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ORIGINAL RESEARCH

Role of Tc-99m Pertechnetate Thyroid Scan to detect Thyroid Gland in Congenital Hypothyroidism: A Comparison with Ultrasound

[1]Shwetal U Pawar, [2]Anuja Anand, [3]Bhairavi M Bhatt, [4]Suruchi S Shetye, [5]Mangala K Ghorpade

ABSTRACT

Introduction: The detection of functioning thyroid tissue is the key information to assess the hormone replacement in congenital hypothyroidism (CH). The purpose of the study was to assess the role of Tc-99m pertechnetate thyroid scintigraphy (TS) and ultrasound in detecting the eutopic and ectopic thyroid tissue.

Materials and methods: A retrospective observational study was done in which 37 children (12 boys and 25 girls), who underwent TS and ultrasound of neck to look for the thyroid tissue. The TS and ultrasound were compared so as to diagnose athyreosis, thyroid hypoplasia, and ectopic thyroid. A Chi-square test was applied to find the difference between the two investigations with 5% confidence limit.

Results: Athyreosis (53%) was the most common reason for hypothyroidism and lingual (53.3%) was the most common location of ectopic thyroid tissue. The sensitivity of ultrasound and TS for detection of eutopic thyroid gland was found to be 100 and 84.62% respectively. However, the sensitivity of ultrasound and TS to detect ectopically located thyroid tissue was 29 and 100% respectively. The dual ectopic location of thyroid was also detected in 26.6% on TS.

Conclusion: The TS performed better to detect the ectopic thyroid tissue, whereas ultrasound was better to detect the thyroid tissue in the normal location.

Keywords: Athyreosis, Ectopic, Eutopic, Hypoplasia, Thyroid scintigraphy, Ultrasound.

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[1]Assistant Professor, [2]Associate Consultant, [3]Additional Professor, [4]Junior Scientific Officer, [5]Senior Technician and Radiation Safety Officer

[1,4,5]Department of Nuclear Medicine, Seth Gordhandas Sunderdas Medical College and King Edward Memorial Hospital Mumbai, Maharashtra, India

[2]Department of Nuclear Medicine, Max Super Specialty Hospital New Delhi, India

[3]Department of Nuclear Medicine, Topiwala National Medical College & B.Y.L. Nair Ch. Hospital, Mumbai, Maharashtra, India

Corresponding Author: Bhairavi M Bhatt, Additional Professor Department of Nuclear Medicine, Topiwala National Medical College & B.Y.L. Nair Ch. Hospital, Mumbai, Maharashtra, India Phone: +912223027650, e-mail: bhairavibhatt@hotmail.com

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INTRODUCTION

The clinical features of CH are often subtle and many newborns remain undiagnosed at birth.[1,2] The passage of maternal thyroid hormone across the placenta provides a protective effect, especially to the fetal brain and masking the clinical signs.[2,3] Congenital hypothyroidism is the most common congenital endocrine disorder in childhood and also is one of the most common preventable causes of mental retardation. The incidence of CH in an Indian experience of screening nearly 40,000 newborns was about 1 in 2,640, which is much higher than the worldwide average of 1 in 3,800.[4]

After making diagnosis, if the treatment is started within a few weeks of birth, neurodevelopmental outcome is generally normal. In the majority of patients, CH is caused by an abnormal development of the thyroid gland (thyroid dysgenesis), which is usually a sporadic disorder and accounts for 85% of cases. It presents itself in three major forms, i.e., thyroid ectopy, athyreosis, and thyroid hypoplasia. Thyroid ectopy accounts for two-thirds of cases of thyroid dysgenesis.[2]

In addition to the thyroxine (T4) and thyroid-stimulating hormone (TSH) evaluation, the imaging of thyroid gland plays an important role in detecting the eutopic or ectopically located thyroid tissue. Ultrasound and Technetium-99m pertechnetate thyroid scintigraphy (TS) help to detect thyroid dysgenesis.[5-8] The preferred tracer in neonate is Iodine-123 (I-123) or Technetium^{99m} Pertechnetate (Tc^{99m}), as I-131 delivers too high a dose of radioactivity to the thyroid and total body.[2]

The low cost of the ultrasound examination also plays an important role in its availability. Imaging in CH primarily involves ultrasound examination, which requires no preparation, and can thus be performed and repeated at any time, without interruption of treatment. It allows repeatable, real-time, and noninvasive assessment of the thyroid morphology. It provides entirely morphological information, and no conclusions pertaining to the hormonal function of the observed structures can be derived. The ultrasound waves do not penetrate through calcified

structures; hence, sonographic assessment of ectopic thyroid in retrosternal, intralaryngeal, or intratracheal locations is largely limited.[9]

In the absence of screening mechanism for CH in India, the clinical features and symptoms raise suspicion of CH. Thus, the diagnosis may be delayed. The purpose of the study was to evaluate children referred to the Nuclear Medicine Department with suspected hypothyroidism of age less than 3 years. The thyroid aplasia or dysplasia diagnosis was important to be made to follow up the children for the need of permanent T4 hormone replacement. The easily available technique of ultrasound and TS was used for the detection of thyroid abnormalities. Due to unavailability of I-123 in India, Technetium^{99m} Pertechetetate was preferred. It gives less radiation to the child and the imaging characteristics are favorable.[10]

MATERIALS AND METHODS

This is a retrospective observational study done in which 37 children (12 boys and 25 girls) referred to the Nuclear Medicine Department during the period from Jan 2008 to Aug 2016 for Technetium^{99m} Pertechetate were included. The children with raised TSH and suspected hypothyroidism were included. The children with thyroid-related surgery, age > 3 years, and history of thyroid-related medication (e.g., T4 replacement) were excluded. The intake of drugs and food items causing iodine interference by the child was ruled out.

The children were injected with a mean dose of 1 mCi (37 MBq) of Technetium^{99m} Pertechnetate intravenously. The anterior and lateral images of head, neck, and mediastinum were acquired for 300 k counts each/20 minutes using gamma camera after the injection of radiotracer.[10] The scan was visually interpreted by the nuclear medicine physician for the presence of uptake of Technetium^{99m} Pertechnetate at the normal thyroid gland location or at the ectopic location. The ultrasound of the neck was done to look for the presence or absence of thyroid tissue by the sonologist.

The diagnosis of athyreosis was made if both ultrasound and TS did not show the thyroid gland in the normal or ectopic location. The diagnosis of hypoplasia was made if small thyroid gland was seen on ultrasound and low uptake on TS. Thyroid ectopia was considered if the functioning thyroid tissue was seen in the location other than normal thyroid gland from the base of the tongue to the neck. The functioning ectopic thyroid gland showed the presence of Technetium Pertechnetate concentration on TS.

A comparison was made between ultrasound and TS to detect the thyroid gland in the normal location.

All the children were followed up till 3 years after the diagnosis for requirement of T4 hormone replacement and correlated with the presence of thyroid gland in the normal or ectopic location based on TS.

The chi-square test was used to find out the difference in the detection of thyroid tissue at normal and ectopic location on TS and ultrasound. The p-value <0.05 was considered as a significant difference.

RESULTS

The M:F ratio of children included in the study was 1:2.1. The mean age was 13 months (6 days to 3 years). The children were grouped based on the age to see for common clinical presentation (Table 1). Jaundice and delayed milestones were most common symptoms in the first year of life. Mental retardation was seen as a more common feature in the subsequent years. The mean TSH value was found to be higher in the earlier age group of infancy. All these children needed T4 replacement till 3 years after diagnosis. The children with mental retardation symptoms did not improve significantly even after T4 replacement therapy, whereas children with functioning ectopic thyroid tissue showed improved symptoms.

Athyreosis (53%) (Table 2 and Fig. 1) was most common reason for hypothyroidism in patients diagnosed during infancy; 27% of babies in the first year of life showed thyroid gland at the normal location that was hypoplastic on TS. The most common location of ectopic thyroid was seen to be lingual (20%) (Table 3).

During the second year of life, 30% (6) of children showed a normally located thyroid gland; 4/6 glands were hypoplastic based on TS; 13 (65%) children in this group showed ectopically located thyroid gland (Fig. 2). Lingual/suprahyoid location was commoner (33.3%). The dually located ectopic thyroid tissue was noted in 26.6% (4) children (Table 3).

There were 2 children in the third year of life included in this study. One of them showed athyreosis and the other child showed eutopic and ectopic thyroid tissue simultaneously.

The mean TSH was significantly raised in children with lingual thyroid and was moderately raised in dual ectopic thyroid tissue due to volume of the tissue producing thyroid hormone.

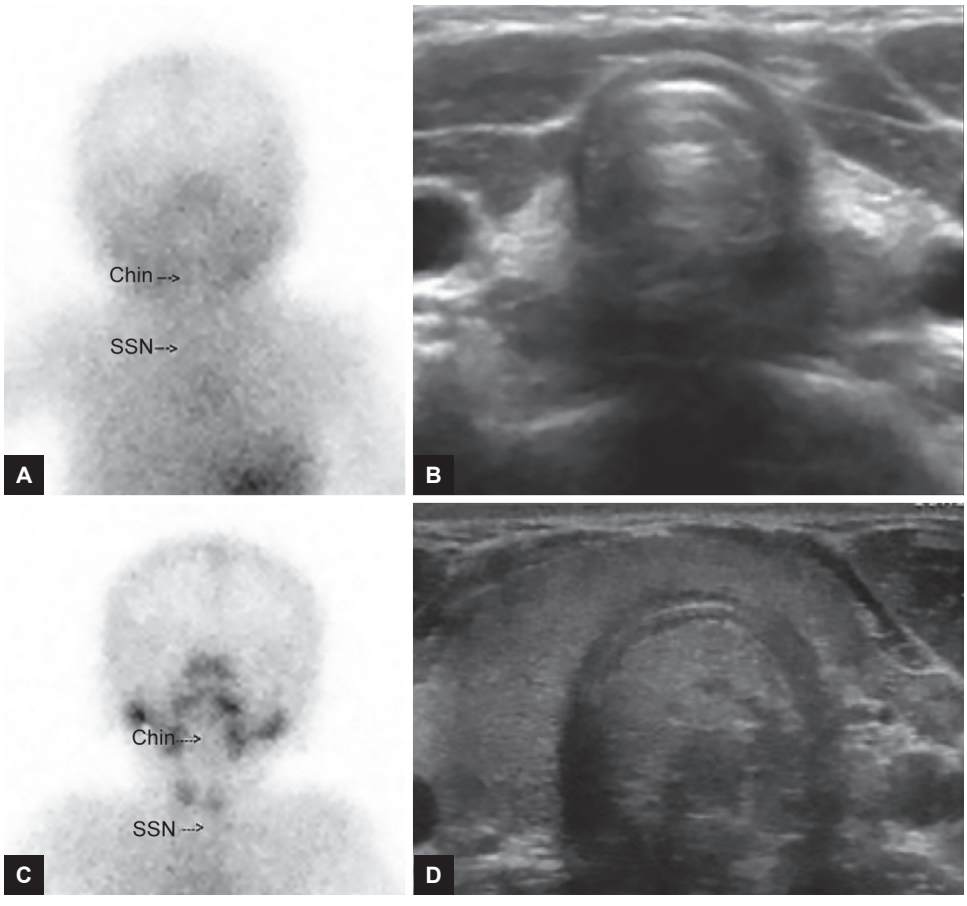
Table 1: Age-wise distribution of children with clinical features

Age (months)	*No of children*	*Common clinical presentation*	*TSH value (mean, mIU)*
0–12	15 (40.5%)	Jaundice and delayed milestones	152.9
12–24	20 (54.1%)	Delayed milestones and mental retardation	99.05
24–36	2 (5%)	Slow learners and midline neck swelling	43.5

Table 2: Correlation between ultrasound and TS findings

		Ultrasound		*Thyroid scintigraphy*			
Age (months)	*No of children*	*Eutopic location*	*Ectopic location*	*Eutopic location (hypoplastic thyroid gland)*	*Ectopic location*	*Both (eutopic and ectopic on TS)*	*(Athyreosis) not seen on ultrasound or TS*
0–12	15	4 (27%)	Nil	4	3 (20%)	0	8 (53%)
12–24	20	6 (30%)	2 (10%)	4	13 (65%)	2 (10%)	1 (5%)
24–36	2	1* (50%)	1*	1*	1*	1*	1 (50%)

*One child showed functioning eutopic thyroid gland and ectopic thyroglossal tissue



Figs 1A to D: The TS image of 3 months baby showing the absence of functioning thyroid tissue in the normal and ectopic location (A) and ultrasound showing agenesis (B) favoring athyreosis. 7 months male child shows a reduced uptake in eutopic thyroid gland on TS (C) and small gland on ultrasound (D) favoring hypoplasia. SSN: Supra-sternal Notch

The sensitivity of ultrasound and TS for the detection of eutopic thyroid gland was found to be 100 and 84.62% respectively. However the, sensitivity of ultrasound and TS to detect ectopically located thyroid tissue was 29 and 100% respectively.

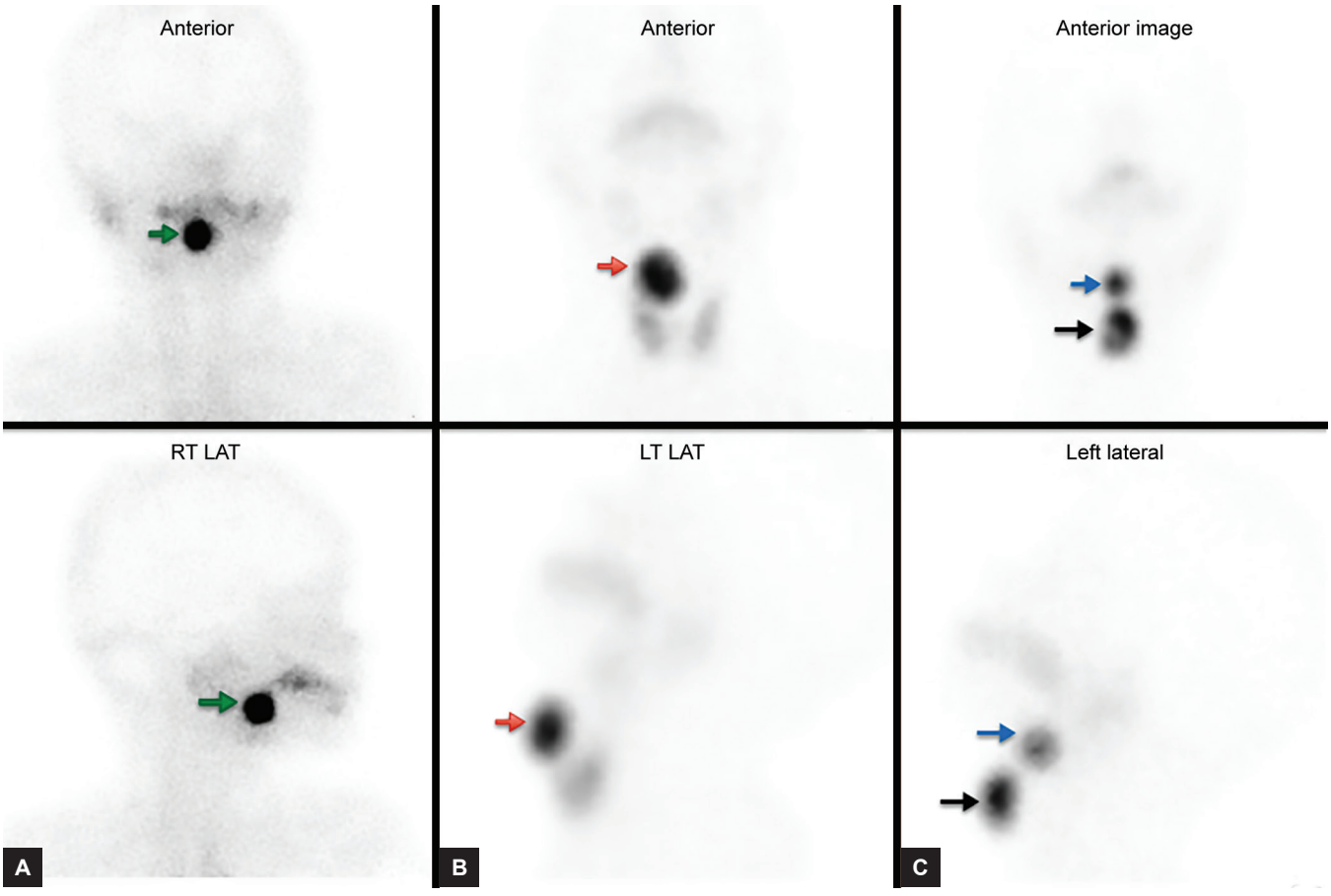
There was a statistically significant difference in ultrasound and TS for the detection of ectopically located thyroid tissue ($p < 0.00069$). The TS scored better in the detection of ectopically located thyroid tissue.

DISCUSSION

Due to the absence of screening program there is no awareness among the parents for CH in India. This study group included children till 3 years of age as per

Table 3: Ectopically located thyroid gland based on TS findings

Age (months)	*No of children with ectopic thyroid*	*Lingual*	*Submental/suprahyoid*	*Thyroglossal tract*	*Dual ectopic*
0–12	3	3 (100%)	0	0	0
12–24	15	5 (33.3%)	5 (33.3%)	1 (6.6%)	4 (26.6%)
24–36	1	0	0	1 (100%)	0
Mean TSH (mIU)		130	89.3	45.8	34



Figs 2A to C: Ectopically located thyroid tissue on TS: 10 months female showing functioning lingual thyroid (green arrow) (A), 15 months male showing dual functioning thyroid tissue and eutopic location and along the thyroglossal duct (red arrow) (B), 18 months female showing dual functioning ectopic thyroid tissue at submental (suprahyoid marked as blue arrow) and along thyroglossal track (black arrow) (C)

the presentation. The children diagnosed late showed delayed milestones, and metal retardation was seen in most of the children that is irreversible in accordance with the published data.[11] All these children were of permanent hypothyroidism and needed T4 replacement at 3 years after diagnosis; however, the doses were variable based on the functioning thyroid tissue at the eutopic or ectopic location. In transient hypothyroidism, the T4 and TSH values tend to return to normal within 1 to 3 weeks after birth without treatment; it was not found in this study group.[12]

The majority of babies in the first year included in this group showed athyreosis (53%), suggesting agenesis. Hyoplasia is a primary cause of CH if diagnosed early. Nayak et al[13] and Iranpour[8] studied the TS in infants and showed that the hypoplasia of thyroid gland was the most common finding.

Perry et al[14] conducted a study on the comparison of combined ultrasound and isotope scanning *vs* ultrasound scanning alone, and concluded that isotope scanning was superior to ultrasound in the detection of ectopic tissue. In this study, the author clearly suggested that the combination of ultrasound of neck and isotope scan is more beneficial than isotope scan alone. Our study also showed that none of the ectopic located or dual ectopic tissues (17) were detected on ultrasound. However, TS showed all of them as functioning thyroid tissue.

Muir et al[15] reported in their comparative study of ultrasound and radionuclide study 50 cases of CH. In that, none of the 13 ectopic thyroid tissues were detected with ultrasound and 4 cases of thyroid aplasia were detected as normal glands on ultrasound neck, and they concluded that ultrasound neck could not be the alternative to TS to define the cause of CH.

Lingual (44.4%) was the most common ectopic location of thyroid gland in our study, which is in coherence with the previous data. The dual ectopic location of thyroid was also detected in 26.6%.[15,16]

The overall sensitivity of ultrasound was found to be better (100 *vs* 84.62%) than TS to detect the eutopic thyroid gland; however, the ultrasound scored poorly to detect the ectopic thyroid gland when compared with TS (29 *vs* 100%). Thus, both can be complementary to detect thyroid tissue in the neck. These findings are in accordance with the existing studies.[15]

Dyshormonogenesis where TS may show no or reduced uptake as described in Clerc et al[16] was not included in this study, as the genetic studies and hormonal analysis were not possible in the given retrospective study.

CONCLUSION

The TS performed better to detect the ectopic thyroid tissue, whereas ultrasound was better to detect the thyroid tissue in the normal location and the functioning status of thyroid tissue was determined by TS. Thus, both studies are not alternatives. The lingual thyroid was the most common location for ectopic thyroid to be detected. The dual ectopia was also found to be commoner and presented late due to the presence of functioning thyroid tissue.

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