Unveiling an Autonomously Functioning Thyroid Nodule: A Diagnostic Approach Using Thyroid Scintigraphy and HRUS of Thyroid

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ABSTRACT

Autonomously functioning thyroid nodule (AFTN) is one of the least common causes of hyperthyroidism. AFTN is a single hyper functioning thyroid nodule that is TSH independent and not controlled by the anterior pituitary gland or thyroid axis. As there are no tissue diagnostic criteria for AFTN, ultrasonography, scintigraphy, and biochemical assessments can evaluate AFTN. High-Resolution Ultrasound (HRUS) is recommended as the first-line modality in evaluating different types of thyroid nodules. Technetium-99m (Tc-99m) pertechnetate thyroid scintigraphy is a functional nuclear medicine study that uses a low level of radioactive tracer to assess the thyroid gland. The ensuing case is based on a 52-year-old male patient presenting with anterior neck swelling and neck pain who was referred to INMAS, Cox's Bazar, for clinical evaluation.

Keywords: Autonomously functioning thyroid nodule, 99m Tc-pertechnetate thyroid scintigraphy, High resolution ultrasound.

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INTRODUCTION

Swellings in the anterior part of the neck most commonly originate from the thyroid and this can be confirmed by demonstrating the movements with swallowing. If there is any doubt about the cause of an anterior neck swelling, an ultrasound scan should be performed immediately. Hyperthyroidism (thyrotoxicosis) describes a constellation of clinical features arising from elevated circulating levels of thyroid hormones. The most common causes are Graves' disease, multinodular goiter (MNG), autonomously functioning thyroid nodule (toxic adenoma), and thyroiditis (1). AFTN was first described by Emil Goetsch in 1918. He demonstrated a high concentration of mitochondria in hyperfunctioning thyroid nodule (2). The current theory on the development of hyperfunctioning nodule is constitutive activation of the thyroid-stimulating hormone receptor (TSHR) due to somatic point mutation and mutations of Gsa (3). AFTN is common in elderly patients (>60 years) (4). Solitary autonomous nodules in adult patients characteristically progress slowly over many years, with toxicity rarely developing in nodules less than 2.5 cm in diameter and occurring primarily in nodules 3 cm or larger and in older patients (5). Thyroid scan, or thyroid scintigraphy, is a medical imaging technique performed in the nuclear medicine department using a low dose of a radioactive tracer. It provides information about thyroid gland morphology and function, thus helping us to guide treatment for thyroid disease. Thyroid scan produces an image of the thyroid gland after intravenous injection of a weak radioactive tracer. The most used radio-active tracer is 99mTc pertechnetate which has a short half-life, cost effective and is absorbed by the thyroid tissue in varying degrees allowing us to diagnose different types of thyroid disease. An autonomous nodule is one that takes all of the radioactive substances, with no uptake in the rest of the gland (6).

CASE REPORT

A 52 years old male patient was referred to INMAS, Cox's Bazar for HRUS of thyroid and Thyroid scintigraphy to exclude thyroiditis. He presented with an anterior neck swelling for 2 years and anterior neck pain for 2 weeks. Patient had history of gradual weight loss and occasional palpitation. On general examination, we found the patient was anxious, cachexic, warm & sweaty hand with fine tremor. His vitals were: Heart rate 120 beats/min, BP: 140/90 mm Hg. On physical examination, an oval-shaped soft palpable mass was found in the left anterior neck which was firm in consistency, non-tender, mobile, no retrosternal extension, no palpable lymph node, and bruit was present. Radio-immune assay of thyroid hormones showed FT3:

10.08 [3.50 – 8.56 fmol/L], FT4: 28.20 [8.56 – 25.00 fmol/L], TSH: 0.01 [0.30 – 5.00 mIU/L], which was diagnostic of hyperthyroid state. HRUS of thyroid gland revealed a fairly big, solid, heterogeneous nodule (3.8 x 2.8 x 3.4 cm) occupying almost the entire left lobe (Figure-1A) with increased vascularity on color doppler (Figure-1B).

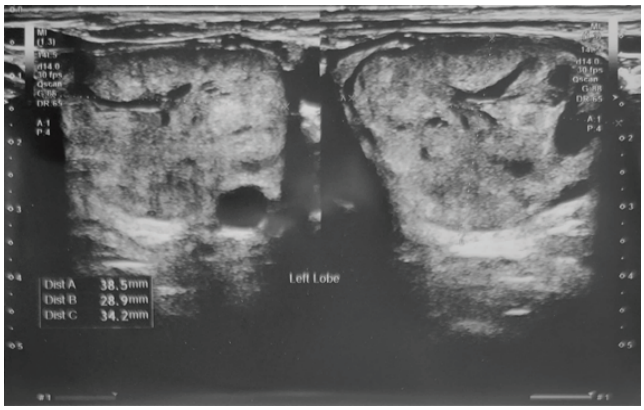

Figure 1A: High-Resolution Ultrasound of Thyroid showing a large solid nodule almost occupying the entire left lobe.

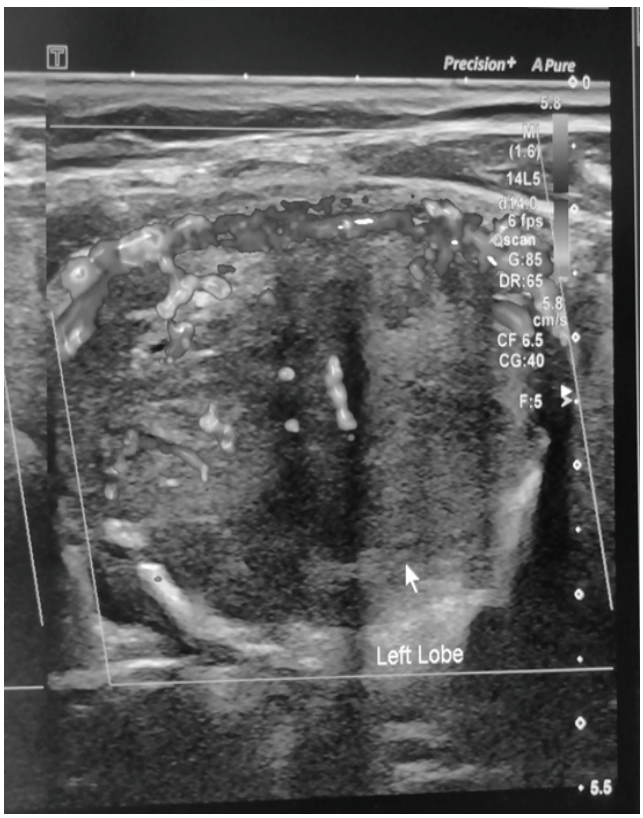

Figure 1B: On Color Doppler High-Resolution Ultrasound of Thyroid showing increased vascularity in left thyroid nodule.

Another smaller, isoechoic solid nodule with dark halo around was seen in right lobe (Figure-2) having and a macro calcification (3.3 mm) within.

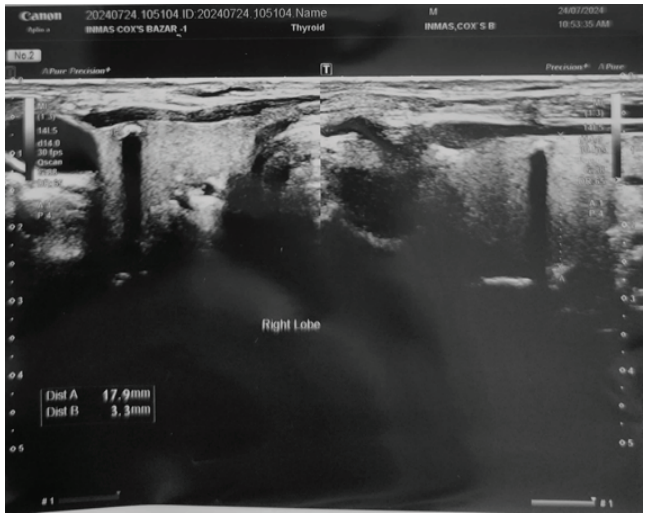

Figure 2: High Resolution Ultrasound of Thyroid showing a small isoechoic solid nodule with dark halo around and a macro calcification in right lobe.

Thyroid scintigraphy was done with 99m-Tc-pertechnetate injection and image revealed increased radio-tracer concentration in left thyroid nodule but suppressed or no radio-tracer concentration was detected in the rest of the gland. Salivary glands showed no radio-tracer uptake (Figure-3).

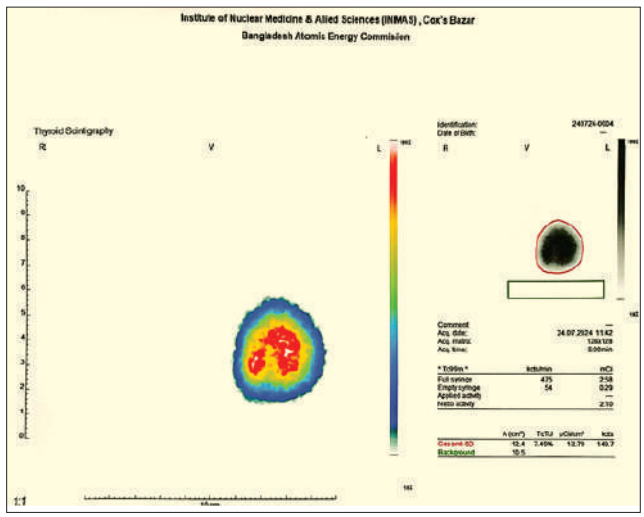

Figure 3. Thyroid Scintigraphy showed high radio-tracer uptake in left thyroid nodule with suppressed or no uptake by rest of the gland.

DISCUSSION

A thyroid nodule is an abnormal growth of thyroid cell that forms a lump within the thyroid gland. Thyroid nodules are extremely common. While most of the thyroid nodules are benign. Approximately 5% are cancerous. A

cancerous nodule or cold nodule is actually non-functioning. Autonomously functioning thyroid nodule is producing excessive amounts of thyroid hormones that lacks the usual regulation of normal thyroid tissue. In the general population, the prevalence of AFTN ranges from 2.7 to 4.4% (7). It varies according to the geographical area and iodine intake. In AFTN, the major risk factor is iodine deficiency which impairs thyroid hormone synthesis and stimulates cellular growth leading to develop autonomous thyroid nodule (8). AFTN may have variable activity levels featuring subclinical hyperthyroidism, overt thyrotoxicosis, and elevated T3 levels. Patients with subclinical hyperthyroidism may present with symptoms to a lesser degree than those with overt hyperthyroidism. Rarely patients with thyroid nodules may complain of neck, jaw, or ear pain. Clinical manifestations of hyperthyroidism vary based on age, sex, comorbidities, duration of disease, and the underlying cause. Older patients may present with fewer and less pronounced symptoms than younger patients but are more likely to develop complications if left untreated, most notably atrial fibrillation, osteoporosis, embolic events, congestive heart failure, and even cardiovascular collapse and death (9). In this case, the patient hailed from the southern part of Bangladesh, Cox's Bazar. He had symptoms that favored hyperthyroidism with anterior neck swelling and pain in the neck region. On thyroid function test patient was in hyperthyroid state. Hyperthyroidism has many causes like grave's disease, toxic multinodular goitre, and AFTN. Among them, AFTN is a very rare case, so often it is underdiagnosed. Although AFTN is very rare in coastal areas, most cases are found in iodine-deficient areas. Despite being a remote area, having a nuclear medicine center here allows us to make prompt diagnosis by using ultrasonogram and thyroid scintigraphy tests. If underlying causes can't be unveiled, the proper treatment will be delayed. High-resolution ultrasound (HRUS) is key tool for thyroid nodule evaluation which uses high-frequency sound waves to obtain a picture of the thyroid gland. It can easily determine the nature (solid, cystic or complex) and size of the nodule. Ultrasound can help identify suspicious nodules since some ultrasound characteristics of thyroid nodules are more frequent in thyroid cancer than in noncancerous nodules. After the initial evaluation, a series of ultrasounds with regular intervals can be done to keep an eye on nodules that do not require surgery to determine if they are growing or shrinking over time. Thyroid scintigraphy has an important role in the evaluation of rare nodules that cause hyperthyroidism. Thyroid scintigraphy with 99mTc pertechnetate should be performed in an individual with a low serum TSH and a nodular thyroid to confirm the presence of an autonomously functioning ('hot') nodule that takes up radioactive substance to an extent either similar to or greater than the uptake of normal cells (1). According to guidelines by the American Thyroid Association, if the TSH is low, typically indicating hyperthyroidism or subclinical hyperthyroidism, thyroid scanning is recommended to determine if the nodule is autonomous (hyperfunctioning). Even with normal TSH levels, thyroid scintigraphy is recommended in the investigation of a solitary nodule of a thyroid exceeding 1–1.5 cm (10). If the nodule is autonomous, biopsy is not recommended because the risk of cancer in these nodules is very low. The autonomous thyroid nodules need to be treated only when they become toxic: in this case, both surgical excision and radioiodine may be used (11). AFTN may be treated surgically (patients younger than 40) or with radioactive iodine (older patients). High-dose radioactive iodine therapy is preferred because it more consistently ablates AFTN function (12). A single 131I dose was effective for the vast majority of patients (93%). 131I therapy with a calculated dose is an effective treatment of AFTN. If a fixed dose is chosen, 16 mCi is often resolutive, and for nodules <3 cm, a dose of 10 mCi can suffice. Nodules >5 cm are eligible for surgery (13). Total thyroidectomy is not indicated in an AFTN as it is a solitary benign lesion (14). It causes permanent hypothyroidism, and patients have to take thyroxine therapy lifelong. Given that antithyroid drugs can reduce thyroid hormones but can't cure AFTN, surgery and radioactive iodine represent the standard of care for this condition (15), particularly when AFTN becomes

symptomatic (16). Minimally invasive ultrasound-guided techniques, such as percutaneous ethanol injection therapy (PEIT), laser ablation, and radiofrequency ablation (RFA), have been recently introduced into clinical practice as alternative treatments for symptomatic benign thyroid nodules, including AFTN (15). Due to their efficacy and tolerability, these techniques have become increasingly available, and their usage has been extended also to autonomously functioning thyroid nodule.

CONCLUSION

An autonomous thyroid nodule is often overlooked in patients with subclinical hyperthyroidism. Early detection using thyroid ultrasound and thyroid scintigraphy can reduce the complication of AFTN, a curative disease and confirm the diagnosis without further any investigation.

REFERENCES

1. Penman, I.D., Ralston, S.H., Strachan, M.W. and Hobson, R. eds., 2022. Davidson's Principles and Practice of Medicine E-Book: Davidson's Principles and Practice of Medicine E-Book. Elsevier Health Sciences.
2. Goetsch, E., 1918. Newer methods in the diagnosis of thyroid disorders: pathological and clinical. NY State J Med, 18, p.259.
3. Krohn, K., Fuhrer, D., Bayer, Y., Eszlinger, M., Brauer, V., Neumann, S., Paschke, R. and Führer-Sakel, D., 2005. Molecular pathogenesis of euthyroid and toxic multinodular goiter. Endocrine reviews, 26(4), pp.504-524.
4. HAMBURGER, J.I., 1980. Evolution of toxicity in solitary nontoxic autonomously functioning thyroid nodules. The Journal of Clinical Endocrinology & Metabolism, 50(6), pp.1089-1093.
5. Thomas Jr, C.G. and Croom III, R.D., 1987. Current management of the patient with autonomously functioning nodular goiter. Surgical Clinics of North America, 67(2), pp.315-328.
6. Chami, R., Moreno-Reyes, R. and Corvilain, B., 2014. TSH measurement is not an appropriate screening test for autonomous functioning thyroid nodules: a retrospective study of 368 patients. European journal of endocrinology, 170(4), pp.593-599.
7. Belfiore, A., Sava, L., Runello, F., Tomaselli, L. and Vigneri, R., 1983. Solitary autonomously functioning thyroid nodules and iodine deficiency. The Journal of Clinical Endocrinology & Metabolism, 56(2), pp.283-287.
8. Baltisberger, B.L., Minder, C.E. and Bürgi, H., 1995. Decrease of incidence of toxic nodular goitre in a region of Switzerland after full correction of mild iodine deficiency. European Journal of Endocrinology, 132(5), pp.546-549.
9. Sag, A.A., Kazaure, H.S. and Kelley, C.E., 2022. Role of thyroid RFA in the treatment of autonomously functioning thyroid nodules. Techniques in Vascular and Interventional Radiology, 25(2), p.100823.
10. Moreno-Reyes, R., Kyrilli, A., Lytrivi, M., Bourmorck, C., Chami, R. and Corvilain, B., 2016. Is there still a role for thyroid scintigraphy in the workup of a thyroid nodule in the era of fine needle aspiration cytology and molecular testing?. F1000Research, 5.
11. Vigneri, R., Catalfamo, R., Freni, V., Giuffrida, D., Gullo, D., Ippolito, A., Iurato, P., Tumino, S., La Rosa, G.L. and Regalbuto, C., 1993. Physiopathology of the autonomous thyroid nodule. Minerva endocrinologica, 18(4), pp.143-145.
12. Hamburger, J.I., 1987. The autonomously functioning thyroid nodule: Goetsch's disease. Endocrine reviews, 8(4), pp.439-447.
13. Ronga, G., Filesi, M., D'Apollo, R., Toteda, M., Di Nicola, A.D., Colandrea, M., Travascio, L., Vestri, A.R. and Montesano, T., 2013. Autonomous functioning thyroid nodules and 131I in diagnosis and therapy after 50 years of experience: what is still open to debate?. Clinical Nuclear Medicine, 38(5), pp.349-353.
14. Pinto, D. and Fernando, R., 2021. Autonomously functioning thyroid nodule: a patient-based review. Sri Lanka Journal of Surgery, 39(3).
15. HaugenBryan, R., AlexanderErik, K., BibleKeith, C., DohertyGerard, M., MandelSusan, J., NikiforovYuri, E., RandolphGregory, W., SawkaAnna, M., SchuffKathryn, G., ShermanSteven, I. and Ann, S., 2016. 2015 American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: the American Thyroid Association guidelines task force on thyroid nodules and differentiated thyroid cancer. Thyroid.
16. Thomas Jr, C.G. and Croom III, R.D., 1987. Current management of the patient with autonomously functioning nodular goiter. Surgical Clinics of North America, 67(2), pp.315-328.