

Role of Various Radiological Modalities in Evaluation of Non-Thyroidal Neck Masses

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Abstract: ***Background:** thirty six patients who were suspected for the non- thyroidal neck masses are taken for this study. Its evaluation and early diagnosis help patients for the further plan of treatment. **Aim:** the aim of this study is to evaluate the role of various radiological imaging modalities in non-thyroidal neck masses for pre- operative characterization based on location, extent, morphological characteristics and enhancement pattern. **Methods and material:** The study will be conducted on 36 patients with complaints of neck masses who are referred to the department of radio-diagnosis, tertiary care hospital during the period one and half year.. **Results:** various neck masses of lymphnodal which involves tubercular, metastatic and lymphomatous and other non lymphnodal masses are evaluated with its characteristics in various radiological imaging modalities **Conclusions:** USG is the primary modality of choice, and although CT is the workhorse for the imaging in neck region, MRI is a valuable problem solving tool when multimodality approach is needed in some non thyroidal neck masses. Being radiation free, it should be the modality of choice as specially in certain group like children.*

Keywords: Non- thyroidal neck masses, X-ray, CT, High resolution sonography, colour doppler, and MRI

1. Introduction

The neck is a wide anatomical area extending from the mandible superiorly to manubrium sterni and clavicles inferiorly, laterally bounded by anterior border of trapezius muscles on both sides. It encompasses a wide variety of anatomical structures which belong to different organ systems and thus the swellings in neck can be caused by innumerable pathological lesions arising from the various anatomical structures lying therein. The neck being an exposed area, the swellings there are easily observed and thus lead to a cosmetic problem, leading to an early presentation of the patients to clinicians for early diagnosis and treatment. Mostly benign, neck masses can be malignant sometimes and may occasionally lead to fatal complications like airway compression, vascular compromise or metastatic spread of the lesion to adjacent structures. This study is an effort to assess the role of X-ray, CT, High resolution sonography, colour doppler, and MRI in detection and characterisation of non-thyroidal neck masses and help in deciding further course of management.

2. Aims & Objectives

- To evaluate the role of various radiological imaging modalities in non-thyroidal neck masses for pre-operative characterization based on location, extent, morphological characteristics and enhancement pattern.
- Outlining the extent in terms of involvement of adjacent structures, vessels and possible lymphadenopathy And to guide FNAC of these lesions whenever indicated and establish their pathological correlation.

3. Materials and Methods

- This was observational type of the study.
 - The study will be conducted on 36 patients with complaints of neck masses who are referred to the department of radio-diagnosis, tertiary care hospital during the period one and half year.
 - In present study, we divide neck masses according to non- thyroidal neck masses, and non thyroidal neck masses are further divided into the nodal neck masses and non-nodal neck masses.
 - All patients referred to the department of the radio – diagnosis is examined by the ultrasound and colour Doppler. Rest of the radiological modalities will be used according to the need of further evaluation.
 - Before evaluating a patient by X-ray, CT or MRI imaging informed consent will be obtained from the patient or guardian.
- a) **Inclusion Criteria**
- Patients who have presented with a clinically palpable and suspected non thyroidal neck mass.
 - Only those patient who were willing to participate were included.
 - Patient referred to radiology department for USG and/or CT scan investigation and found to have lesion, were included in this study.
- b) **Exclusion Criteria:**
- Post operative patients.
 - Patients with contraindications to intravenous administration to contrast medium.
 - Pregnant females.

Statistical Analysis: All collected data from the patients included within the present study will be done in Microsoft Excel. Data analysis would be done by appropriate statistical test (descriptive analysis) would be applied. Various statistical characteristics of the test such as (sensitivity, specificity, positive predictive value, negative predictive value) were calculated wherever applicable. The data is classified accordingly and frequencies described in number and their respective percentage.

4. Results

1. Lymphnodal masses

Total number of cases: 20, Non-neoplastic :11 (tubercular), Neoplastic : 9 (4 metastatic, 5 lymphomatous)

Table 1: Distribution of pathologies in lymphnodal masses(Total no. of cases -20)

| Pathology | No. of cases | Percentage |
|--------------|--------------|------------|
| Tubercular | 11 | 55 |
| Metastatic | 04 | 20 |
| Lymphomatous | 05 | 25 |
| Total | 20 | 100 |

Table 2: Age distribution of lymphnodal masses (Total no. of cases -20)

| Pathology | Age group (in years) |
|--------------|-----------------------|
| Tubercular | 10-35 |
| Metastatic | 50-70 |
| Lymphomatous | 15-60 |

Table 3: Gender distribution of lymphnodal masses

| Pathology | Male | female |
|--------------|------|--------|
| Tubercular | 7 | 4 |
| Metastatic | 3 | 1 |
| Lymphomatous | 4 | 1 |

Tubercular lymphnodal masses (no. of cases :11)

No. of cases: 11, **Age group:** 10-35 years, **Sex:** Male: 7, Female: 4, **Clinical features:** 10 patients presented with painless neck swelling & 1 patients presented with painful neck swelling. Among 10 patients, 6 patients had history of fever. 1 patient had history of abdominal koch's & 2 patients had history of pulmonary koch's. **Location:** Most common nodal location was level IV followed by level III & V. **USG features:** 9 out of 11 cases shows the well defined, hypochoeic round to oval shaped lymphnodes of variable sized and shows Internal necrosis, without internal vascularity. 7 out of 11 cases it appears matted. **CT/MRI features:** All cases appeared hypointense on T1WI & hyperintense on T2WI. On post contrast study 6 cases showed peripheral enhancement, 3 cases showed heterogenous enhancement & 1 showed homogenous enhancement case was present in Necrosis suggested by peripheral or heterogenous enhancement out of 10 cases. There was no evidence of vascular invasion

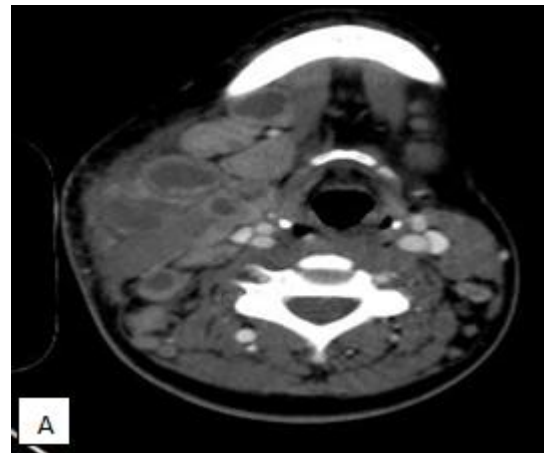


Figure A: Contrast enhanced CT scan of the neck region axial images shows multiple peripherally enhancing centrally hypodense lymph nodes in right sided level Ia, Ib, II.

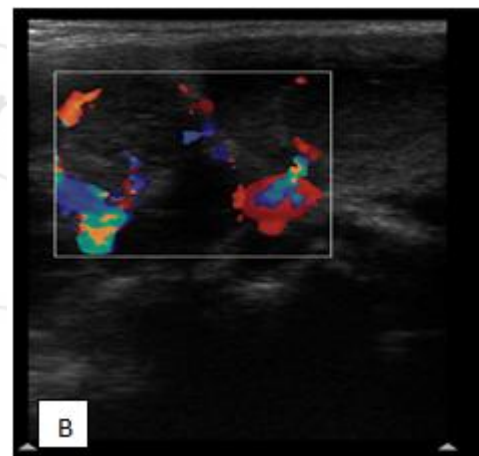


Figure B: Ultrasound of the submandibular area shows multiple well defined, hypochoeic lesions are seen with central necrosis and peripheral vascularity .

Table 21: Metastatic lymphnodal masses(Total no. of cases -04)

No. of case: 4 cases. **Age group:** 40-70 years. **Sex:** Male:3 , Female:1

Clinical features: 3 patients presented with painless neck swelling & 1 patients presented with painful neck swelling. Out of 4 patients, 4 of them had history of weight loss. All patients were known case of head & neck squamous cell carcinoma. 2 patients had oral cavity carcinoma & 2 patients had carcinoma of tongue. **Location:** Most common nodal location was level IIb, followed by level II, Ia & III **USG features :** 4 out of 4 cases shows the well defined , round to oval shaped, conglomerated, hypochoeic lymphnodes of variable sized and shows Internal necrosis, with minimal internal vascularity. **MRI features:** All cases appeared hypointense on T1WI & hyperintense on T2 WI. On post contrast study 3 cases showed peripheral enhancement, all cases showed heterogenous enhancement. Necrosis suggested by peripheral or heterogenous enhancement 4 out of 4 cases. Vascular invasion was present in 1 case with involvement of nodal level III.

Table 22: Lymphomatous lymphnodal mass(Total no. of cases -05)

Lymphomatous lymphnodal mass: No. of cases 5. **Age group:** 15-60 years. **Sex:** Male: 4, Female: 1

Clinical features: All 5 patients presented with painless neck swelling. Among 5 patients, 3 patients had history of fever. One patient had history of thoracic Hodgkin's lymphoma & history of chemoradiotherapy for the same. **Location:** Most common nodal location was level IV and III & in all 4 cases of NHL. The 1 case HL had nodal levels of IV & V.

USG findings: 4 out of 5 cases show the well defined, oval shaped, isoechoic lymph nodes of variable sized, with minimal internal vascularity. One out of five cases appears Isoechoic and shows internal necrosis. **MRI features:** 4 cases appeared hypointense on T1WI & hyperintense on T2WI, of which 3 were NHL & 1 was HL. One case appeared isointense on T1W, T2WI, which was of NHL. On post contrast study, 1 case of NHL showed heterogeneous enhancement. 3 cases of NHL & 1 case of HL showed homogenous enhancement. Necrosis suggested by peripheral or heterogeneous enhancement was present 1 in out of 5 cases, which was of NHL. 4 out of 5 cases showed extracapsular spread with evidence of vascular encasement without invasion.

Non-lymphnodal masses:

Table 4: Distribution of pathologies in non-lymphnodal masses (Total no. of cases -16)

| pathology | No. of cases |
|--------------------------------|--------------|
| lipoma | 4 |
| Cystic hygroma | 4 |
| Carotid body tumour | 1 |
| Common Carotid artery aneurysm | 1 |
| Pharyngeal pouch cyst | 1 |
| Osteo-sarcoma of mandible | 2 |
| Submandibular gland carcinoma | 2 |
| Plunging ranula | 1 |

Table 5: Gender distribution of non-lymphnodal masses (Total no. of cases -16)

| Pathology | Male | Female |
|-------------------------------|------|--------|
| lipoma | 1 | 3 |
| Cystic hygroma | 1 | 3 |
| Carotid body tumour | 1 | 0 |
| Carotid artery aneurysm | 0 | 1 |
| Pharyngeal pouch cyst | 0 | 1 |
| Osteo-sarcoma | 2 | 0 |
| Submandibular gland carcinoma | 1 | 1 |
| Plunging ranula | 0 | 1 |

Table 6: Age distribution of non-lymphnodal masses

| Pathology | Age group (in years) |
|-------------------------------|----------------------|
| Lipoma | 30-55 |
| Cystic hygroma | 2 months to 10 years |
| Carotid body tumour | 35 |
| Arterio-venous malformations | 25 |
| Pharyngeal pouch cyst | 11 |
| Osteo-sarcoma | 35-45 |
| Submandibular gland carcinoma | 50-55 |
| Plunging ranula | 16 |

Cystic hygroma (no. of cases-4)

Age group: 2 months to 10 years. **Sex:** 1 male, 3 female. **Location:** Posterior cervical space: 3 cases- Right side: 1. Left side: 2. submandibular space: 1 cases. Right side: 1, Left side: 0

Presenting complaints: all presented with neck swelling since birth. One male patient had complaint on pain in the swelling. **Usg features:** All 4 cases appear well defined hypointense anechoic lesions without internal vascularity. However, vascularity is present in septations.

Morphological features on MRI

3 cases had multilocular lesions with presence of internal septations. 1 case had large unilocular lesion. 2 cases had large multiloculated lesions had well defined yet infiltrating margin infiltrating into a soft tissue like muscles, No case had presence of enhancing soft tissue component. **MR Signal characteristics:** 1 case, the 5 year old male child who had complaint of pain in neck swelling, had well defined multilocular non infiltrating lesion in right submandibular region, which appeared hyperintense on T1WI, T2WI & STIR images with presence of fluid-fluid levels suggestive of haemorrhage within the lesion. Rest all 3 cases followed fluid signal evident as hypointensity on T1WI & hyperintensity on T2WI & STIR images. **Enhancement characteristics:** swelling in right case, who had painless neck showing septal submandibular region, had well defined multiloculated lesion enhancement on post contrast study contrast study. Rest all 3 cases didn't show any enhancement on post contrast.



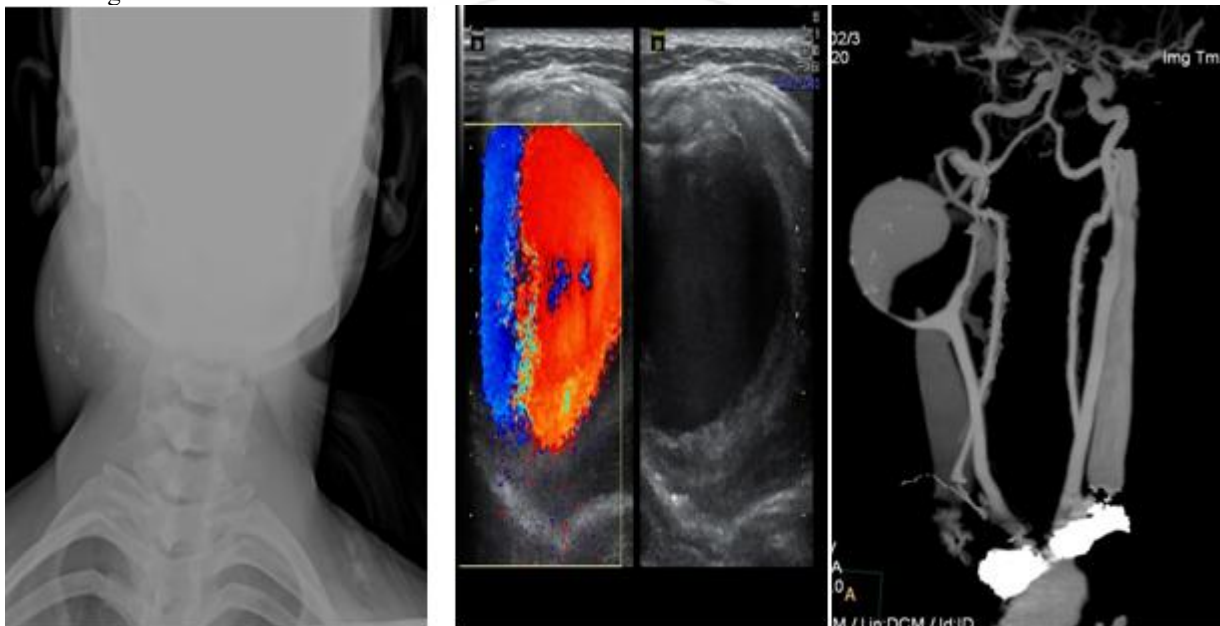
MRI neck STIR axial, coronal images show, large, well defined, multilobulated, hyperintense lesion is seen in midline and extending on both sides, may represent lymphatic malformation

Lipoma (No. of cases-4)

Age group: 30-50 years. **Sex:** 1 male, 3 female. **Presenting complaints:** all presented with painless neck swelling. **Location:** Posterior cervical space: 3 cases- Right side: 1, Left side: **Submandibular space:** 1 case on Left side **USG features :** all 4 cases appears well defined hyperechoic lesions in subcutaneous plane without internal vascularity **Morphological features on MRI:** All cases had unilocular lesions with well-defined margins. No case had evidence of internal septations. 1 case, All 4 cases followed fat signal evident as hyperintensity on T1 W & T2WI & suppression on STIR images. No evidence of soft tissue intensity or fluid signal intensity in any cases to suggest soft tissue component or necrosis. Enhancement characteristics: No case showed enhancement on post contrast study.

Other non nodal neck masses:

I) Submandibular gland carcinoma :Two cases of the submandibular gland carcinoma on each side was observed



X-ray soft tissue neck antero-posterior view shows large, well defined soft tissue swelling on the right side of neck with linear internal calcifications.

USG with colour Doppler : bidirectional flow due to swirling of blood within the (true or false) aneurysm known as the yin-yang sign.

ct angiography the patent portion of the lumen of the aneurysmal vessel shows increased attenuation, due to contrast enhancement, , peripheral wall calcification of aneurysm noted

III) Ranula:One case of 19 years of female patient observed and which is on USG shows well defined collection with internal moving echoes noted within involving the muscles of the floor of the mouth.

IV) Pharyngeal pouch cyst :No of cases : One case 17 year old female patient of the pharyngeal pouch cyst was observed on young female and appears well defined cystic lesion noted in the right submandibular region whci appears hypoechoic with internal echoes. On CECT neck appears well defined, hypodense, peripheral enhancing lesion noted.

V) Osteosarcoma of mandible :No of cases: two cases of the the osteosarcoma with soft tissue involvement of noted . **Age group:** 35 to 45 year , male On X-ray both cases shows large, ill defined, sclerotic lesion with speculated periosteal

reaction involving of the left side body of the mandible with adjacent soft tissue swelling . on ultrasound it appears as ill defined, heteroechoic lesion with internal vascularity. On CECT neck shows involvement of the left side of the body of the mandible with spiculated periosteal reaction with heterogeneously enhancing soft tissue component noted in the both case in submandibular region5.

II) Internal Carotid artery aneurysm:one case of the internal carotid artery aneurysm is seen . **x-ray soft tissue neck antero-posterior view:** large , well defined soft tissue swelling on the right side of neck with linear internal calcifications.**Ultrasound with colour Doppler :** Dilated lumen of the right internal carotid artery with eccentric echogenic material noted within the lumen and on colour doppler examination bidirectional flow due to swirling of blood within the (true or false) aneurysm known as the yin-yang sign.**CT angiography of neck:** The patent portion of the lumen of the aneurysmal vessel shows increased attenuation, due to contrast enhancement, whereas a part of the lumen shows reduced attenuation due to mural thrombus, peripheral wall calcification of aneurysm also noted.

5. Discussion

In the present study 36 patients with clinically suspected non thyroidal neck masses were evaluated by various radiological modalities and pathologic correlation was obtained cases whenever required.

5.1 Lymphnodal masses

- 1) **Tubercular lymphnodal masses** Though necrosis is an important finding to suggest tubercular or infective etiology, it is not specific for TB lymphadenitis, especially when presence of history of malignancy or presence of aggressive features like vascular invasion. Absence of necrosis cannot rule out tubercular etiology because non necrotic homogenous enhancement is seen in early cases. Though presence of calcification helps to differentiate tubercular & metastatic etiology, MRI cannot depict presence of calcification. So, observations of our study of tubercular lymphnodal masses are comparable with studies of **Engin G et al. in 2000 & Joshua et al in 2007.**
- 2) **Metastatic lymphnodal masses:** So, in patients of known case of head & neck squamous cell carcinoma with larger lymphnodes greater than 1 cm, echopattern in ultrasound, pattern on enhancement in CT scan or MRI signal characteristics on T1W & T2W images, presence of necrosis & extracapsular spread are important MR imaging criteria to suggest metastatic nodal involvement, our findings are comparable with two different studies by **van den Brekel, M.W. et al. in 1990 & one study by Ding ZX et al in 2005.**
- 3) **Lymphomatous lymphnodal masses:** According to our study non-necrotic homogeneously enhancing lymphnodal masses with extracapsular spread & vascular encasement can reliably suggest diagnosis of lymphoma. However necrosis can be present in especially in NHL. So our findings of lymphoma are consistent with studies of **Waber AL et al 2003 , Toma P et al. 2007 & King AD et al 2004.**

5.2 Non –lymphnodal masses

- 1) **Lipoma** In our study, only benign neoplastic lesions were found in 4 patients of age group of 30 to 50 yrs. Posterior cervical space was the most common location. All were well defined hyperechoic lesions in subcutaneous plane on USG and on MRI All were well defined unilocular lesions of fat signal intensity on T1W, T2W & STIR images without evidence of malignant nature like any cystic/necrotic areas, soft tissue components, enhancing septations or vascular invasion. So we conclude that USG and MRI can reliably depict the nature of lipomatous lesion in neck region. Our findings are consistent with studies of **Munk PL et al. 1997 & Kransdorf MJ et al 2002.**
- 2) **Lymphatic malformations** we conclude that cystic hygroma has quite characteristic MR appearance to suggest appropriate pre-operative diagnosis as well as complications like intra-lesional haemorrhage. So our findings are consistent with studies of **Yuh, William TC et al. 1991 & Siegel, M. J, et al 1989.**
- 3) **Carotid body tumour** In our study, the carotid body tumour is seen involving right carotid space. However, Flow voids to hypervascularity were present in carotid body tumour, however carotid body tumour caused splaying of internal & external carotid arteries. findings are similar with **wang et al in 2014.**
- 4) **Internal carotid artery aneurysm** : In our study, one case of the internal carotid artery aneurysm was

observed, on X-ray soft tissue neck antero-posterior view shows large, well defined soft tissue swelling on the right side of neck with linear internal calcifications. On ultrasound dilated lumen of the right internal carotid artery with eccentric echogenic material noted within the lumen and on colour doppler examination bidirectional flow due to swirling of blood within the aneurysm known as the yin-yang sign. On CT angiography of neck The patent portion of the lumen of the aneurysmal vessel shows increased attenuation, due to contrast enhancement, whereas a part of the lumen shows reduced attenuation due to mural thrombus, peripheral wall calcification of aneurysm noted.

5.3 Other non- nodal neck masses

- 1) **Submandibular gland carcinoma** In our study, two cases of the submandibular gland carcinoma was observed which were well defined hypoechoic in echotexture with the internal vascularity and on ultrasonography it was detected as benign etiology but on histopathology it turn out to be malignant. this findings are similar as **Rapidis A Det. al 2004.**
- 2) **Plunging Ranula** One case of the ranula was observed and which is on USG shows well defined collection with internal moving echoes noted within involving the muscles of the floor of the mouth.
- 3) **Pharyngeal pouch cyst** In our study , One case 17 year old female patient of the pharyngeal pouch cyst was observed on young female and appears well defined cystic lesion noted in the right submandibular region which appears hypoechoic with internal echoes. On CECT neck appears well defined, hypodense, peripheral enhancing lesion noted.
- 4) **Osteosarcoma of mandible** : In our study, two male patients of the osteosarcoma with soft tissue involvement of noted. Age group of patients between 35 to 45 year, On X-ray both cases shows large, ill defined, sclerotic lesion with speculated periosteal reaction involving the left side body of the mandible with adjacent soft tissue swelling. On ultrasound it appears as illdefined, heteroechoic lesion with internal vascularity. On CECT neck shows involvement of the left side of the body of the mandible with spiculated periosteal reaction with heterogeneously enhancing soft tissue component noted in the both case in submandibular region.

6. Conclusion

This study was an observational and prospective study. Total 36 All Patients that came to the radiology department wide clinical suspicion of non-thyroidal neck masses.

Out of the 36 cases of non-thyroid diseases 55.5% were male and 45.5% were females. Maximum number 27.8% of patients were within age group 11-20 years.

In our study of 36 patients were evaluated for neck pathologies non-thyroidal pathologies by using various radiological modalities

- X-ray is helpful in detection of calcifications within non thyroidal masses and compression or shifting of trachea by the neck masses.
- High resolution sonography is a useful modality for distinguishing thyroidal from extrathyroidal neck masses.
- Benign vs Malignant thyroid lesions, the sonographic features favouring malignancy are Predominantly solid lesions, Hypoechoic echopattern in a solid lesion, microcalcifications, Local invasion, significant cervical lymphadenopathy, Intralesional vascularity on colour Doppler.
- Role of CT is helpful in margin, density, necrosis/cystic areas or presence or absence of soft tissue components, extension of the lesion, involvement of the adjacent structure, and classified the lesion into categories like neoplastic/non-neoplastic and benign/malignant with appropriate staging.
- In the study, among lymphnodal masses, tubercular lymphadenitis was clustered in younger age group as compared to metastatic lymphadenopathy. Lymphoma has large range of age variation.
- MRI findings such as nodal level, extracapsular spread, adjacent soft tissue invasion, vascular encasement, signal intensities, presence of necrosis and enhancement characteristics helps in differentiating pathologic lymphadenopathy from reactive benign lymphadenopathy and can also help differentiating various pathologies in the setting of give clinical scenario.
- In the study, among non-lymphnodal masses, cystic hygroma and aneurysm were clustered among children. Benign tumours like lipoma, carotid body tumours were seen in young adults.
- MR imaging provides excellent contrast resolution to help identifying the epicenter of the lesion in the particular neck space and the narrowing down the list of differential diagnosis.
- After deciding the location and narrowing down the differentials, the ability of MR imaging to depict the tissue composition and lesion further narrow down the list of the differential diagnosis and in some cases it may be the diagnostic.
- In the study, MR criterians like margin, signal intensity, necrosis/cystic areas or presence or absence of soft tissue components broadly classified the lesion into categories like neoplastic/non-neoplastic and benign/malignant, presence of fluid signal intensity suggested vascular malformation. Presence of fat signal intensity without malignant features like soft tissue, septum or enhancement suggested benign fat containing tumours.
- Further differentiation was also possible with MRI, such as among vascular malformations, arterial feeders and enhancement differentiated AVM from cystic hygroma. Presence of flow voids and carotid splaying and absence of cystic non enhancing areas differentiated carotid body tumour from neurogenic tumour.
- Excellent contrast also provides better delineation of the lesion and soft tissue invasion providing valuable pre-operative information to surgeons.
- So, here we conclude USG is the primary modality of choice, and although CT is the workhorse for the imaging in neck region, MRI is a valuable problem solving tool when multimodality approach is needed in some non

thyroidal neck masses. Being radiation free, it should be the modality of choice as specially in certain group like children.

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