL and the median was 8.0600 uIU/mL.Association of serum TSH& USG findings of thyroid gland (cf. strap muscle) was statistically significant (p=0.0020).

Our study showed that group of hyperattenuating thyroid parenchyma (in CT finding), the mean of TSH (mean±s.d.) of patients was 2.5314 ± 2.4022 uIU/mLwith range 0.0100 - 29.0000 uIU/mL and the median was 2.1900 uIU/mL.In group- hypoattenuating thyroid parenchyma, the mean of TSH (mean±s.d.) of patients was 9.6379 ± 2.7144 uIU/mLwith range 6.1800 - 13.6500 uIU/mL and the median was 8.4400 uIU/mL.Association of serum TSH vs. CT finding of thyroid gland was statistically significant (p<0.0001). In group of EUTHYROID patients, the mean of TSH (mean±s.d.) of patients was 2.4133 ± 1.3847 uIU/mLwith range 0.0700 - 9.4200 uIU/mL and the median was 2.2000 uIU/mL.In group of HYPERTHYROID patients, the mean of TSH (mean±s.d.) of patients was 0.1533 ± 0.1266 uIU/mLwith range 0.0100 - 0.2500 uIU/mL and the median was 0.2000 uIU/mL.In group of HYPOTHYROID patients, the mean of TSH (mean±s.d.) of patients was 10.5169 ± 5.6437 uIU/mLwith range 5.9000 - 29.0000 uIU/mL and the median was 8.2100 uIU/mL.

We found that on USG of thyroid gland (cf. SMSG), inhypoechoicgroup, 13(56.5%) patients had Euthyroid, and 10 (43.5%) patients had Hypothyroidstatus. Association of Serum TSHvs. USG cf. SMSG was statistically significant (p<0.0001).On USG of thyroid gland (cf. strap muscle), in hypoechoicgroup,4 (57.1%) patients had Euthyroid statusand 3(42.9%) patients had Hypothyroidism. Association of serum TSHvs. USG of thyroid gland (cf. to Strap Muscle) was statistically significant (p=0.0025).

Our study showed that association of ageand USG cf. to Strap Muscle was not statistically significant (p=0.4231).

We found that on USG of thyroid gland (cf. SMSG) in hypoechoic group, 13(56.5%) patients are female and 10(43.5%) patients are male. A higher percentage of women had hypoechoic thyroid, compared to men (25% vs. 6.76%) OnUSG of thyroid gland (cf. strap muscle); women had hypoechoic thyroid, compared to men (9.62% vs. 1.35%).

DISCUSSION

Present study was conducted in the department of Radiology in Command Hospital (EC), Kolkata, West Bengal. Two hundred patients were selected using above defined criteriaand the study period was from Jan 2017 to Aug 2018.

Maldjian PD *et al*[15] found that low-attenuation thyroid is an unusual finding present in only 4.2% (32/765) of a sample population. Of these 32 patients, 12 were male (38%) and 20 (62%) were female. The mean age of these patients was 59.1years (standard deviation [SD]11.9 years, and age range= 40 to96 years). Seven hundred and thirty-three patients (96%) had high-attenuation thyroid glands. Of these, 347 were male (47%) and 386 were female (53%). The mean age of this subset was 58.8 years (SD =13.9 years, range: 20 to 95 years).

We found that, out of the 200 patients we studied,maximum patients were in the fifth decade of life. The mean±s.d of age of our patients was 48.48± 15.35 yrs with an age range of 18- 80yrs and the age median was 49.5 yrs.Fifty two (26.0%) patients were female and 148(74.0%) patients were male. It was observed that out of 52 female cases, 13(25%) cases had hypoechoic thyroid gland & of the 148 male cases, only 10(6.76%) had hypoechoic thyroid gland when compared with SMSG. Again, on comparison of thyroid gland echogenicity with adjacent strap muscles, of the 52 patients who were females,five (9.62%),and out of 148 male cases, only 2(1.35%) cases had hypoechoic thyroid gland on USG. So, we can conclude that occurrence of thyroid dysfunction appears to be more prevalent in females than males.

Among the thyroid hypoechoic group on USG(cf. SMSG),in our study of a total of 23 patients, 13(56.5%) patients were inEuthyroid state, and 10(43.5%) patients wereinhypothyroid state. Hence, less than half (43.5%) the patients with hypoechoic thyroid had hypofunctioning thyroid glands. Association of serum TSH vs. USG findings (cf. SMSG)is statistically significant (p<0.0001).

On USG of thyroid gland(cf. strap muscle), inthe group of hypoechoic cases, of a total of 7 patients with positive findings, 4(57.1%) patients were ineuthyroid statusand 3(42.9%) patients were inhypothyroid state. Association of Serum TSH vs. USG findings (cf. to Strap Muscles)is statistically significant (p=0.0025). So, we can come to a conclusion that USG findings of thyroid gland compared with SMSG is better to pick up subclinical hypothyroidism than USG of thyroid glandwhen the echogenicity is compared to strap muscles.

Association of serum TSH vsUSG echogenicity of thyroid gland (cf.SMSG) is statistically significant (p<0.0001).Association of serum TSH vsUSG finding of thyroid gland (cf. strap muscle) is statistically significant (p=0.0020).

Evaluating NCCT characteristics of thyroid gland;among the

hyperattenuating group of thyroid on NCCT, the mean of serum TSH vs CT attenuation of thyroid gland (mean±sd) of patients was 2.5314 ± 2.4022 uIU/mLwith range 0.01 - 29.00 uIU/mL and the median was 2.19 uIU/mL.In hypoattenuatingthyroid group;the mean of TSH vs CT attenuation of thyroid gland (mean±sd) of patients was 9.6379 ± 2.7144 uIU/mLwith range 6.18 - 13.65 uIU/mL and median was 8.4400 uIU/mL.Association of serum TSH vs. CT attenuation of thyroid glandis statistically significant (p<0.0001).

Maldjian PD et al[15]found in his CT study that 11.4% (87/765) were hypothyroid, 85.5% (654/765) were euthyroid, and only 3.1% (24/765) were hyperthyroid. Thyroid glands of low attenuation were present in 4.2% (32/765) of the patients. Nearly half (47%) of the patients with low-attenuation thyroids had hypofunctioning thyroid glands.

In our present study, on NCCT,186(93.0%) patients had hyperattenuating glands and 14(7.0%) patients had hypoattenuating thyroid gland. Out of the 14 cases with hypo attenuating thyroid gland, 12 (85.7%) cases had hypothyroidismstatus. Hence, it appears that NCCT attenuation of thyroid gland is better modality than USG echogenicity determination in predicting subclinical hypothyroidism.

Tam AA *et al*[16] found that TSH was normal in 86.1% of the subjects with normal USG and thyroid antibodies were negative in 93.4% of the subjects. All thyroid tests were normal in 77.6% of the subjects.

In our study;177(88.5%) patients had hyperechoicthyroid gland on USG (cf. SMSG) and 23(11.5%) patients had hypoechoic thyroid gland. In comparison, 193(96.5%) patients had hyperechoicthyroid gland on USG finding(cf. Strap muscles)and 7(3.5%) patients had hypoechoic thyroid gland.

We found that in hyperattenuating NCCT group, 179(96.2%) patients had euthyroid status, 3(1.6%) patients had hyperthyroidism and 4(2.2%) patients had hypothyroidism. In hypoattenuation group, 2(14.3%) patients had euthyroid status and 12(85.7%) patients had Hypothyroidism. Association of serum TSH vs. CT finding of thyroid gland is statistically significant (p<0.0001).

We also observe that association of USG finding of thyroid (cf. SMSG) vs. CT attenuation of thyroid glandis statistically significant (p<0.0001).

In hyperattenuationgroup on CT scan, association of USG findings vs. CT finding was statistically significant (p=0.00015).

Vivek Panday *et al*[17]whostudied both low and high TSH groups, demonstrated that there was a significant positivecorrelation between thyroid CT densities and TSH levels (r = 0.40;P < 0.0001) for subjects with a TSH level of less than 3.0 µIU/mL and asignificant negative correlation (r = −0.66; P < 0.0001) for those with aTSH level of greater than or equal to 3.0 µIU/mL.

So, we can conclude that there is a significant association of hypothyroidismwithhypoattenuation of thyroid gland onNCCT.

Hennessey JV*et al*[18] found that the estimated prevalence of subclinical hypothyroidism(SHypo) in the general population is 3% to 8%.In our study, we found the out of 200 patients, 16 (8%) cases had subclinical hypothyroidism.

In present study, out of 16 hypothyroid cases,10(62.5%) patients had hypoechoic thyroid on USG (cf. SMSG) and 3(18.7 %) patients had hypoechoic thyroid on USG (cf. strap muscle).

On assessment of NCCT Thyroid viz a vizTSH which was taken as the gold standard for being screening marker of hypothyroidism; the parameters obtained included; Sensitivity of 75.0%, a Specificity 98.9%. A Positive Predictive Value of 85.7% and Negative Predictive value 97.8%.

In comparison, evaluation of USG Thyroid cf. SMSG against the assumed gold standard marker of hypothyroidism, revealed a lower sensitivity and positive predictive value, than NCCT. The results included; Sensitivity of 62.5%, Specificity 92.9%, Positive Predictive Value of 43.5% and Negative Predictive value 96.6%. USG Thyroid cf. neck strap muscles in comparison to TSH showed a further decrease in sensitivity and positive predictive value, than even the SMSG compared mode. It had a low Sensitivity of only 18.8%, Specificity was high (97.8%), the Positive Predictive Value was 42.9% and Negative Predictive value was maintained, 93.3%. Specificity of USG compared to strap muscles was better than that of USG compared with SMSG. The negative predictive value of all three modes (both the USG and NCCT) were comparable.

CONCLUSION:

Our study indicates that attenuation evaluation of thyroid gland on NCCT is more beneficial in predicting the subclinical hypothyroid cases than USG evaluation. The evaluation of echogenicity of thyroid gland (cf. SMSG)on USG is fruitful to determine the subclinical hypothyroid cases than echogenicity of thyroid gland (cf.strap muscle).

Out of 16 total subclinical hypothyroid casesdetected on TSH study, 12 (75%) patients were picked up on assessmentof the attenuation of thyroid gland on NCCT, whereas 10(62.5%) and 3(18.8%) wasdiagnosed by evaluating the echogenicity by USG (cf. SMSG) and (cf. strap muscle) respectively.

Table 1: Distribution ofSerum TSH(Normal = 0.39-5uIU/mL) and Distribution of NCCT Findings

		Frequency	Percent
TSH VALUE	**EUTHYROID**	181	90.5%
	HYPERTHYROIDISM	3	1.5%
	HYPOTHYROIDISM	16	8.0%
CT Finding	**HYPERATTENUATION**	186	93.0%
	HYPOATTENUATION	14	7.0%

Table 2: Distribution of serum TSH vs. USG findings of thyroid gland (cf. to SMSG), Distribution of serum TSHvs. CT findings of thyroid parenchyma, Evaluation of NCCTThyroid vs. TSH (taken as gold standard for screening marker of hypothyroidism) and Evaluation of USGThyroid cf. SMSG vs. TSH (taken as gold standard for screening marker of hypothyroidism).

	USG of thyroid gland (cf. SMSG)			Chi-square value	p-value
Serum TSH		**HYPOECHOIC**	**HYPERECHOIC**		
TSH	**EUTHYROID**	13	168	44.5954	<0.0001
	Row %	7.2	92.8		
	Col %	56.5	94.9		
	HYPERTHYROIDISM	0	3		
	Row %	0.0	100.0		
	Col %	0.0	1.7		
	HYPOTHYROIDISM	10	6		
	Row %	62.5	37.5		
	Col %	43.5	3.4		
	CT FINDINGS	**HYPERATTENUATION**	**HYPOATTENUATION**		
	EUTHYROID	179	2	123.5346	<0.0001
	Row %	98.9	1.1		
	Col %	96.2	14.3		

	HYPERTHYROIDISM Row % Col %	3 100.0 1.6	0 0.0 0.0		
	HYPOTHYROIDISM Row % Col %	4 25.0 2.2	12 75.0 85.7		
	TSH level (Gold Standard)	**hypothyroid**	**Normal or high**		
NCCT (test score)	**Hypodense**	**12**	**2**	**NA**	**NA**
	Hyperdense	**4**	**182**		
USG Thyroid cf. SMSG (test score)	**Hypoechoic**	**10**	**13**	**NA**	**NA**
	Hyperechoic	**6**	**171**		

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