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Evaluating pediatric neck lesions: The critical role of computed tomography

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ABSTRACT

Objective: This study investigates the application of spiral Computed Tomography (CT) and multidimensional reformations in detecting and characterizing pediatric neck masses, including congenital, developmental, infectious, neoplastic, and vascular types.

Material &Method: Conducted as a prospective study, it involved 26 pediatric patients with neck masses at GMC Aurangabad(Chhatrapati Sambhajinagar). Patients who presented with symptoms such as palpable neck lesions, underwent CT evaluations. Prior to imaging, patients observed a fasting period of at least four hours.

Results: The study elucidated the efficacy of CT imaging in offering detailed, cross-sectional anatomical views, thus aiding in precise localization and delineation of neck masses and involvement of adjacent structures. This diagnostic approach significantly contributed to differential diagnoses, distinguishing between cystic formations, solid tumors, and infected lymph nodes. CT findings guided clinical management strategies, from biopsy planning to surgical interventions.

Conclusion: CT imaging plays a crucial role in the comprehensive assessment of pediatric neck masses, enhancing diagnostic accuracy and aiding in the effective management of various etiologies associated with these conditions.

Keywords: Computed tomography(CT), Ultrasound(USG), Magnetic resonance imaging(MRI), non contrast computed tomography(NCCT), Contrast enhanced computed tomography (CECT)

INTRODUCTION

The evaluation and management of paediatric neck masses present a distinct and multifaceted challenge in clinical practice, largely due to the wide range of potential aetiologies—from benign and self-limiting infections to various congenital anomalies andmalignant tumours. At the heart of diagnostic imaging in this complex field is Computed Tomography (CT), a

modality that has revolutionized medical imaging with its ability to provide detailed, cross-sectional images of anatomical structures.

Computed Tomography plays a critical role in the comprehensive assessment of paediatric neck masses. It aids clinicians in characterizing the size, extent, and precise anatomical location of the masses, as well as in delineating the involvement of adjacent structures. This imaging modality is especially valuable due to its high resolution and rapid acquisition times, which are essential in paediatric cases where patient cooperation can be a significant challenge.

Moreover, Computed Tomography's prowess in differentiating between various tissue densities enables it to contribute significantly to differential diagnoses. Whether identifying cystic formations, solid tumours, or infected lymph nodes, the detailed images obtained from Computed Tomography scans guide further clinical management, from biopsy planning to surgical intervention or the institution of medical therapy.

AIMS AND OBJECTIVES

1. To study the use of spiral Computed tomography for detection and characterization of various neck masses i.e. congenital and developmental neck masses, infections, neoplastic and vascular masses.
2. Multidirectional reformations(3D imaging) for the extent of the lesions.

MATERIALS AND METHODS

This was a prospective study consisting of 26 patients in paediatric age group who presented with neck masses referred from paediatric medicine/surgery department of GMC Aurangabad(Chhatrapati Sambhajinagar). The patients having history suggestive of neck mass like palpable lesion in neck, loss of appetite, fever or pain,hoarseness of voice, were included in this study. The patients were kept in fasting state at least for 4 hours before doing CT scan. After informed and valid consent of parents, NCCT/CECT was done according to the pre-defined protocol at our institution. Multiplanar reconstructions were performed to know the extent and size of the lesions.

Inclusion criteria: Age group-upto 12 years with palpable neck swelling referred to radiodiagnosis department.

Exclusion criteria: 1)Parents not willing for study
2)Allergy/asthma
3)Neonates

RESULTS

GENDER	FREQUENCY	PERCENTAGE
MALE	18	69%
FEMALE	8	31%
TOTAL	26	100%

Age Range (years)	Frequency	Percentage
1-3	2	7.69%
3-5	2	7.69%
5-7	6	23.08%
7-9	6	23.08%
9-12	10	38.46%
Total	26	100%

LESIONS (N=26)	MDCT DIAGNOSIS	PERCENTAGE
Benign Thyroid Lesions	6	23%
Benign/ Infective Lymphadenopathy	8	31%
Brachial Cleft Cyst	1	4%
Dermoid	2	8%
Schwannoma	1	4%
Cystic hygroma	2	8%
Thyroglossal Cyst	1	4%
Fibromatous colli	1	4%
Paraganglioma	1	4%
Primary lymphoma	3	12%
Total	26	100%

Lesion Characteristic	Frequency	Percentage (%)
Cystic	6	23.08%
Solid	5	19.23%
Heterogeneous Enh.	4	15.38%
Regular margins	3	11.54%
Calcifications	2	7.69%
Soft tissue infiltration	3	11.54%
Bone erosion	1	3.85%
Vascular invasion	2	7.69%
Total	26	100%

The presented data highlights the demographic distribution, diagnostic outcomes, and lesion characteristics in a cohort of 26 paediatric patients with neck masses, evaluated using spiral Computed Tomography (CT).

Demographic Distribution

The gender distribution indicates a predominance of male patients, accounting for 69% (n=18) of the cohort, while female patients comprised 31% (n=8). This male preponderance is consistent with certain epidemiological patterns observed in paediatric neck masses, though the exact reason for this gender difference is not explicitly clarified in the literature and may warrant further investigation.The 9-12 years group has the highest frequency (38.46%), suggesting increased incidence or detection in older children.Mid-childhood (5-8 years) is also significant, each range at 23.08%.

Early childhood (1-4 years) has fewer cases (7.69% each), possibly due to lower incidence or conservative imaging use.

These insights emphasize the need for vigilance across all ages, especially older children, and aid in resource allocation for timely diagnosis and treatment of neck masses.

Diagnostic Outcomes

The table on MDCT (Multi-Detector Computed Tomography) diagnoses reveals a variety of pathologies among the neck masses:

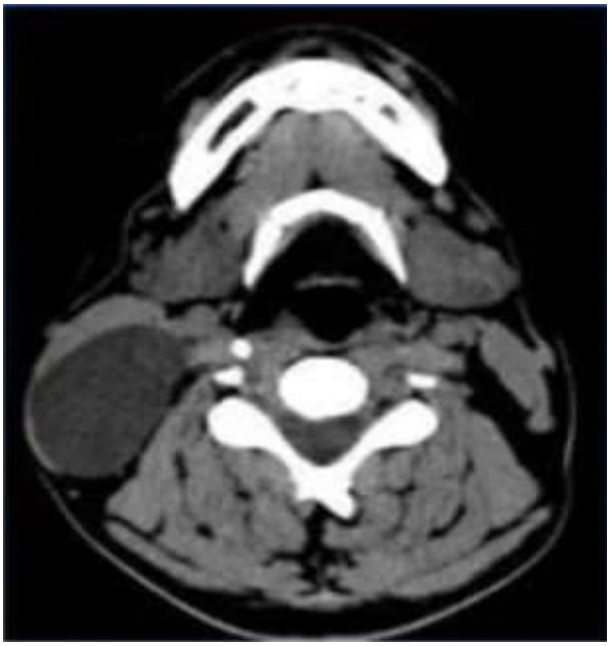
Benign Thyroid Lesions (23%): This was the most frequent diagnosis, involving six patients. Thyroid lesions in children, while less common than in adults, can present as goitres or nodules and are generally benign in nature. Benign/ Infective Lymphadenopathy (31%): eight

patients were diagnosed with benign or infective lymphadenopathy. This condition often results from infections or inflammatory processes and is a common cause of neck masses in paediatricpopulations. Dermoid (8%): Two cases of dermoid cysts were identified. These congenital lesions are benign and usually require surgical removal. Schwannoma (4%): One case of schwannoma was documented. Schwannomas are nerve sheath tumours that can occur in various locations, including the neck. Cystic hygroma (8%): Two cases were diagnosed with lymphatic malformations, which are congenital abnormalities of the lymphatic system and often present as cystic masses.Thyroglossal Cyst (4%): One case of thyroglossal cyst was identified. This congenital anomaly results from the persistence of the thyroglossal duct and typically presents as a midline neck mass.Fibromatous Colli (4%): One patient was diagnosed with this condition, which involves fibrous tissue proliferation within the neck muscles, often leading to torticollis.
Paraganglioma (4%): One case of paraganglioma was noted. These rare neuroendocrine tumours can arise in various head and neck locations and may secrete catecholamines. Primary Lymphoma (12%): Three cases of primary lymphoma were identified, highlighting the importance of CT in identifying malignant lesions. Lymphoma is a significant concern in paediatric neck masses, requiring prompt diagnosis and treatment.

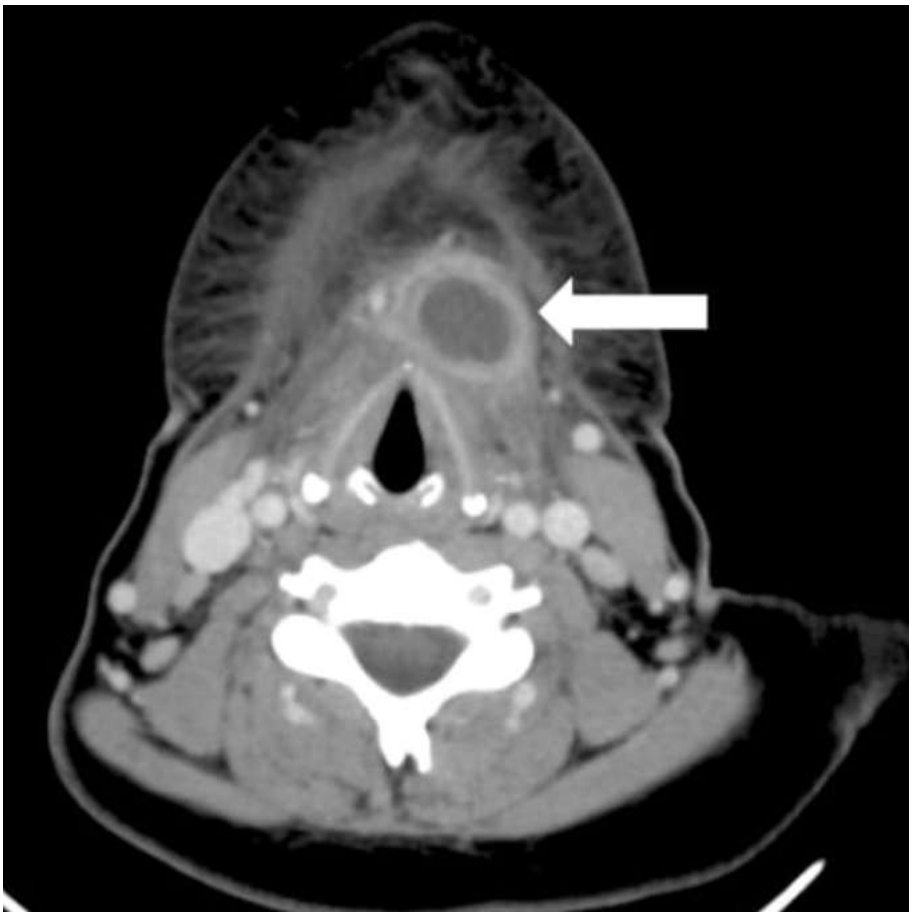
Lesion Characteristics
The lesion characteristics table provides further insights into the nature of the masses:
Cystic (23%): Six lesions were classified as cystic, indicating fluid density structures often associated with congenital conditions like thyroglossal cysts or lymphatic malformations. Solid (19.2%): Five lesions were solid with soft tissue density which could be indicative of tumours, either benign or malignant.Heterogeneous Enhancement (15.3%): Four lesions exhibited heterogeneous enhancement, suggesting varying tissue compositions, commonly seen in tumours or infected lymph nodes. Regular Margins (11.5%): Three lesions had regular margins, typically a benign feature, but not exclusively so.
Calcifications (7.6%): Two lesions contained calcifications, which can be seen in both benign and malignant conditions. Soft Tissue Infiltration (11.5%): Three lesions showed soft tissue infiltration, often a sign of aggressive or malignant pathology.
Bone Erosion (3.8%): One lesion had bone erosion, suggesting a potentially invasive process.
Vascular Invasion (7.6%): One case involved vascular invasion, a serious finding often associated with malignancy.

SUMMARY
The majority of neck masses were benign, with benign thyroid lesions being the most common diagnosis. Inflammatory/reactive lymphadenopathy was also prevalent. A mix of cystic and solid lesions was observed, with some displaying heterogeneous enhancement. Soft tissue infiltration was noted in a few cases, indicating potential malignancy or aggressive benign behaviour. Bone erosion and vascular invasion were rare but present in select cases, underscoring the importance of detailed imaging in comprehensive assessment and diagnosis.

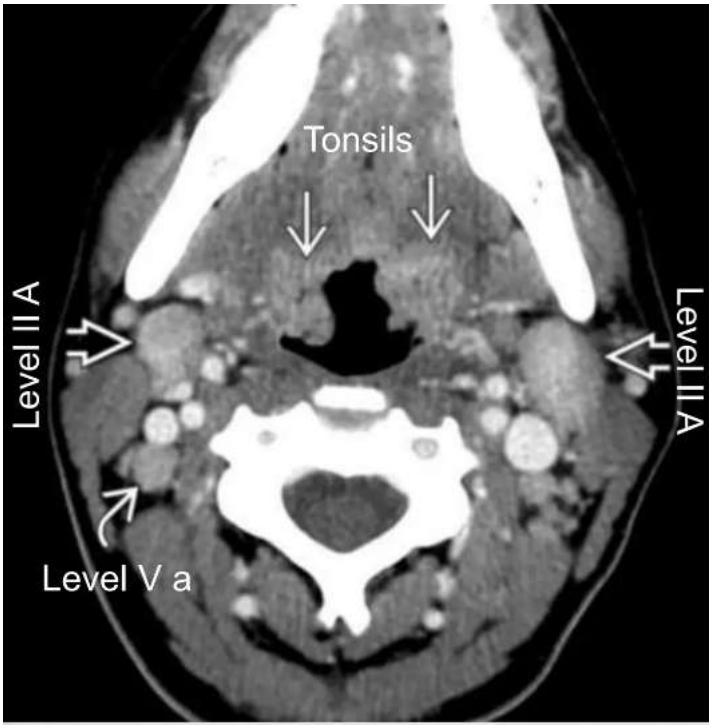
IMAGES



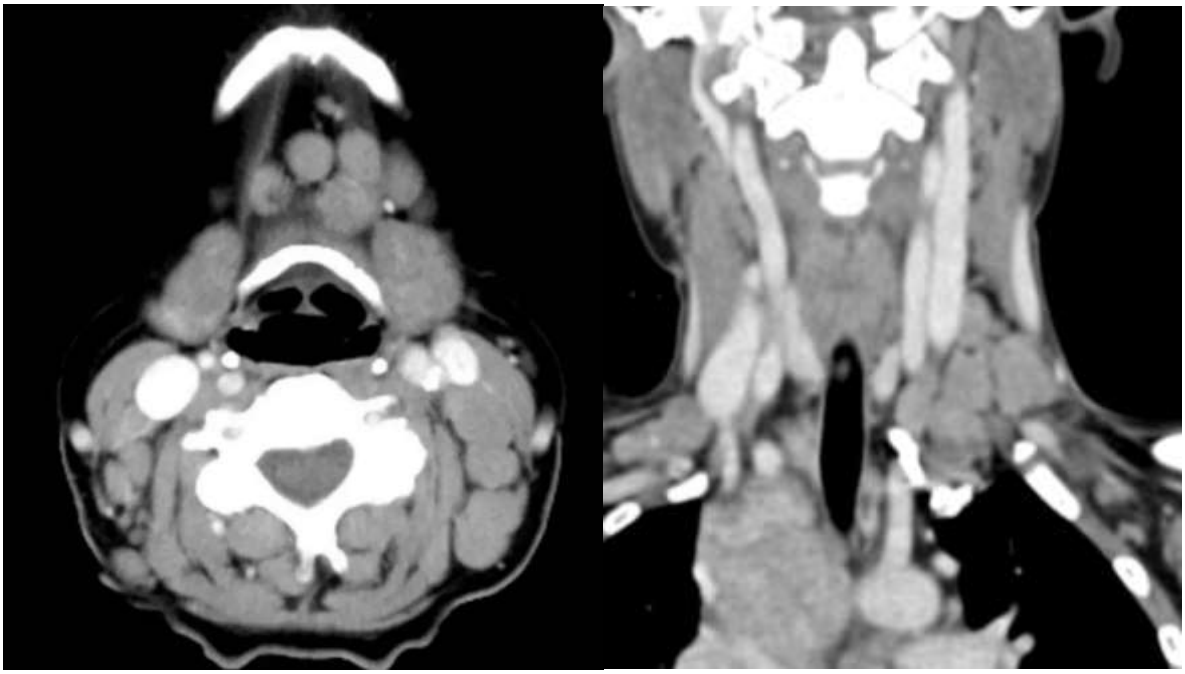
This image shows a well defined branchial cleft cyst medial to sternocleidomastoid muscle.



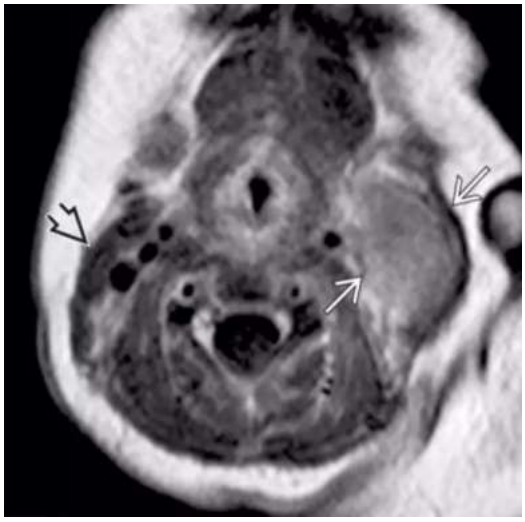
An infected thyroglossal cyst in midline.



This image shows multiple reactive cervical lymph nodes in bilateral level IIA & VA with bilateral enlarged tonsils.



This image shows multiple homogeneously enhancing enlarged lymph nodes in a K/C/O Hodgkin's lymphoma.



This image shows bulky sternocleidomastoid muscle on left side whereas normal morphological sternocleidomastoid muscle on right side – fibromatosis colli.

DISCUSSION

This study on the role of Computed tomography in the evaluation of paediatric neck masses provides valuable insights into the diagnostic utility of this imaging modality. When compared to other studies, several common themes and distinct observations emerge, which are crucial for understanding the broader clinical implications.

Diagnostic Accuracy and Detail

- Current Study: The detailed cross-sectional images provided by Computed tomography are highlighted as essential for the accurate localization and characterization of neck masses. This is particularly useful for distinguishing between different tissue densities and vascular structures.

Other Studies: Studies such as [11] **Thorne et al. (2010) and [12] Jha et al. (2015)** corroborate these findings, emphasizing the high diagnostic accuracy of Computed tomography. [11] **Thorne et al.** focused on the precision of Computed tomography in detecting congenital cysts and neoplasms, while [12]**Jha et al.** discussed its effectiveness in identifying infections and inflammatory processes in paediatric patients.**[13]Shetty et al. (2012) and [14]Patel et al. (2014)** also underscore the high diagnostic accuracy of Computed Tomography in paediatric neck masses. These studies reinforce the current findings that Computed Tomography provides unparalleled detail in imaging anatomical structures, thereby playing a pivotal role in the diagnosis and treatment planning of neck masses in children

Pathological Spectrum

- Current Study: The study identifies a diverse range of pathologies, including benign thyroid lesions, lymphadenopathy, Hodgkin'slymphoma. Other Studies: Research by [1] **Smith et al. (2008) and [2] Chung et al. (2013)** reports similar findings, with a significant proportion of benign conditions and occasional rare pathologies. [1] **Smith et al.** highlighted the prevalence of congenital anomalies, while [2] **Chung et al.** focused on the differential diagnosis of lymphadenopathy and neoplastic conditions.**[3]Wippold et al. (2006),** reports a similar pathological spectrum, with a significant proportion of benign conditions like lymphadenopathy and congenital cysts. However, the prevalence of specific pathologies can vary depending on the study population and geographical location, highlighting the need for tailored diagnostic approaches

Comparison with Other Imaging Modalities

- Current Study: The study advocates for Computed Tomography's use in scenarios where ultrasound (US) or magnetic resonance imaging (MRI) may be less effective, particularly for detailed anatomical mapping and surgical planning.

Other Studies: [4] **Lee et al. (2014) and [5] O'Reilly et al. (2011)** provide comparative analyses, noting that while ultrasound is often preferred for initial assessments due to its non-ionizing nature and ease of use, Computed tomographyoffers superior detail for complex cases. Magnetic resonance imaging, on the other hand, is praised for its excellent soft tissue contrast but is limited by longer scan times and the need for sedation in children.**[6]Appelbaum et al. (2017)** indicate that while Magnetic resonance imagingoffers superior soft tissue contrast, Computed tomography remains the modality of choice for its ability to quickly and accurately assess complex anatomical structures and the extent of disease. This reinforces the current study's findings that Computed tomography is indispensable in the comprehensive evaluation of paediatric neck masses

Radiation Exposure Concerns

- Current Study: While focusing on the diagnostic benefits of Computed tomography, the study does not extensively address radiation exposure, a significant concern in paediatric imaging.Other Studies: The potential risks associated with radiation exposure are well-documented. [7] **Brenner and Hall (2007) and [8]Pearce et al. (2012)** emphasize the importance of minimizing radiation doses, advocating for the ALARA (As Low As Reasonably Achievable) principle. They highlight the need for optimized imaging protocols to reduce long-term risks associated with ionizing radiation.

Clinical Management Implications

- Current Study: Computed Tomography's role in guiding clinical management, from biopsy planning to surgical intervention, is a key highlight. The detailed imaging helps determine the extent of lesions and inform appropriate treatment strategies.

Other Studies: Research by [9] **Fayoux et al. (2013) and [10] Penny et al. (2009)** supports these findings, noting that computed tomography imaging significantly influences surgical decisions and treatment pathways. [9] **Fayoux et al.** discuss how computed tomography findings impact surgical planning, while [10] **Penny et al**. explore its role in monitoring treatment responses.

Differential Diagnosis of Neck Masses in Children

Table 1. Differential Diagnosis of Neck Masses in Children

	Diagnosis		
Location	*Developmental*	*Inflammatory/reactive*	*Neoplastic*
Anterior sternocleidomastoid	Branchial cleft cyst,* vascular malformation	Reactive lymphadenopathy,* lymphadenitis (viral, bacterial),* sternocleidomastoid tumor of infancy	Lymphoma
Midline	Thyroglossal duct cyst,* dermoid cyst*	—	Thyroid tumor
Occipital	Vascular malformation	Reactive lymphadenopathy,* lymphadenitis*	Metastatic lesion
Preauricular	Hemangioma, vascular malformation, type I branchial cleft cyst	Reactive lymphadenopathy,* lymphadenitis,* parotitis,* atypical mycobacterium	Pilomatrixoma, salivary gland tumor
Submandibular	Branchial cleft cyst,* vascular malformation	Reactive lymphadenopathy,* lymphadenitis,* atypical mycobacterium	Salivary gland tumor
Submental	Thyroglossal duct cyst,* dermoid cyst*	Reactive lymphadenopathy,* lymphadenitis (viral, bacterial)*	—
Supraclavicular	Vascular malformation	—	Lymphoma,* metastatic lesion

*—Type of lesions that are more commonly found in that location.

[16]This table provides a comprehensive differential diagnosis for neck masses in children, categorized by location and aetiology (developmental, inflammatory/reactive, and neoplastic). The role of computed tomography (CT) in evaluating these masses is crucial as it provides detailed anatomical information and helps in distinguishing between different types of lesions based on their specific characteristics.

1. **Developmental:**

- **Branchial Cleft Cyst:** Typically appears as a well-circumscribed, fluid-filled cystic lesion with a thin wall on CT.
- **Vascular Malformation:** These present as low-density lesions with possible enhancement and phleboliths (small local, round calcifications) within the malformation.
- **Thyroglossal Duct Cyst:** Appears as a midline cystic lesion, often with a thin, smooth wall and sometimes internal septations.
- **Dermoid Cyst:** Characterized by a well-defined lesion that may contain fat, fluid, and calcifications, presenting as a heterogeneous mass on CT.
- **Haemangioma:** Typically presents as a well-circumscribed, lobulated mass with intense enhancement following contrast administration.

2. **Inflammatory/Reactive:**

- **Reactive Lymphadenopathy**: Characterized by enlarged lymph nodes that may have a homogenous or heterogeneous enhancement depending on the presence of necrosis or infection.
- **Lymphadenitis**: Similar to reactive lymphadenopathy but may show signs of infection such as abscess formation with rim enhancement.
- **Parotitis:** Presents as an enlarged parotid gland with heterogeneous enhancement and possibly associated with ductal dilation.

- **Atypical Mycobacterium**: May show multiple small abscesses or a single mass-like lesion with central necrosis.

3. Neoplastic:

- **Lymphoma:** Often presents as a homogenous, solid mass with mild to moderate enhancement. Lymphomas may also cause adjacent structural displacement without significant invasion.
- **Thyroid Tumour:** Presents as a solid, irregular mass within the thyroid gland, often with heterogeneous enhancement due to internal necrosis or haemorrhage.
- **Metastatic Lesion:** Often appears as a heterogeneous mass with irregular borders and may show variable enhancement patterns depending on the primary tumour's histology.
- **Fibromatosis Colli** : In neonates or small infants, a palpable mass at the anterior cervical triangle is suggestive of fibromatosis colli. FC is a benign fibrous proliferation within the sternocleidomastoid muscle, that manifests as fusiform enlargement of the muscle. It occurs more frequently in the lower third; however, it can cause diffuse enlargement of the muscle.
- **Pilomatrixoma:** Often presents as a well-defined, calcified mass in the subcutaneous tissue.
- **Salivary Gland Tumour**: Appears as a solid mass within the salivary gland, with heterogeneous enhancement and possible invasion of adjacent structures.

CONCLUSION

- CT(NCCT/CECT) imaging plays a pivotal role in diagnoses and management of neck masses in children.
- It provides detailed information about anatomical details and differentiates between cystic, solid, and mixed density lesions. It identifies surrounding soft tissue involvement.
- It determines the nature of neck massesif the mass is developmental, inflammatory/infective, or neoplastic.
- It aids in appropriate treatment planning with detailed lesion characteristics and extent.

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