Pictorial Review of Unexpected and Extrathyroidal findings on Routine Thyroid Ultrasound Examinations

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ABSTRACT

Thyroid ultrasound is essential for the non-invasive assessment and management of thyroid diseases. While its primary focus is on evaluating the thyroid gland, incidental findings in the surrounding neck structures, known as extrathyroidal pathologies, are frequently encountered. These findings can have significant clinical implications and must not be overlooked.

This retrospective review of 1,000 thyroid ultrasound examinations conducted between January 1, 2018 and December 31, 2023, aims to illustrate various extrathyroidal and unexpected findings. Notable examples include peripheral nerve sheath tumors (e.g., Schwannoma, plexiform neurofibromatosis), thyroglossal duct cysts, Zenker's diverticulum, parathyroid adenomas, thyroid lymphomas, thrombus within the internal jugular vein, ectopic thymus and Zuckerkandl tubercle mimicking a thyroid mass.

While ultrasound remains the cornerstone imaging modality, in several cases, further evaluation with advanced imaging techniques such as computed tomography and magnetic resonance imaging was required, and some patients underwent surgical interventions.

The objective of this review is to highlight the importance of recognizing these unexpected findings during routine thyroid ultrasounds and to discuss their clinical management. Understanding the imaging characteristics of these pathologies enables radiologists to make accurate diagnoses, improving patient outcomes and reducing the need for unnecessary procedures.

This study underscores the role of multidisciplinary approaches in managing incidental extrathyroidal pathologies, emphasizing the combined use of imaging modalities to ensure effective and timely treatment planning.

REVIEW ARTICLE

BACKGROUND

Thyroid ultrasound is essential for the non-invasive assessment and management of thyroid diseases. While its primary focus is on evaluating the thyroid gland, incidental findings in the surrounding neck structures, known as extrathyroidal pathologies, are frequently encountered. This review contributes to the literature by illustrating a diverse array of extrathyroidal pathologies that can be identified on thyroid ultrasound. This review emphasizes the importance of not overlooking incidental findings, as these can have significant clinical implications.

INTRODUCTION

Thyroid ultrasound serves as a cornerstone in the non-invasive assessment and management of thyroid diseases. While it's primary purpose is to evaluate the thyroid gland, routine ultrasound examinations often reveal **unexpected and extrathyroidal findings** in the surrounding neck structures.

These incidental discoveries, often outside the thyroid gland, can have significant clinical implications and should not be overlooked, as they can hold significant clinical implications.

In the context of a retrospective audit, we scrutinized 1000 thyroid ultrasound studies conducted between 1st January 2018, and December 31, 2023, at the department of radiology of our hospital. The aim of this review is to highlight the variety of **unexpected and extrathyroidal findings** detected during routine thyroid ultrasounds. Through selected case examples, we illustrate a broad spectrum of lesions, including peripheral nerve sheath tumors (e.g., schwannomas, plexiform neurofibromatosis), thyroglossal duct cysts, Zenker's diverticulum, parathyroid adenomas, thyroid lymphomas, thrombus within the internal jugular vein, ectopic thymus and the Zuckerkandl tubercle mimicking a thyroid mass.

In many cases, these extrathyroidal findings required further evaluation using advanced imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI), with some patients undergoing surgical intervention. This review underscores the importance of recognizing and appropriately managing **unexpected extrathyroidal findings** encountered during routine thyroid ultrasound examinations, as they can impact clinical decisions and patient outcomes.

Peripheral nerve sheath tumor

Peripheral nerve sheath tumors (PNSTs) are a group of primary neurogenic tumours that arise from the peripheral nerve sheaths. The two most common types of PNSTs are schwannomas and neurofibromas. Schwannomas account for approximately 5% of all benign soft tissue tumors, while neurofibromas make up slightly more than 5% [1]. Differentiating between these two entities can be challenging as they share common imaging features. A rare form, plexiform neurofibroma, is a slow growing, painless and locally infiltrating tumor involving multiple nerve fascicles, occurring in 5-15% of patients with **neurofibromatosis type 1 (NF-1) [1]** (Figures 1,2).

Ultrasound is valuable for the initial evaluation of PNSTs. These tumors typically appear as homogeneous, hypoechoic lesions with posterior acoustic enhancement and often show continuity with the peripheral nerve [2]. A characteristic imaging feature of PNSTs is the **'target sign',** observed on ultrasonography, which is characterized by a central hyperechoic zone surrounded by a peripheral hypoechoic area [2].

On CT scans, PNSTs typically exhibit low to intermediate attenuation. The enhancement pattern may vary between schwannomas and neurofibromas. Smaller schwannomas may show homogeneous enhancement while larger ones often exhibit heterogeneous enhancement. In contrast, neurofibromas often show little to no enhancement.

MRI is considered the modality of choice for evaluating PNST due to its superior soft tissue contrast. **Schwannomas** typically appear as T1-hypointense and T2-hyperintense lesions, often with heterogeneous enhancement on MRI. **Neurofibromas**, on the other hand, may display the **'target sign'** on T2-weighted MRI, characterized by a central area of low signal intensity surrounded by a peripheral hyperintense rim [3].

Recognizing these imaging features is crucial for differentiating between schwannomas and neurofibromas, which provides essential information for treatment planning and patient management.

Thyroglossal duct cyst

Thyroglossal duct cysts are the most common midline neck abnormalities, accounting for approximately 70% of congenital neck lesions [4]. These cysts can occur anywhere along the course of the thyroglossal duct from the foramen cecum to the thyroid gland although most commonly located in the infrahyoid region within 2 cm of the midline (Figure 3).

Ultrasound is typically the first imaging modality used to evaluate suspected thyroglossal duct cysts. Uncomplicated cysts appear as well-circumscribed, thin-walled, anechoic lesions, but may occasionally appear pseudosolid due to the presence of proteinaceous fluid, cholesterol crystals, or keratin [4]. Complicated cysts however may present as hypoechoic lesions with internal echoes or demonstrate heterogeneous complex features with internal septa and wall nodularity. Additionally, ultrasound can detect surrounding soft tissue oedema and sinus tracts or fistula as well as regional reactive lymphadenopathy.

CT and MRI are valuable modalities for further characterization and delineation of thyroglossal duct cysts. On CT, uncomplicated thyroglossal duct cysts typically appear as smooth, well-circumscribed, thin-walled midline lesions, closely related to the hyoid bone, with homogeneous fluid or mucoid attenuation (10–25 HU) with or without septations [5]. Complex or complicated cysts may demonstrate increased attenuation, particularly in the presence of infection.

On MRI, uncomplicated thyroglossal duct cysts typically exhibit fluid signal intensity on both T1-weighted and T2-weighted images. In the presence of infection or hemorrhage, the signal intensity may become more variable. High signal on T1-weighted images can be observed due to hemorrhagic or proteinaceous fluid content, or the presence of thyroglobulin within the cyst fluid. In some cases (18%), a tract extending toward the base of the tongue may be identified on T2-weighted fat-saturated images [5].

It is important to consider the rare possibility of **thyroglossal duct carcinoma, which** occurs in about 1–2% of all thyroglossal cysts [6]. The presence of a solid component within the cyst on imaging should raise concerns for malignancy and prompt further evaluation, including biopsy for definitive diagnosis. Overall, a thorough understanding of the imaging characteristics of thyroglossal duct cysts and their potential complications is essential for accurate diagnosis and appropriate management.

Zenker's diverticulum

Zenker's diverticulum, also known as a pharyngeal pouch, typically occurs just proximal to the upper oesophageal sphincter. It arises as a posterior outpouching due to a weakness in the inferior pharyngeal constrictor muscles; this defect is known as the Killian dehiscence. The overall prevalence of **Zenker's diverticulum** among the general population is believed to be between 0.01% and 0.11% [7]. It accounts for 75% of all oesophageal diverticula [8].

Ultrasound can be used to visualize Zenker's diverticulum, where it typically appears as an isoechoic or hypoechoic mass located posterior to the thyroid gland [9]. Internal echoes may be present, representing the content of the diverticulum, such as air, fluid or debris. It's important to note that Zenker's diverticulum can mimic thyroid nodules on ultrasound. However, certain sonographic features can help differentiate it from thyroid nodules, such as changes in shape and shadowing due to gas microbubbles entering the diverticulum during swallowing. Additionally, the presence of a peripheral echogenic line with a multilayered pattern (mucosa, sub-mucosa, and muscular layers) of the lesion suggests an origin from the digestive tract [10]. Performing water swallowing and compression/decompression manoeuvers during ultrasound can aid in confirming the diagnosis (Figure 4).

Barium swallow study is considered the gold standard for evaluating Zenker's diverticulum. It typically shows an outpouching arising from the midline of the posterior wall of the hypopharynx near the pharyngoesophageal junction. The diverticulum is best visualized during swallowing and may protrude laterally, often to the left side if large in size. On CT scans, Zenker's diverticulum typically presents as a structure arising posteriorly from the hypopharynx. It can be filled with air, fluid or orally administered contrast material.

Overall, a combination of imaging modalities including ultrasound, barium swallow studies, and CT scans, can be used to accurately diagnose Zenker's diverticulum and differentiate it from other neck pathologies.

Parathyroid adenoma

Parathyroid adenomas are benign tumors of the parathyroid glands that often manifest as primary hyperparathyroidism. In 80% to 90% of cases, primary hyperparathyroidism is caused by a single parathyroid adenoma [11]. These adenomas are typically located near or within the thyroid gland and can be evaluated using a combination of imaging techniques [12] (Figure 5).

A combination of ultrasound and Tc-99m sestamibi scintigraphy which integrates both anatomic and functional information, is current first line imaging approach in suspected parathyroid adenoma [13].

Parathyroid adenomas can be incidentally identified on thyroid ultrasound. These adenomas typically appear as round to ovoid-shaped nodules that are homogeneously hypoechoic relative to the thyroid gland on ultrasound. In some cases, internal echogenicity may be present due to factors such as fat, hemorrhage, or calcification. The adenoma is usually separated from the thyroid tissue by an echogenic capsule and may exhibit hypervascularity on color Doppler imaging [13]. Identification of a feeding vessel at the lower pole of the adenoma can significantly improve diagnostic accuracy.

Combining Tc-99m sestamibi scintigraphy with single-photon emission computed tomography (SPECT)/CT provides a valuable imaging modality for localizing parathyroid adenomas. These adenomas typically show high radiotracer uptake on these scans, aiding in their localization. SPECT/CT fusion imaging enhances the performance of Tc-99m sestamibi scintigraphy compared to planar imaging and SPECT alone. The 4D CT scan is increasingly utilized for preoperative localization of abnormal parathyroid tissue. This modality involves multiple phases, including a non-contrast phase, followed by arterial phase imaging (25-30 seconds after contrast bolus), venous phase (~30 seconds after the arterial phase), and delayed venous phase (~60 seconds after the arterial phase). Parathyroid adenomas usually appear hypoattenuated on non-contrast scans and exhibit higher attenuation than the thyroid in the arterial phase, with subsequent "wash-out" in the venous phase. However, this classic pattern is observed in only about 20% of adenomas. The 4D CT scan is sensitive and specific for detecting parathyroid adenomas, especially in cases with discordant or inconclusive findings on other imaging modalities or in patients with altered neck anatomy [14].

Overall, a combination of ultrasound, Tc-99m sestamibi scintigraphy with SPECT/CT, and 4D CT scans offers a comprehensive evaluation and localization of parathyroid adenomas, facilitating effective preoperative planning and improving surgical outcomes.

Thyroid lymphoma

Thyroid gland lymphomas represent a small percentage of thyroid neoplasms, accounting for approximately 5% of all cases [15]. These lymphomas predominantly occur in older individuals, with a marked female predilection and a median age between 70 and 80 years [15]. Notably, around 80% of thyroid lymphomas develop in the context of Hashimoto's thyroiditis, an autoimmune thyroid disorder [16]. The most common histological subtype of thyroid lymphoma is diffuse large B cell lymphoma [16] (Figure 6).

Ultrasound is the primary imaging modality for evaluating thyroid masses, including lymphomas. Thyroid lymphomas can exhibit one of three sonographic patterns: nodular, diffuse, or mixed. When presenting as a solitary mass, the ultrasound appearance of thyroid lymphoma may closely mimic that of other thyroid tumors, making it challenging to distinguish [16].

In cases of diffuse thyroid lymphoma, ultrasound typically shows a heterogeneous hypoechoic parenchyma, often with septal-like structures. Multinodular lesions with distinct margins may also be observed, which can resemble a goiter. However, unlike goiters, thyroid lymphomas generally do not exhibit cystic degeneration. To obtain a definitive diagnosis and guide treatment, ultrasound-guided fine needle aspiration (FNA) or core biopsy is necessary to obtain cytology or histology .

Although cross-sectional imaging modalities such as CT and MRI are not typically used to evaluate the thyroid lesion itself, they play a crucial role in assessing the extent of disease and involvement of surrounding structures. These imaging techniques are particularly valuable for surgical planning, as they provide detailed information about cervical and mediastinal nodal involvement and help determine the extent of the disease beyond the thyroid gland. CT and MRI are therefore instrumental in evaluating potential compression or invasion of adjacent structures by the thyroid lymphoma. For instance, these modalities can assess whether the lymphoma is impinging on the trachea, esophagus, or blood vessels, which is essential for planning surgical or other therapeutic interventions. CT, in particular, is useful for evaluating the size, shape, and density of the lesion and for detecting calcifications, while MRI is superior for assessing soft tissue contrast and distinguishing between different tissue types. This comprehensive imaging approach ensures accurate staging and helps in formulating an effective treatment plan for patients with thyroid lymphoma.

Thyroid carcinoma

Thyroid carcinoma is the most prevalent endocrine cancer in adults, accounting for approximately 2.1% of all cancer diagnoses globally [17]. The main diagnostic tool for evaluating primary thyroid carcinoma is ultrasound. This imaging modality is especially valuable for identifying thyroid nodules and assessing their features. The American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS) is increasingly employed to standardize the reporting and management of thyroid nodules based on ultrasound characteristics. This system aids in guiding decisions regarding whether to perform fine needle aspiration (FNA) or to recommend follow-up ultrasound for nodules that appear suspicious (Figures 7,8).

Ultrasound is particularly effective in detecting thyroid carcinoma, often presenting as a solitary mass with suspicious sonographic features for malignancy [18,19]. Some key features include:

- Irregular margins: Nodules with spiculated or lobulated edges are more likely to be malignant.
- Increased vascularity: Hypervascularity, especially in a subcapsular location, suggests a higher risk of cancer.
- Punctate echogenic foci: The presence of microcalcifications are often associated with papillary thyroid carcinoma.

While ultrasound is the primary imaging modality for evaluating thyroid nodules and diagnosing thyroid carcinoma, CT scans also play a significant role, especially in cases of locally advanced or regionally metastatic disease. CT imaging is particularly useful in the following scenarios:

- Assessment of vascular anatomy: CT provides detailed information on the vascular structures around the thyroid gland, which is critical for planning surgeries and avoiding complications.
- Evaluation of adjacent structures: CT scans help assess the relationship of the thyroid mass to surrounding tissues, including the trachea, esophagus, and major blood vessels.
- Detection of lymph node metastases: CT is valuable for identifying regional lymph node involvement, which is crucial for accurate staging and treatment planning. Metastatic lymph nodes may appear enlarged or exhibit calcifications and may enhance differently from non-cancerous nodes following contrast administration.

In summary, the combination of ultrasound and CT provides a comprehensive approach to the diagnosis and management of thyroid carcinoma. Ultrasound remains the primary modality for initial assessment, guided by ACR TI-RADS to streamline decision-making for further evaluation or biopsy. CT complements ultrasound by offering additional detail on the extent of the disease, particularly in cases involving complex anatomy or suspected metastases, thus facilitating effective treatment planning and improving patient outcomes.

Internal jugular vein thrombosis

Intravascular thrombus within the internal jugular vein (IJV) and carotid arteries carries significant risks and can lead to life-threatening complications such as pulmonary embolism, superior sagittal sinus thrombosis, superior vena cava syndrome, and secondary complications from head and neck cancers. A cross-section study suggested that the prevalence of internal jugular vein thrombosis is 1.49% in patients exhibiting deep vein thrombosis (DVT). The most common causes of internal jugular vein thrombosis are cancer and central venous catheter [20]. Timely detection of these thrombi is crucial for effective management and prevention of adverse outcomes (Figure 9).

Colour Doppler ultrasound is often the initial imaging modality used for screening and follow-up of intravascular thrombosis [21]. For IJV thrombosis, ultrasound typically shows a hyperechoic thrombus with a non-compressible venous segment. In addition, the absence of colour flow within the vein indicates a complete occlusion by the thrombus.

CT Venography is another valuable tool for detecting IJV thrombus, and it can provide precise information about thrombus characteristics using density measurement. The density of nonocclusive thrombus within the vessels ranges from 38-44 HU, whereas occlusive thrombus has a density ranging from 48-65 HU. In this way, CT venogram can differentiate between acute and chronic thrombus based on the variable density of the clot. Moreover, it provides information of the extent of the thrombus and surrounding anatomy which can be useful for treatment planning.

MRI and MR venography with time-of-flight (TOF) sequence are non-invasive diagnostic tool that is highly sensitive and specific in assessing the patency of vessels. The signal intensity of venous thrombus on MRI can vary with the time of imaging from the onset of thrombus formation for example in acute stage (0–5 days), the thrombus typically shows predominantly T1 iso- and T2 hypo-intensity.

Invasive cerebral angiographic procedures may be necessary in cases where MRI or CT scan results are inconclusive, or when considering an endovascular procedure.

Overall, a combination of imaging modalities, including ultrasound, CT Venography, MRI, and occasionally invasive angiographic procedures, may be utilized based on the clinical scenario to accurately diagnose and manage intravascular thrombosis in the internal jugular vein and carotid arteries. Early detection and appropriate management are essential to prevent complications and improve patient outcomes.

Zuckerkandl tubercle

The Zuckerkandl tubercle is a projection from the normal thyroid lobe that extends towards the tracheoesophageal groove. It is an important anatomical landmark in thyroid surgery due to its close proximity to the recurrent laryngeal nerve, which is critical to preserve during thyroidectomy. Additionally, it serves as a useful guide for surgeons to locate and protect the nerve. A study reported the presence of the Zuckerkandl tubercle in approximately 70% of ultrasound cases [22] (Figure 10).

On ultrasound, the Zuckerkandl tubercle may be mistaken for an extrathyroidal lesion because of its location and appearance. This highlights the importance of careful ultrasound interpretation and the consideration of clinical context when evaluating thyroid anatomy to avoid misdiagnosis.

In terms of size variation, a grading system is used to classify the tubercle: grade 0 (unrecognizable tubercle), grade 1 (only thickening of the lateral edge of the thyroid lobe), grade 2 (tubercle < 1 cm), and grade 3 (tubercle > 1 cm) [23]. This grading system provides a standardized method for assessing the size and prominence of the tubercle, which can vary among individuals. By categorizing it into different grades based on size and appearance, surgeons can better anticipate its location and plan their surgical approach accordingly.

Understanding the anatomy and variations of structures like the Zuckerkandl tubercle is crucial for surgeons performing thyroid surgeries. Proper identification helps minimize the risk of injury to critical structures, such as the recurrent laryngeal nerve, thereby improving surgical outcomes.

Ectopic Thymus in the neck

Ectopic thymus is an embryological abnormality most commonly seen in cervical region in children. It occurs in approximately 1% to 13% of children who undergo neck imaging [24]. Ectopic thymus can be misinterpreted as a compressive neck mass or malignant tumour. Ultrasound is the ideal first-line imaging modality for investigating pediatric neck masses, as it effectively identifies normal thymic tissue in ectopic locations within the neck, as well as the cervical extension of the anterior mediastinal thymus **(Figure 11).**

On ultrasound, an ectopic cervical thymus typically exhibits hypoechoic echotexture with scattered hyperechoic foci giving a 'starry night' appearance and occasionally contain vascularity in colour Doppler ultrasound.

Occasionally, an ectopic thymus can be misinterpreted as malignant or neoplastic process which may lead to unnecessary biopsies. To avoid such invasive procedures, it is crucial for radiologists to recognize the imaging characteristics of ectopic thymic tissue, particularly in the pediatric population.

Although the thymus is larger in children compared to adults, its CT imaging characteristics remain relatively unchanged across age groups. However, in the pediatric population, MRI may have limited sensitivity in distinguishing between malignant and normal thymic tissues due to the higher cellularity and lack of fat content in the thymus. On MRI, thymic tissue in children appears homogeneously hyperintense relative to muscle on fat-saturated T1- and T2-weighted sequences, with mild post-gadolinium enhancement. Additionally, the signal intensity of normal thymic tissue increases with age due to rising fat content and thymic involution.

CONCLUSION

Routine thyroid ultrasound examinations often reveal incidental extrathyroidal lesions, many of which carry significant clinical implications. Accurate identification and appropriate management of these findings are crucial for preventing complications and ensuring optimal patient outcomes. The use of advanced imaging modalities, such as CT, MRI, and, when necessary, invasive angiographic procedures, enhances diagnostic accuracy and aids in effective treatment planning. This study highlights the need for radiologists and clinicians to be vigilant about extrathyroidal pathologies and underscores the value of a multidisciplinary approach in managing these incidental findings.

TEACHING POINT

Routine thyroid ultrasound examinations often reveal incidental extrathyroidal lesions, many of which carry significant clinical implications. Accurate identification and appropriate management of these findings are crucial for preventing complications and ensuring optimal patient outcomes.

QUESTIONS

Question 1: Regarding peripheral nerve sheath tumors (PNSTs), which of the following answer choices is false?

1. Two most common types of peripheral nerve sheath tumors (PNSTs) are schwannomas and neurofibromas.
2. Plexiform neurofibroma is associated with **neurofibromatosis type 1.**
3. **'Target sign' is not a feature of ultrasound.** (applies)
4. **'Target sign' is a feature of MRI.**
5. PNSTs can show posterior acoustic enhancement on ultrasound.

Explanation:

1. Two most common types of peripheral nerve sheath tumors (PNSTs) are schwannomas and neurofibromas. [The two most common types of PNSTs are schwannomas and neurofibromas.]
2. Plexiform neurofibroma is associated with **neurofibromatosis type 1. [**A rare form, plexiform neurofibroma, is a slow growing, painless and locally infiltrating tumor involving multiple nerve fascicles, occurring in 5-15% of patients with **neurofibromatosis type 1 (NF-1).]**
3. **'Target sign' is a feature of ultrasound. [**A characteristic imaging feature of PNSTs is the **'target sign',** observed on ultrasonography, which is characterized by a central hyperechoic zone surrounded by a peripheral hypoechoic area.]
4. **'Target sign' is a feature of MRI. [Neurofibromas**, on the other hand, may display the **'target sign'** on T2-weighted MRI, characterized by a central area of low signal intensity surrounded by a peripheral hyperintense rim.]
5. PNSTs can show posterior acoustic enhancement on ultrasound. [These tumors typically appear as homogeneous, hypoechoic lesions with posterior acoustic enhancement and often show continuity with the peripheral nerve.]

Question 2: Regarding t**hyroglossal duct cyst, w**hich of the following answer choices is false?

1. Thyroglossal duct cysts are the most common midline neck abnormalities.
2. These cysts most commonly located in the infrahyoid.
3. Uncomplicated cysts must appear anechoic. (applies)
4. Complicated cysts may present as hypoechoic lesions with internal echoes or internal septa or wall nodularity.
5. Complex or complicated cysts may demonstrate increased attenuation.

Explanation:

1. Thyroglossal duct cysts are the most common midline neck abnormalities. [Thyroglossal duct cysts are the most common midline neck abnormalities.]
2. These cysts most commonly located in the infrahyoid. [These cysts can occur anywhere along the course of the thyroglossal duct from the foramen cecum to the thyroid gland although most commonly located in the infrahyoid region within 2 cm of the midline.]
3. Uncomplicated cysts can appear pesudosolid. [Uncomplicated cysts appear as well-circumscribed, thin-walled, anechoic lesions, but may occasionally appear pseudosolid due to the presence of proteinaceous fluid, cholesterol crystals, or keratin.]
4. Complicated cysts may present as hypoechoic lesions with internal echoes or internal septa or wall nodularity. [Complicated cysts however may present as hypoechoic lesions with internal echoes or demonstrate heterogeneous complex features with internal septa and wall nodularity.]
5. Complex or complicated cysts may demonstrate increased attenuation. [Complex or complicated cysts may demonstrate increased attenuation, particularly in the presence of infection.]

Question 3: Regarding Zenker's diverticulum, which of the following answer choices is false?

1. It arises as a posterior outpouching due to a weakness in the superior pharyngeal constrictor muscles. (applies)
2. It typically appears as an isoechoic or hypoechoic mass located posterior to the thyroid gland.
3. It may change in shape and shadowing due to gas microbubbles entering the diverticulum during swallowing.
4. Barium swallow study is considered the gold standard for evaluating Zenker's diverticulum.
5. Performing water swallowing and compression/decompression manoeuvers during ultrasound can aid in confirming the diagnosis.

Explanation:

1. It arises as a posterior outpouching due to a weakness in the inferior pharyngeal constrictor muscles. [It arises as a posterior outpouching due to a weakness in the inferior pharyngeal constrictor muscles; this defect is known as the Killian dehiscence.]
2. It typically appears as an isoechoic or hypoechoic mass located posterior to the thyroid gland. [Ultrasound can be used to visualize Zenker's diverticulum, where it typically appears as an isoechoic or hypoechoic mass located posterior to the thyroid gland.]
3. It may change in shape and shadowing due to gas microbubbles entering the diverticulum during swallowing. [However, certain sonographic features can help differentiate it from thyroid nodules, such as changes in shape and shadowing due to gas microbubbles entering the diverticulum during swallowing.]
4. Barium swallow study is considered the gold standard for evaluating Zenker's diverticulum. [Barium swallow study is considered the gold standard for evaluating Zenker's diverticulum.]
5. Performing water swallowing and compression/decompression manoeuvers during ultrasound can aid in confirming the diagnosis. [Performing water swallowing and compression/decompression manoeuvers during ultrasound can aid in confirming the diagnosis.]

Question 4: Regarding parathyroid adenomas, which of the following answer choices is false?

1. Parathyroid adenomas often manifest as primary hyperparathyroidism.
2. Internal echogenicity can be seen.
3. Identification of a feeding vessel at the lower pole of the adenoma can significantly improve diagnostic accuracy.
4. Delayed phase in 4D CT is 5 minutes after the arterial phase. (applies)
5. SPECT/CT provides a valuable imaging modality for localizing parathyroid adenomas.

Explanation:

1. Parathyroid adenomas often manifest as primary hyperparathyroidism. [Parathyroid adenomas are benign tumors of the parathyroid glands that often manifest as primary hyperparathyroidism.]
2. Internal echogenicity can be seen.[In some cases, internal echogenicity may be present due to factors such as fat, hemorrhage, or calcification.]
3. Identification of a feeding vessel at the lower pole of the adenoma can significantly improve diagnostic accuracy. [Identification of a feeding vessel at the lower pole of the adenoma can significantly improve diagnostic accuracy.]
4. 4. Delayed phase in 4D CT is 60 seconds after the arterial phase. [This modality involves multiple phases, including a non-contrast phase, followed by arterial phase imaging (25-30 seconds after contrast bolus), venous phase (~30 seconds after the arterial phase), and delayed venous phase (~60 seconds after the arterial phase).]
5. SPECT/CT provides a valuable imaging modality for localizing parathyroid adenomas.

[Combining Tc-99m sestamibi scintigraphy with single-photon emission computed tomography (SPECT)/CT provides a valuable imaging modality for localizing parathyroid adenomas.]

Question 5: Regarding **Thyroid lymphoma**, which of the following answer choices is false?

1. Predominantly occur in younger individuals. (applies)
2. Commonly associated with Hashimoto's thyroiditis.
3. Thyroid lymphomas can exhibit one of three sonographic patterns: nodular, diffuse, or mixed.
4. Thyroid lymphomas generally do not exhibit cystic degeneration.
5. CT and MRI play a crucial role in assessing the extent of disease and involvement of surrounding structures.

Explanation:

1. Predominantly occur in older individuals. [These lymphomas predominantly occur in older individuals, with a marked female predilection and a median age between 70 and 80 years.]
2. Commonly associated with Hashimoto's thyroiditis. [Notably, around 80% of thyroid lymphomas develop in the context of Hashimoto's thyroiditis, an autoimmune thyroid disorder.]
3. Thyroid lymphomas can exhibit one of three sonographic patterns: nodular, diffuse, or mixed. [Thyroid lymphomas can exhibit one of three sonographic patterns: nodular, diffuse, or mixed.]
4. Thyroid lymphomas generally do not exhibit cystic degeneration. [However, unlike goiters, thyroid lymphomas generally do not exhibit cystic degeneration.]
5. CT and MRI are not typically used to evaluate the thyroid lesion itself, they play a crucial role in assessing the extent of disease and involvement of surrounding structures. [Although cross-sectional imaging modalities such as CT and MRI are not typically used to evaluate the thyroid lesion itself, they play a crucial role in assessing the extent of disease and involvement of surrounding structures.]

AUTHORS' CONTRIBUTIONS

Yuxin Zheng: Data collection, drafting the manuscript
Chi Long Ho: Design of study, revision of manuscript

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DISCLOSURES

We have no conflicts of interest to disclose.
All authors declare that they have no conflicts of interest.

CONSENT

Nil.

HUMAN AND ANIMAL RIGHTS

Nil.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ETHICAL STATEMENT

Institutional review board approval was obtained.

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FIGURES

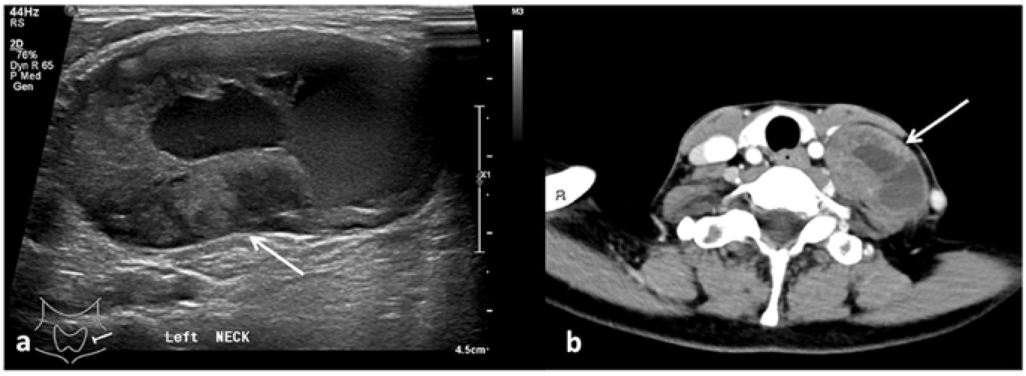

Figure 1: Ultrasound thyroid of a 63-year-old female (a) shows a mixed solid-cystic lesion (arrow) situated lateral to the left thyroid lobe. The characteristic 'target sign' of central hyperechoic and peripheral hypoechoic areas, is not well demonstrated here due to the mixed solid-cystic nature of the lesion. Axial CT scan (b) shows the mass (arrow) situated between the left common carotid artery and internal jugular vein. It enhances heterogeneously with low attenuating areas of necrosis. Histological analysis of the excised tumor specimens reveals a schwannoma.

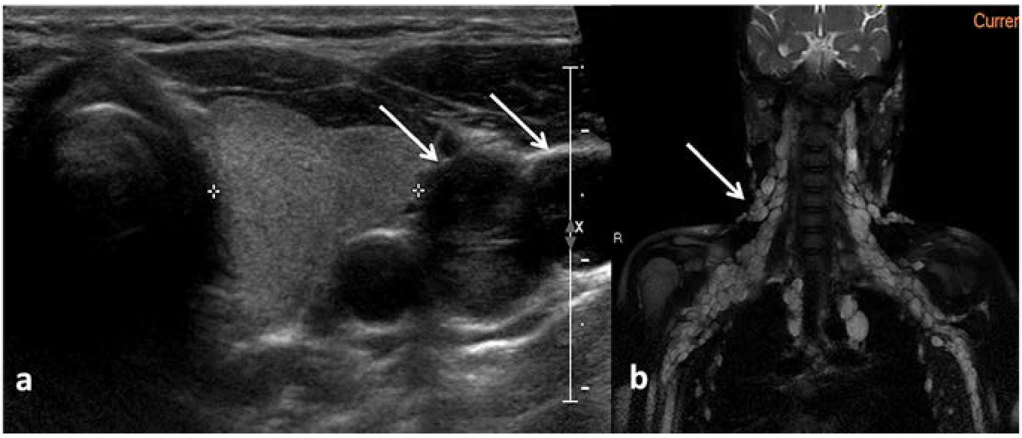

Figure 2: Thyroid ultrasound of a 15-year-old female with neurofibromatosis type I (NF-1) (a) demonstrating multiple lobulated hypoechoic solid lesions posterolateral to the left thyroid lobe (arrows). Coronal STIR MRI neck (b) shows innumerable fusiform lesions (arrow) from the skull base to both sides of the neck and axillae along the brachial plexus in keeping with plexiform neurofibromatosis. Neurofibromas typically demonstrate 'target sign' with central area of hypointensity and peripheral hyperintense rim.

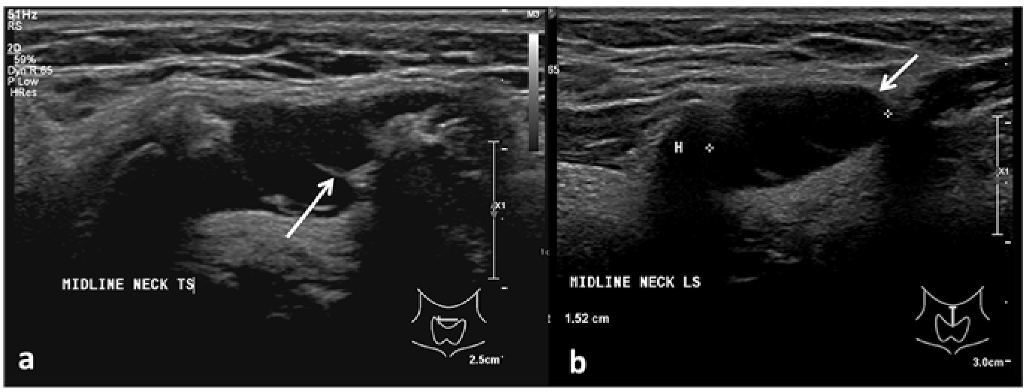

Figure 3: Transverse (a) and longitudinal (b) Ultrasound images of a 58-year-old female show an encapsulated cystic structure with internal septation and echogenic debris in the midline of the anterior neck. This is consistent with a thyroglossal duct cyst (arrows).

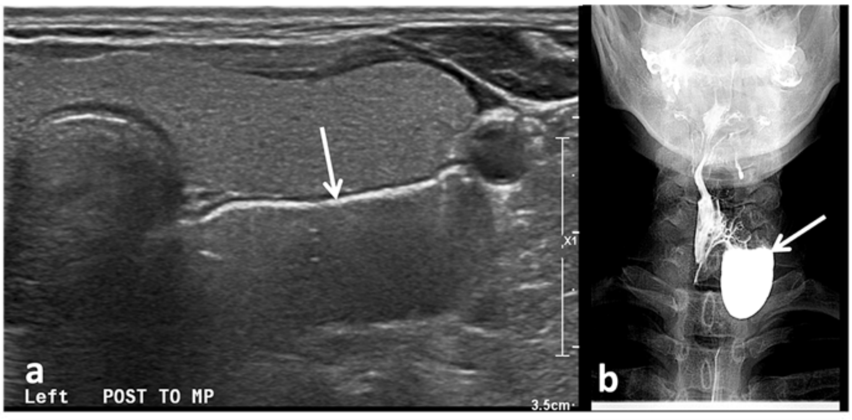

Figure 4: Transverse Ultrasound of a 44-year-old-female (a) shows an inhomogeneous structure posterior to left thyroid lower pole (arrow), containing a linear echogenicity indicating air within a structure with hollow viscus. Frontal pharyngeal view of barium swallow study (b) demonstrating a large left laterally directed pharyngeal pouch arising at C6 level (arrow) indicating a Zenker's diverticulum.

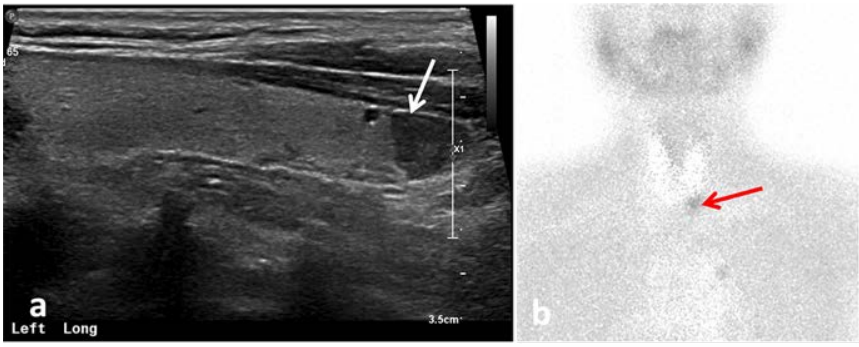

Figure 5: Longitudinal thyroid ultrasound image of a 61-year-old female (a) reveals a hypoechoic nodule inferior to the lower pole of the left thyroid lobe (white arrow). Thyroid scintigraphy scan (b) reveals a focus of increased sestamibi tracer uptake (red arrow) with delayed tracer washout projected over the lower pole of the left thyroid lobe, corresponds to the abnormality on thyroid ultrasound which is consistent with a parathyroid adenoma.

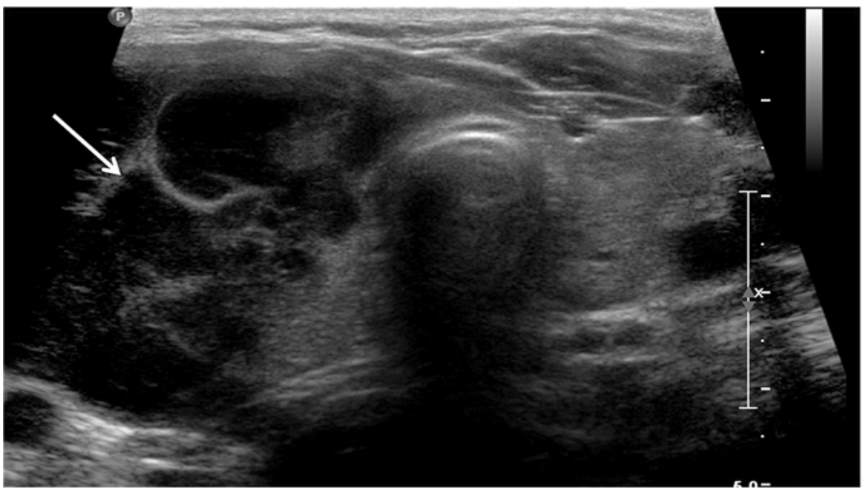

Figure 6: Thyroid ultrasound of a 70-year-old female reveals a hypoechoic, lobulated multiseptated mass (arrow) occupying the expected position of right thyroid lobe with extra-thyroid extension. Fine needle aspiration cytology reveals a thyroid lymphoma with extrathyroidal extension/ infiltration.

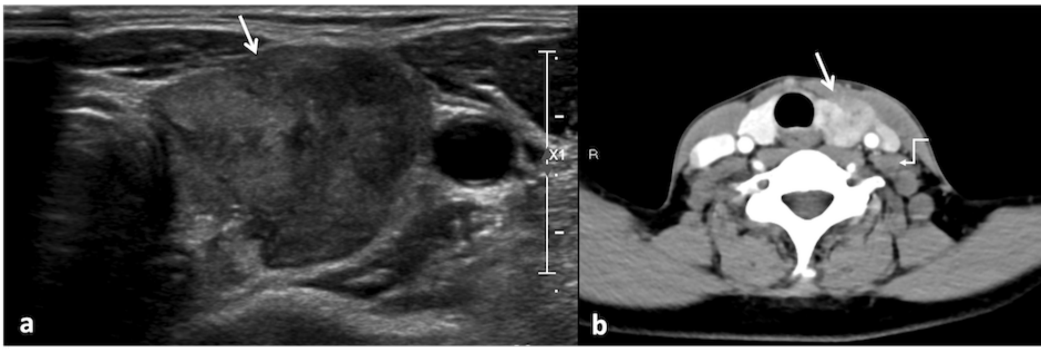

Figure 7: Transverse ultrasound of a 55-year-old female (a) demonstrates a predominantly solid, hypoechoic lesion (arrow) in the upper-mid pole of left thyroid lobe with extra-thyroidal extension. Axial CT neck image (b) shows a heterogeneous enhancing, lobulated lesion (arrow) arising from the left thyroid lobe with extra-thyroidal extension. It is associated with mild enlarged left level IV lymph nodes (elbow connector arrow) situated lateral to the left carotid vessels . Histological analysis of the resected specimen and adjacent lymph nodes following total thyroidectomy reveals a papillary thyroid carcinoma with nodal metastases.

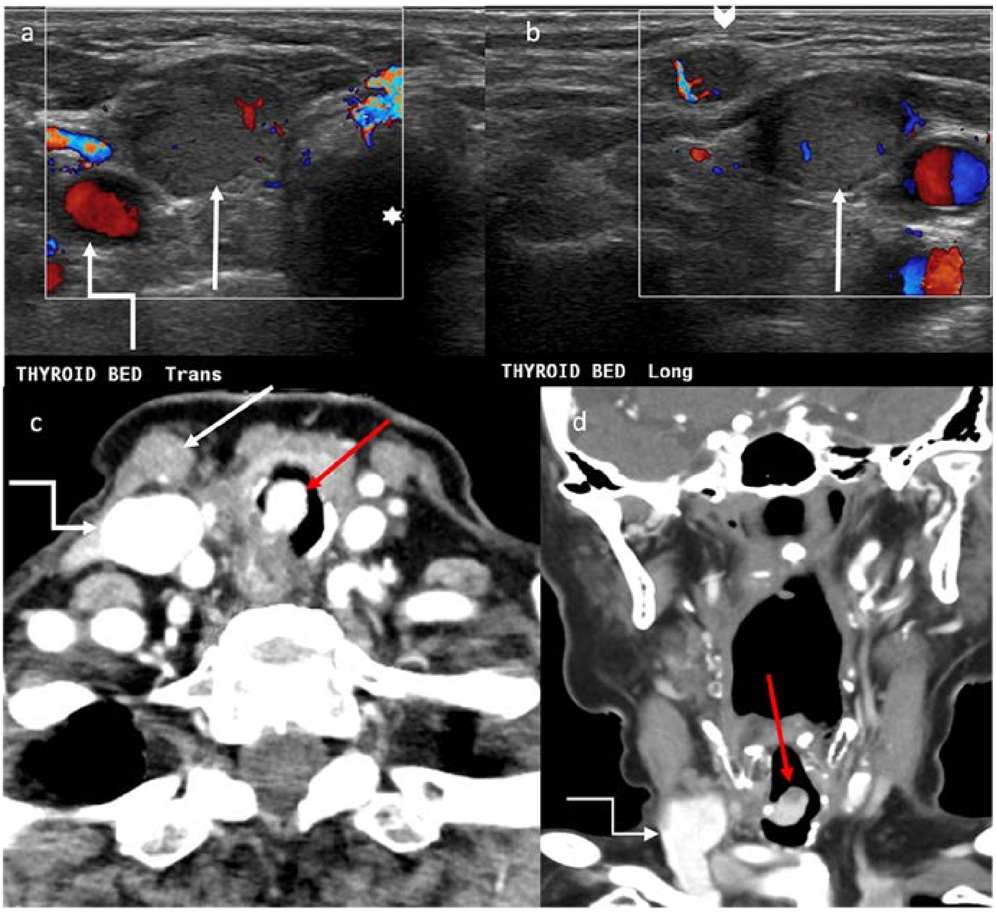

Figure 8: A 92-year-old female presented with stridor after total thyroidectomy. Post thyroidectomy reveals a follicular cell carcinoma. Endoscopy reveals a nodular lesion within the larynx. Transverse ultrasound image (a) shows a large hyperechoic nodular lesion in the right thyroid bed situated between the trachea medially (white star) and the right internal jugular vein laterally (connector elbow arrow). This nodular lesion is suspected of recurrent tumor in the surgical bed. Longitudinal ultrasound image (b) shows an abnormal lymph node with absence of central echogenic hilum (arrowhead) located anterior to the aforementioned recurrent lesion in the thyroid bed (straight arrow). Axial (c) and Coronal (d) contrast-enhanced CT neck reveals nodular lesions in the right thyroid bed (straight arrow) situated anterior to the right IJV (connector elbow arrow) and within the subglottic larynx (red arrow). Subsequent biopsy of the thyroid bed and subglottic nodular lesions reveal (recurrent) follicular cell carcinoma.

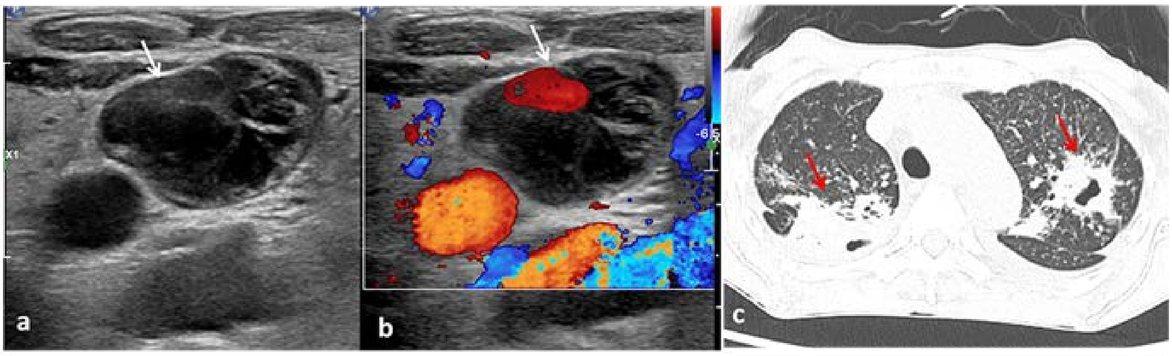

Figure 9: Transverse ultrasound (a) and color doppler (b) images of a 63-year-old female demonstrate hyperechoic thrombus within the distended left internal jugular vein (IJV) with lack of vascular flow signal (white arrows). Axial CT chest (c) demonstrates cavitary lesions in both lungs (red arrows) consistent with a known disseminated tuberculosis.

Figure 10: Ultrasound of a 47-year-old male shows an inferior extra-thyroidal extension of hypo- to isoechoic tissues (arrow) adjacent to the lower pole of the right thyroid lobe. This is consistent with a Zuckerkandl tubercle.

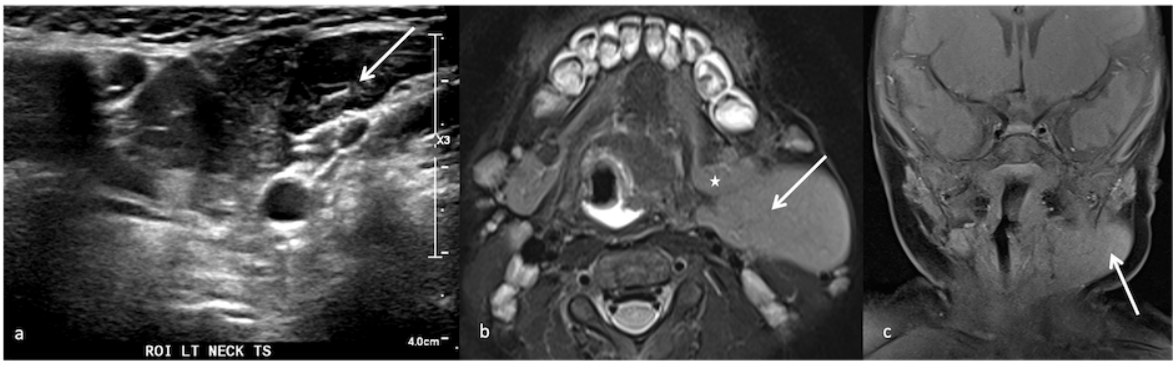

Figure 11: A one-year-old baby with an ectopic thymus on the left side of the neck. Transverse ultrasound of the left side of neck (a) demonstrates a soft tissue lesion (arrow) with parenchymal echogenicity resembling 'starry night' appearance indicating thymic tissues. Axial T2 (b) and coronal T1-weighted images (c) of the neck demonstrate mild hyperintense soft tissue lesion situated lateral to the left submandibular gland (star) compatible to an ectopic thymic tissue (arrows).

KEYWORDS

Thyroid ultrasound, extrathyroidal findings, peripheral nerve sheath tumors, thyroglossal duct cyst, Zenker's diverticulum, parathyroid adenomas, thyroid lymphoma, internal jugular vein thrombus, Zuckerkandl tubercle

Imaging modalities include:
US
Fluoroscopy
CT
MRI – STIR (Figure 2b)
MRI – T2 (Figure 11b)
MRI – T1(Figure 11c)
Scintigraphy