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A Prospective Comparative Study of Ct and MRI in Evaluation of Suprahyoid Neck Masses

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Abstract

Introduction: *The neck has a complex anatomy and contains small anatomic structures that are closely spaced. This necessitates a thorough understanding of normal spatial relationships and anatomical variants for the diagnosis of lesions. Cross sectional imaging remains the corner stone for elucidation of anatomy and detection of pathology. This study compares CT with MR, to find modality best suited for various pathologies of the region. Better visualization with the appropriate modality can provide the clinician with key information for best possible management of the patient.*

Materials and Methods: *The prospective hospital-based study was carried out on hundred cases in Department of Radiology, AJ Institute of Medical Sciences and Research, Mangalore, Karnataka from January 2018 to December 2019. Informed consent of patient/attendant was taken. After taking appropriate history, and with necessary laboratory investigations, the patient was prepared for CT scan.CT scanning was performed on Siemens Somatom Definition128 Slice scanner. For IV contrast examination, the patient was kept nil per orally for four to six hours prior to the scan. CT imaging consisted of scanning patient in the supine position with the neck mildly hyperextended, such that the hard palate was roughly perpendicular to the table. When possible scanning was performed with quiet breathing and swallowing suspended.*

MRI was performed on Siemens Magnetom Avanto 1.5 T. Patient was asked to remove all metallic objects, undress and change into hospital gown. Patient was instructed to keep still and avoid swallowing.Contrast injection risks and benefits are explained to the patient. Gadolinium was given only if creatinine was < 2 mg/dL. Standard MRI sequences were used and this included T2 STIR Coronal (4mm slice thickness), T2WI axial (3mm), T1WI axial (3mm), T1WI Fat sat axial (3mm), Post contrast T1WI Fat Sat (3mm) in coronal, axial and sagittal planes and Diffusion Weighted Imaging (DWI).

Results: *MRI detected 100% cases while CT detected 88.8% of all congenital lesions. Odds ratio is 5.6, Kappa value is 0. MRI detected 60.7% cases while CT detected 92.7% of all inflammatory lesions. Odds ratio is 6.9, Kappa value is -0.138. MRI detected 100% cases while CT detected 83.3% of all neoplastic lesions. Odds ratio is 22.8, Kappa value is 0.*

Conclusion: *MRI was better for imaging of congenital and neoplastic lesions with case detection rate of 100%. CT was better for imaging of inflammatory lesions with case detection rate of 93% due to it being better at detecting air, calcification, bone fragments and stones with less motion induced artefacts.*

Key Words: MRI, CT, *T2WI axial*

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I. Introduction

The neck has a complex anatomy and contains small anatomic structures that are closely spaced. This necessitates a thorough understanding of normal spatial relationships and anatomical variants for the diagnosis of lesions. Cross sectional imaging remains the corner stone for elucidation of anatomy and detection of pathology. This study compares CT with MR, to find modality best suited for various pathologies of the region. Better visualization with appropriate modality can provide the clinician with key information for best possible management of the patient.[1]

The soft tissue of the neck can be divided at the level of hyoid bone into two separate areas the suprahyoid and infrahyoid portions. The three sheets of the deep cervical fascia, i.e. superficial, middle and deep layers, split the suprahyoid part of the neck into distinct spaces that are valuable anatomic markers for evaluating pathological alterations and their spread.[2] The spaces of the suprahyoid neck region are divided into parotid space, masticator space, parapharyngeal space,submandibular space, retropharyngeal space,posterior cervical space, pharyngeal mucosal space, carotid space, and perivertebral space. Space occupying lesions (SOL's originating in any of these spaces will initially expand the respective space and then distort the neighboringspaces, which offer the evidence regarding its place of origin.[3]

A neck mass can be a diagnostic challenge in patients of any age and is commonly evaluated with computed tomography (CT), magnetic resonance imaging (MRI) or ultrasound. The use of multislice helical CT has led to better resolution and substantial reduction in scan acquisition and display time. CT is non-invasive, non-operator dependent and allows for precise measurements of tissue attenuation coefficients.[4] Better quality volume data sets can be acquired with multi-slice CT, which can be retrospectively manipulated to acquire axial sections of preferred thickness and increment. Multiplanar reconstructions can be obtained in any preferred plane with isotropic resolution. CT offers superb distinction of fat from other tissues and is undoubtedly better than magnetic resonance imaging (MRI) for the assessment of bone and calcifications. Additionally, CT is less susceptible to motion artifacts, has better temporal resolution, and therefore has better compliance with claustrophobic patients as compared to MRI, and can also be done in patients with MR incompatible devices.[5] Brilliant 3-dimensional imaging is achievable using volume rendering, maximum intensity projection and shaded surface display methods, which enables the surgeon to comprehend the anatomical extent of the lesion and its relationship to adjacent structures in a much better way.

On the other hand, MR imaging do not use ionizing radiation, has superb intrinsic soft tissue contrast and better display of exogenous contrast enhancement as compared to CT. MR imaging is better than CT in showing the relationship of neck masses to adjacent muscles and soft tissues due to better soft tissue delineation. MR imaging and contrast-enhanced CT are comparable in delineating vascular anatomy and pathology. MR imaging is superior to CT imaging when done without intravenous contrast material. Nevertheless, CT is more useful in showing bone, cartilage and airway abnormalities.[6]

Ultrasound is widely accessible, easy-to-use, non-invasive, low-priced, without metallic artifacts and is relatively safe as it uses only ultrasound waves that are non-ionizing. Ultrasound easily differentiates cystic from solid lesions and is also helpful in evaluating malignant/benign masses and detecting the presence of enlarged lymph nodes. However, this modality is extremely reliant on operator skill and has restricted fields of view. Unlike MRI, ultrasound lacks high soft tissue contrast and specificity required for tumour staging.[7]

II. Materials And Methods

The prospective hospital-based study was carried out on hundred cases in Department of Radiology, AJ Institute of Medical Sciences and Research, Mangalore, Karnataka from January 2018 to December 2019. Informed consent of patient/attendant was taken. After taking appropriate history, and with necessary laboratory investigations, the patient was prepared for CT scan.CT scanning was performed on Siemens Somatom Definition128 Slice scanner. For IV contrast examination, the patient was kept nil per orally for four to six hours prior to the scan. CT imaging consisted of scanning patient in the supine position with the neck mildly hyperextended, such that the hard palate was roughly perpendicular to the table. When possible scanning was performed with quiet breathing and swallowing suspended.

MRI was performed on Siemens Magnetom Avanto 1.5 T. Patient was asked to remove all metallic objects, undress and change into hospital gown. Patient was instructed to keep still and avoid swallowing.Contrast injection risks and benefits are explained to the patient. Gadolinium was given only if creatinine was < 2 mg/dL. Standard MRI sequences were used and this included T2 STIR Coronal (4mm slice thickness), T2WI axial (3mm), T1WI axial (3mm), T1WI Fat sat axial (3mm), Post contrast T1WI Fat Sat (3mm) in coronal, axial and sagittal planes and Diffusion Weighted Imaging (DWI).

III. Results

MRI detected 100% and CT 88.8% of congenital lesions. Odds ratio is 5.6, that is MRI is 5.6 times more likely to detect congenital lesions compared to CT Kappa value is 0, which means the agreement between the findings of CT and MRI is poor.

CT detected 92.8% and MR 60.7% of inflammatory pathologies. In 39.3% cases, findings crucial for diagnosisand management such as stones, air and bone fragments which were detected by CT could not be demonstrated by MR. CT also showed significantly less motion artifacts compared to MR in this subgroup. Odds ratio is 6.9 that is CT is 6.9 times more likely to detect inflammatory lesions compared to MRI. Kappa value is -0.138, which means the agreement between the findings of CT and MRI is poor.

Table 1: Distribution of Congenital Lesions

S.No	Pathology	No of cases
1	Ectopic thymus (Fig.1)	1
2	1stBranchial cleft cyst	1
3	Vascular malformations	10
4	Thyroglossal duct cyst	1
5	Vallecular cyst (Fig.3)	3
6	Lingual thyroid (Fig.2)	2

Table 2: Congenital Lesions

	Detected	Not clearly detected
MRI	18	0
CT	16	2

Table 3: Distribution of Inflammatory Lesions

S.No	Pathology	No of cases
1	Ludwig Angina	4
2	Cellulitis	3
3	Sialadenitis (fig;10)	11
4	Retropharyngeal abscess (Fig.9)	2
5	Prevertebral space abscess	1
6	Ranula	3
7	Pseudoaneursm	1
8	Infected haematoma	1
9	Tuberculous lymphadenopathy	1
10	Suppurative Lymph nodes	1

Table 4: Inflammatory Lesions

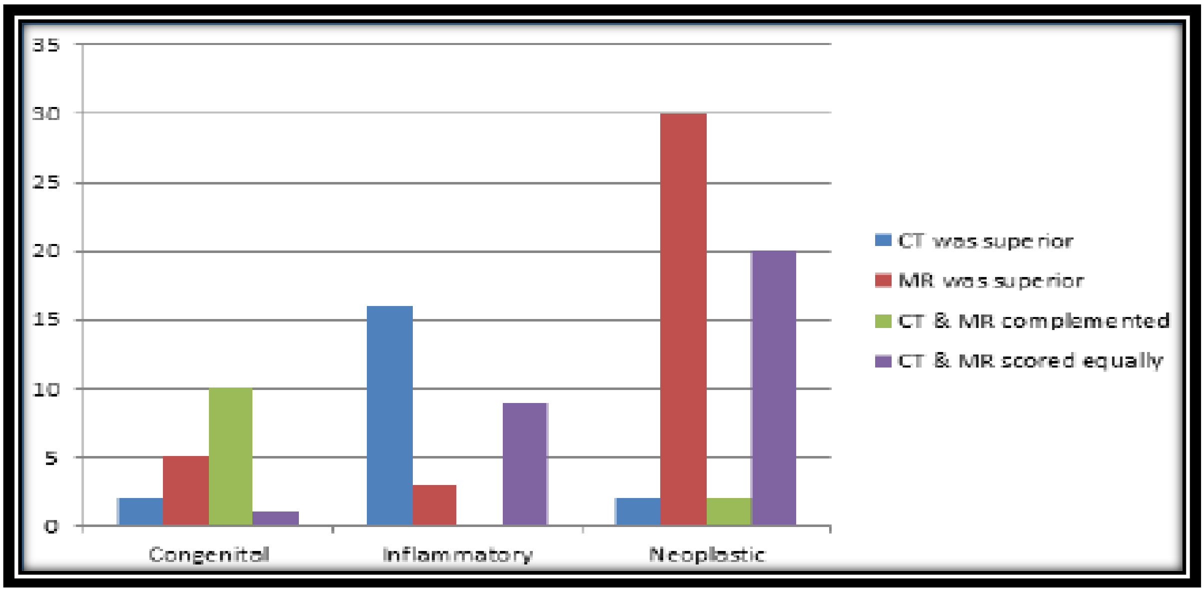
	Detected	Not clearly detected
CT	26	2
MR	17	11

Table 5: Distribution of Neoplastic Lesions

S.No	Pathology	No. of cases
1	Salivary gland tumours (Fig. 4, 5 & 6)	*30*
2	Vagal schwannoma (Fig. 7)	*2*
3	Carotid body paragangliomas (Fig.8)	*2*
4	Carcinoma tongue	*12*
5	Vallecular carcinoma	*2*
6	Schwannoma of sublingual space	*1*
7	Lymphoma of pharyngeal mucosal space	*2*
8	Lipoma	*3*

Table 6: Neoplastic Lesions

	Detected	Not clearly detected
MR	54	0
CT	45	9



Graphic 1: Shows the detection rates of various pathologies by CT and MR

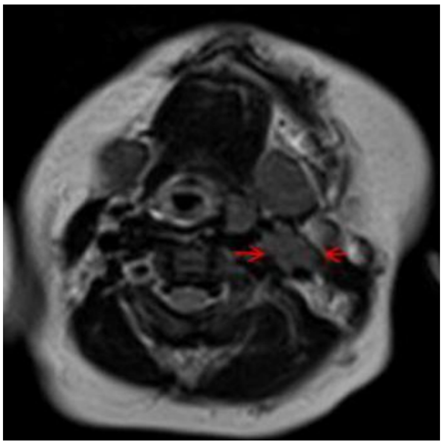


Figure 1. T2WI Sequence shows a Soft Tissue of Intermediate Signal Intensity in the Carotid Space on the Left Side Splaying the Carotid Artery and the Jugular Vein [Ectopic Thymus]

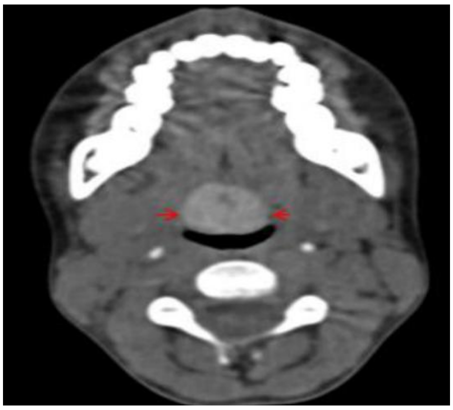


Figure 2. Shows Well-Defined Midline Base of the Tongue Mass showing High Density on Unenhanced CT Scan [Lingual Thyroid]

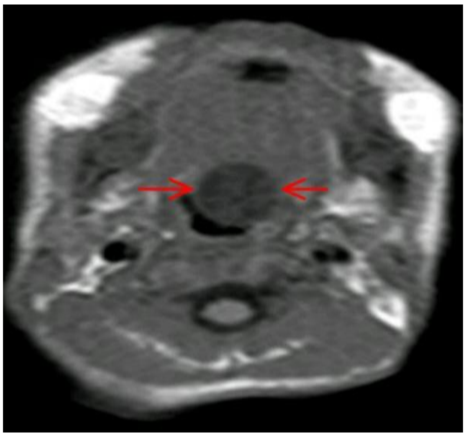


Figure 3. Axial T1WI MR Sequence shows a well-defined Hypointense Lesion in the region of Vallecula (vallecular cyst)

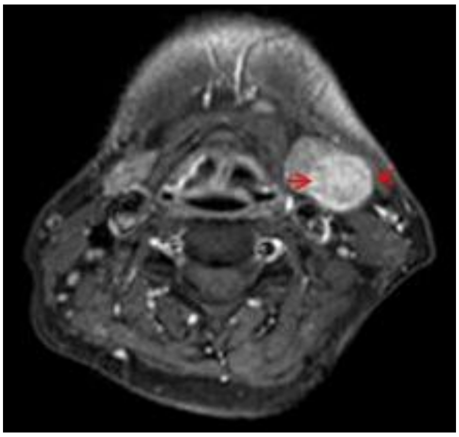


Figure 4. Post Contrast T1WI Sequence shows an Enhancing Mass in Left Submandibular [Pleomorphic Adenoma]

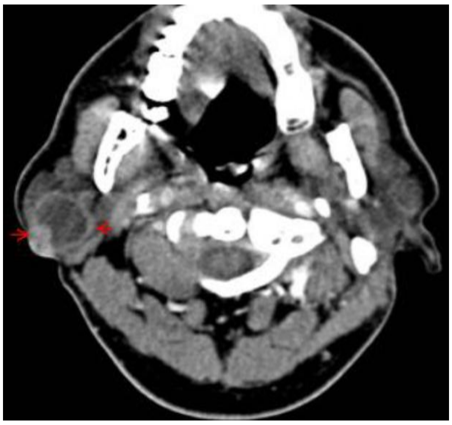


Figure 5. CECT shows a Cystic Lesion with an Enhancing Mural Nodule in the Right Parotid Gland [Warthin's Tumour]

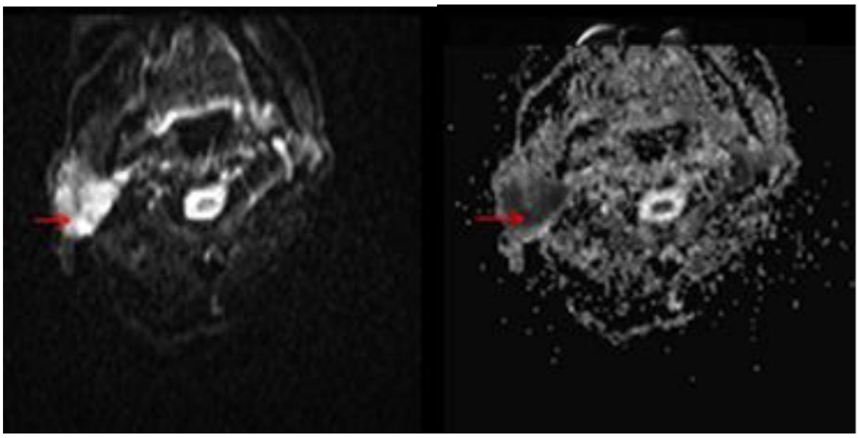


Figure 6. On DWI and ADC Mapping Sequences of the Lesion in the Right Parotid Gland shows Restricted Diffusivity Suggesting its High Cellularity. [Primary Nodal Non-Hodgkin's Lymphoma]

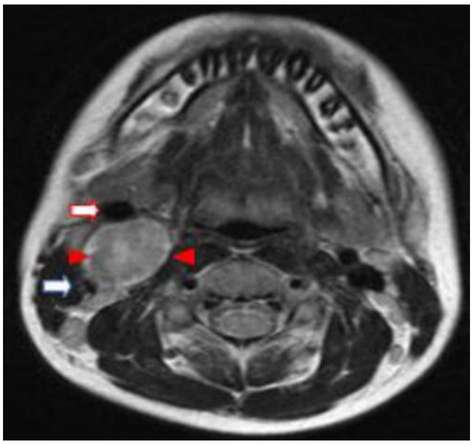


Figure 7. T2WI Sequence shows a Heterogeneous Mass Lesion in the Carotid Space on the Right Side Displacing the Carotid Artery (Double Red Arrow) Anterolaterally and the Internal Jugular Vein (Double Blue Arrow) posterolaterally. [Vagal Schwannoma]

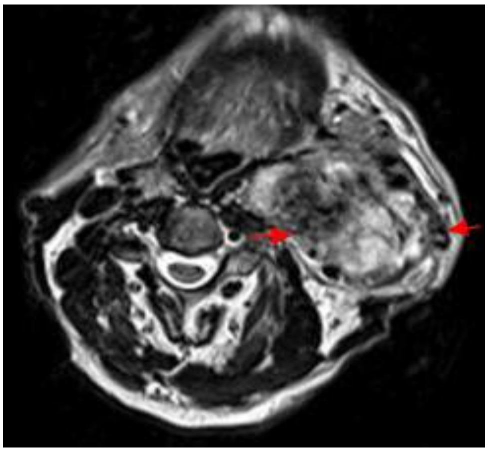


Figure 8. T2WI Sequence shows Salt and Pepper Appearance of a Paraganglioma in the Left Carotid Space due to Haemorrhage and Arterial Flow Voids. [Carotid Body Paraganglioma]

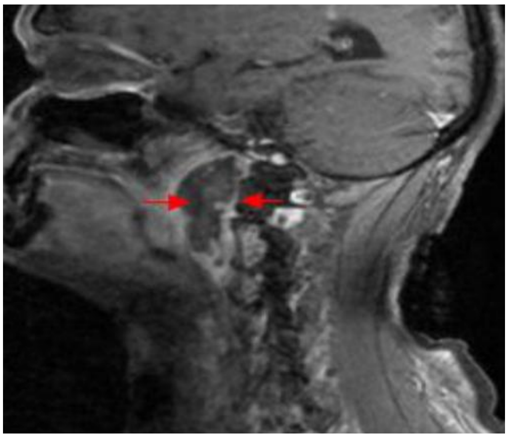


Figure 9. Post Contrast T1WI Sequence shows a Peripherally Enhancing Collection in the Retropharyngeal Space. [Retropharyngeal Abscess]

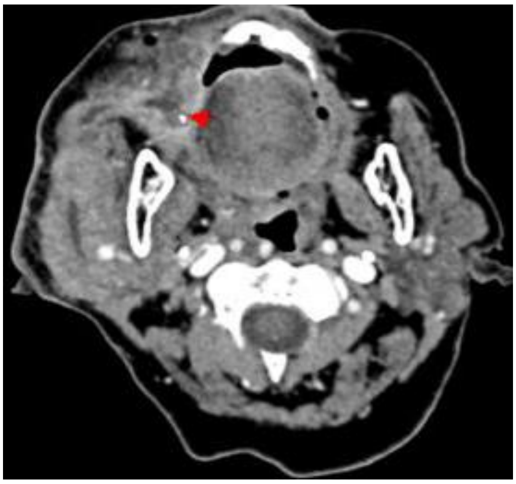


Figure 10. CECT shows a Calculus (Arrow) Obstructing the Stensen's Duct on the Right Side with Associated Parotitis. [Sialocele]

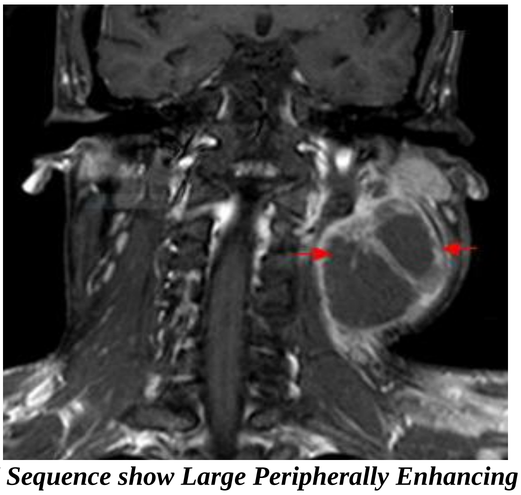


Figure 11. Post Contrast T1WI Sequence show Large Peripherally Enhancing Lymph Node along the Upper Jugular Chain on the Left Side with Inflammation of the Surrounding Soft Tissue [Nodal Abscess]

MRI detected 100% and CT 83.3 % of neoplastic cases. In 16.7% of cases, findings crucial for diagnosis and management which were detected by MR could not be demonstrated by CT. Odds ratio is 22.8, that is MR is 22.7 times more likely to detect neoplastic lesions compared to CT. Kappa value is 0, which means the agreement between the findings of CT and MRI is poor.

IV. Discussion

CT provided the information necessary for emergency management, faster in cases of Ludwig's angina with airway compromise[3,7]. In addition gas collections easily distinguishable on CT appear as non-specific signal voids on all the pulse sequences of MR making the diagnosis difficult. In a case of post-traumatic osteomyelitis of temporal bone with associated rim enhancing collections in the masticator space, CT best demonstrated the irregular and sclerosed bone while MR did not.

Intraosseousabscess in a case of periapical abscess with myositis, which had tunnelled through the mandibular ramus was also better demonstrated on CT. Calculi in cases of sialadenitis[4], which were evident on CT were seen as nonspecific signal voids on MR. In a case of intraparotid abscess secondary to acute otomastoiditis temporal bone CT defined the bony changes and CECT the infectious complications. CT and MR demonstrated similar findings in cases of granulomatous and non-granulomatous infections of the parotid gland. In cases of Sjogren's syndrome of the parotid gland, CT failed to reveal cystic dilatations of the intraglandular ducts which were demonstrated by MRI along with lipid infiltration and gland enlargement. Similar findings were described by Izumi M et al. On both CECT and MRI rim enhancing collections and craniocaudal extent of retropharyngeal abscesses was shown and distinction from perivertebral space abscess was made. However, MRI is rarely utilised in haemodynamically unstable septic patients. In a case of prevertebral space abscess, CT best demonstrated the bony changes and helped guide aspiration. Uncertainty about the epidural space involvement had to be cleared by MR. Similar findings were described by Roberto Maroldi MD et al. In cases of ranula CECT and MR,both could define the extent. CT angiography with a shorter acquisition time and ability to detect associated injuries scored over MR in a case of post-traumatic pseudoaneurysm of the superficial temporal artery. Subcutaneous manifestations of infection on MRIwere not as obvious as in CT in a case of suppurative lymph node[3]. Similar findings were described by Alfred L.Weber et al.

Among cases of benign mixed tumours of parotidgland involving deep lobe and that recurred following parotidectomy we noticed CT was suboptimal in picking up deep lobe involvement. In another case of benign mixed tumour of the deep lobe of parotid gland which was inaccessible for biopsy, CT demonstrated nonspecific findingswhereas hyperintensity on T2WI sequence of MR helped in suggesting the benign nature of the lesion. In cases of Warthin's tumours, CT and MR both provided adequate pre-surgical information. MR was useful for assessing the accurate extent of malignant tumors of the parotid gland. However subtle erosion of the mandibular cortex in one of the cases was better demonstrated on CT. In case of lymphomas and metastases to parotid gland CT only shows diffusely enlarged gland whereas MR demonstrates well-defined intermediate signal intensity lesions with mild homogeneous enhancement and diffusion restriction. Similar findings were described in the imaging of salivary gland tumours[8] by*Kim KH et al*and *A.Christe et al.*

CT and MR both demonstrated the relationship of masses to carotid artery and IJV in cases of vagal schwannoma and carotid body paraganglioma. Ultimately, the arterial velocity flow voids on T2WI and T1WI sequence helped confirm paragangliomas. Similar findings were described by Ibeh and Potigailo.

In cases of carcinoma of tongue, vallecular carcinoma and schwannoma of sublingual space, MRI with its better soft tissue definition was the imaging modality of choice. In one case of carcinoma of the tongue, mandibular erosion was better demonstrated on CT. CT was better in staging of cases of nasopharyngeal NHL and Burkitt's lymphomaof the pharyngeal mucosal space. Because of its high cellularity lymphoma shows restriction on diffusion weighted imaging. Similar findings[2] were described by Kind AD et al. In cases of lipoma, both CT and MR scored equally.

Recent advances[9] in evaluation of suprahyoid neck masses include Dual-Energy CT (DECT), MR perfusion and MR spectroscopy. Dual-energy scanning is a breakthrough in CT technology. DECT also has potential in suprahyoid neck imaging. Benefits of DECT include material specific dataset (differentiation of calcification from iodine), improved image quality, better lesion detection and quantitative calculation of the degree of enhancement. Dynamic Contrast-Enhanced (DCE) MR perfusion imaging is a non-invasive imaging technique that helps in differentiation of benign from malignant tumours and malignant tumour from post radiation changes. High tumour perfusion early during the course of therapy predicts a good response to radiation therapy. This phenomenon may be related to reoxygenation of the tumour early during radiotherapy. MR spectroscopy could be used as complementary method to routine MRI to differentiate between benign and malignant lesions. Mean value of Cho/Cr ratio is 4.42for malignant tumours and 1.93 for benign tumours on Hydrogen (1H) MR spectroscopy with echo time 270ms at 1.5 T. Limitation[10].

V. Conclusion

MRI, because of its multiplanar ability, better soft tissue resolution and lack of ionising radiation, is imaging modality of choice for evaluation of suprahyoid congenital and neoplastic lesions with detection rates of 100%. CT, because of its ability to accurately identify calcification, bone fragments, stones and air foci, is imaging modality of choice for inflammatory lesions insuprahyoid neck spaces.

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