A Hospital Based Observational Study on Diagnostic Role of High-Resolution Ultrasound and Doppler Imaging in Evaluation of Non-Thyroidal Neck Masses of Patients Attending the Department of Radiodiagnosis, AMCH, Dibrugarh with Fine-Needle Aspiration / Histopathological Correlation

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ABSTRACT

BACKGROUND

Neck swellings consists of a wide spectrum of pathological entities. These swelling can occur due to a variety of aetiologies consisting of congenital, acquired inflammatory, neoplastic, or vascular origin. It is essential to have an extensive knowledge of the anatomy and contents of each cervical compartment to achieve a diagnosis. The age of presentation and clinical findings often narrows down the differential diagnosis. Ultrasonography (USG) is helpful in differentiating the nature of the lesions and differentiating solid from cystic neck lesions. Ultrasound is often used as an initial modality for pre-treatment assessment of any neck swelling.

METHODS

Patients with clinically palpable / non-palpable neck swellings were scanned using 7.5 - 11 MHz transducers, excluding patients with diagnosed thyroid swellings.

RESULTS

In total 120 cases were studied; the mean age of patients was 34 years with a male to female ratio of 1.1:1. The age wise categorisation included paediatric population (34.2 %) and adult population (65.8 %). 96 (80 %) cases presented with painless neck swelling, 76 (63.3 %) cases were non-neoplastic and 44 (36.7 %) cases were neoplastic in nature. Cervical lymphadenopathy being the most common ultrasound finding in both paediatric and adult population. Malignant lesions were most common in adult age group. Heterogeneous echotexture, rounded nodes, intranodal necrosis, loss of echogenic hila, peripheral nodal blood flow and increased pulsatility index (PI) and resistive index (RI) were important features of malignant lymph nodes. Sensitivity and specificity of USG and Doppler in differentiating neoplastic from non-neoplastic lesions were 97.7 % and 98.3 % respectively and for differentiating benign from metastatic nodes were 97.7 % and 98.3 % respectively.

CONCLUSIONS

Considering the study results and observations, USG is the best initial investigation for the evaluation of inflammatory, cystic and neoplastic swellings in various age groups. It is non-invasive, cost effective readily available and repeatable technique. It is relatively easier to use and does not involve radiation hazards. Colour Doppler can evaluate the vascularity of the lesions and provide details of any vascular invasion of metastatic lesions. Ultrasound can differentiate aetiology of lymph node enlargement to a significant extent.

KEYWORDS

High Resolution Ultrasound, Paediatric Neck Mass, Metastatic Lymph Node, Histopathology, FNAC, Tubercular Lymph Nodes, Colour Doppler, Non-Thyroidal

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DOI: 10.18410/jebmh/2021/117

How to Cite This Article:
Das KP, Borah P, Borgohain M, et al. A hospital based observational study on diagnostic role of high-resolution ultrasound and Doppler imaging in evaluation of non-thyroidal neck masses of patients attending the department of radiodiagnosis, AMCH, Dibrugarh with fine-needle aspiration / histopathological correlation. J Evid Based Med Healthc 2021;8(11):597-602. DOI: 10.18410/jebmh/2021/117

Submission 06-11-2020,
Peer Review 13-11-2020,
Acceptance 18-01-2021,
Published 15-03-2021.

BACKGROUND

Neck masses are a commonly encountered entity in patients in our everyday clinical practice. The antecedent factors associated with swelling in the neck region are heterogeneous. The spectrum of disorders is extensive which encompasses both neoplastic and non-neoplastic pathologies. Hence careful history taking, and thorough examination of the head and neck may be sufficient to permit diagnosis, but in circumstances where the diagnosis is uncertain, imaging can be very helpful to discriminate the mass. This conjecture is mainly due to the limitations of clinical examination in differentiating between solid and cystic lesions on one hand, and the substantiation of exact anatomic properties.[1]

Most of the times it has been noted that there is a proportion of lesions which, despite in detailed diagnostic work-up remain elusive and are subjected to premature surgical interventions. Cross sectional imaging like CT scan may help as a pre-treatment work-up but it is associated with some important drawbacks: radiation exposure, costly, lack of availability and usage of intravenous contrast. A simple, but reliable, non-invasive and cost-effective test would be very much helpful in these cases. Even though computed tomography scan (CT) and magnetic resonance (MRI) imaging can be used for the evaluation of most of head and neck lesions, ultrasonography (US) often is considered as the initial modality for evaluating superficial structures. High-resolution ultrasonography plays a major role in the investigation of the soft tissue structures of the head and neck.

With this imaging modality, it is possible to confirm the clinical impression of a neck mass as well as demonstrate a lesion that is not detectable on physical examination. Moreover, ultrasonography can provide valuable information about the tissue characteristics of the lesion, its anatomic location, and its effect on adjacent structures. It provides valuable details in many clinical indications - to determine pathology, volume data, vascularity of the lesion, size of the tumour and helps in guiding fine needle biopsy.

Head and neck studies should be conducted with a linear transducer. The machine ought to be adjusted to work at the very best clinically acceptable frequency, realizing that there's a trade-off between resolution and beam penetration. For most instances, mean frequencies of 8 to 12 MHz are preferred, though some patients might need a lower frequency transducer for deeper penetration. Ultrasound as because it is a non-invasive imaging modality and also administration of contrast media is not required, this makes it an ideal modality for evaluating neck masses in infants and children.[2]

The current study was designed to determine the accuracy of high-resolution ultrasound as a cost-effective tool in the evaluation and characterization of neck masses as well as differentiating benign and malignant, inflammatory, solid and cystic and congenital swellings, correlating it with clinical diagnosis and also to evaluate their Doppler characteristics.

Objectives

1. To identify the sonographic and doppler characteristics of non-thyroidal neck masses.
2. To differentiate benign and malignant masses based on their sonomorphology and Doppler characteristics.
3. Confirmation of ultrasonography findings by fine-needle aspiration cytology (FNAC) and / or histopathological examination.

METHODS

The present study is an hospital based observational study conducted over a period of 1 year from 1st July 2018 to 31st June 2019.The study was conducted in the Department of Radiology, Assam Medical College & Hospital, Dibrugarh, Assam.

Inclusion Criteria

Patients referred for the ultrasound examination of clinically palpable or symptomatic non-palpable neck mass / swellings irrespective of age and gender.

Exclusion Criteria

Patients presenting with clinically / ultrasonographically diagnosed case of thyroidal lesions.

Sample Size and Selection

A total of 120 patients who were referred from various department were included in the study.

All cases with visible or clinically palpable or symptomatic non-palpable neck mass / swelling referred to the department of radio-diagnosis during the study period and fulfilling the inclusion criteria were included in the study.

Equipment

The ultrasound scans were performed using a SAMSUNG RS80A ultrasound machine with 7.5 to 10 MHz high frequency linear transducer.

Study Protocol

We evaluated the following regions consecutively: submandibular, submental, midline of the neck, parotid, upper cervical, mid cervical, lower cervical, supraclavicular fossa and posterior triangle. Ultrasound was performed in multiple planes through anterior, posterior and over the mass. Findings like number, size, consistency, texture, vascularity pattern with marginal definition were recorded on the specially designed proforma. FNAC / histopathological examination (HPE) evaluation was done in patient with detectable lesions and wherever applicable. Institutional ethical and research committee approval was taken prior to start the study.

Statistical Analysis

The data collected was entered in SPSS-16 software, Microsoft Excel 2016 and was used for analysis. Continuous variables were described using mean and standard deviation (SD), and categorical variables were described using frequency and percentage. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy of USG findings were obtained.

RESULTS

In the study, 120 subjects with neck masses were recruited of whom 39 % of the subjects were in the age group of 0 - 20 years and 27 % of the subjects were in the age group of 21 – 30 years. Patients ranging from 23 days of age to 88 yrs. were included in this study, the youngest and oldest being male patients with fibromatous coli and metastatic lymphadenopathy respectively.

Mean age of subjects was 34 years with a median age of 30 years (Table 1), which was correlated with a study conducted by Siddiqui D et al.[3] where they conducted a study on 105 cases and found the mean age of presentation as 36.8 years and a male: female ratio of 1.2:1.

We found that 52.5 % of subjects were males and 47.5 % were females (Table 1), which was correlated with study done by Subramanyam N et al.[4] on 100 patients where they found that male: female ratio was 1.25:1. Male preponderance was also established in a study done by Goutam A et al.[5] where they studied a group of 50 patients and found a male: female ratio of 1.7:1. Most of the females presented with benign nodal lesions (N = 25). Most of the males presented with metastatic nodal pathology (N = 29).

However, the present study included only those patients who came to our department of radio-diagnosis, so this might not be true age and sex prevalence of neck masses.

In our study, swelling was the most common presenting complaint in 100 % cases, among which most common presenting complaint was painless neck swelling in 96 patients and painful neck swelling was present in 24 cases. This observation was correlated well with study conducted by Siddiqui D et al.[3] where they found swelling as chief complaint in 84 % cases. Symptoms of dysphagia, which was associated with neck mass shows 8.0 % of the subjects had the symptom of dysphagia where as 92.0 %, did not have dysphagia. Change of voice, another symptom associated with neck mass shows that 9.1 % of subjects had a voice change whereas 81.9 % did not have a voice change.

The sonographic consistency of neck masses shows 70.8 % solid masses 10.8 % cystic masses and 18.4 % are mixed consistency. The findings of our study were similar with the study conducted by Sardar Q et al.[6] where they evaluated a study group of 73 patients and found that solid lesions comprised of about (N = 85) 65 % cases, (N = 22) 19 % lesions were of mixed type and (N = 13) 15 % cases were cystic in nature. 75.2 % of the neck lesions were located in the submandibular space of neck followed by 15 % in the posterior triangle. The findings were similar to a study done by Irani S, et al.[7] on 1208 patients. (Table 2).

The screening value of ultrasound for metastatic neck mass sensitivity is 100 %, specificity is 96 %, PPV is 97 % and the NPV is 100 % (Table 3). Screening value of sonography for neoplastic masses showed a sensitivity of 97.7 %, specificity 98.3 %, PPV 97 % and NPV 99 % (Table 3). The screening value of ultrasound for cystic mass showed a 100 % sensitivity, 98.4 % specificity, 93 % positive and 100 % negative predictive values (Table 3), which correlated with a study done by Subramanya B et al.[8] on 131 patients in which they found 84 benign cases and 47 malignant swellings.

Heterogeneous echotexture of lymph node showed a sensitivity of 88 % and specificity of 69 % in the detection of metastatic lymphadenitis. Loss of echogenic hila of lymph node showed a sensitivity of 81 % and specificity of 100 % in the detection of metastatic lymphadenitis. The above findings were well correlated with a study conducted by Kumar S, et al.[9] and Singh A et al.[10] where they concluded that heterogeneous echotexture is a characteristic of metastatic node.

Presence of intra nodal necrosis in lymph node showed a sensitivity of 74 % and specificity of 88 % in the detection of metastatic lymphadenitis. Metastatic nodes predominantly showed peripheral vascularity whereas hilar vascularity pattern was shown in benign nodes. Of the metastatic nodes 35 cases had PI value > 1.8 whereas majority (N = 32) of the benign nodes had PI values < 1.8 and most of the metastatic nodes had RI value > 0.8, whereas benign nodes predominantly had RI values < 0.8 (N = 33).

In a study conducted by Shirakawa T et al.[11] they reported that increased RI > 0.8 and increased PI > 1.75 were significant in diagnosing metastatic from benign nodes.

Brnic Z et al.[12] concluded that a PPV of 86 % and absolute specificity (100 %) for metastases were shown for PI > 1.80. An RI > 0.80 has PPV and specificity of 100 % for metastasis. Our study had 9 cases of salivary gland lesions among which there were 4 cases of pleomorphic adenoma, 3 cases of sialolithiasis and 1 case each was of sialo adenitis and parotid abscess.

Among the 4 cases of pleomorphic adenoma one case was of submandibular origin. The lesions were typically homogenously hypoechoic, lobulated, showing minimal vascularity with posterior acoustic enhancement. These findings were well correlated with study done by Mittal S et al.[13]

Out of the 3 cases of sialolithiasis 100 % cases were from submandibular gland. 2 cases had intraductal sialolith with ductal ectasia and one case was of intraglandular calculi with associated sialoadenitis. Submandibular gland is the most common place for calculi formation because it's particularly viscous, mucous and more alkaline saliva, and relatively high concentration of hydroxyapatites and phosphates.[14]

One case of parotid abscess was noted involving the superficial lobe which was hypoechoic with evidence of echo debris within. This feature is consistent with parotid abscess described by Bialek et al.[15]

In our study 13 cases of neck abscess were diagnosed on USG of which 9 cases underwent FNAC evaluation, rest of the cases didn't undergo FNAC evaluation and were observed by follow up scans. 5 no of cases each were in the

age group of 11 - 20 years and 30 - 40 years. Most of the lesions were in the anterior triangle (N = 15) 2 cases were in the midline. The lesions presented as swelling ± fever ± pain. On grayscale the lesions were predominantly heterogeneous in echotexture with evidence of moving echo debris within and evidence of surrounding soft tissue inflammation. The above findings were correlated with a study conducted by Mittal M, et al.[16] where they concluded that submandibular region is the most common location of abscess formation followed by posterior triangle.

Age Group (in Years)	Male	Female	Percent (%)
0 - 10	12	7	15.8
11 - 20	8	20	23.4
21 - 30	3	15	15.0
31 - 40	10	5	12.5
41 - 50	6	4	8.4
51 - 60	13	2	12.5
61 - 70	7	4	9.1
71 - 80	1	0	0.8
81 - 90	3	0	2.5
Total	**63**	**57**	**100**

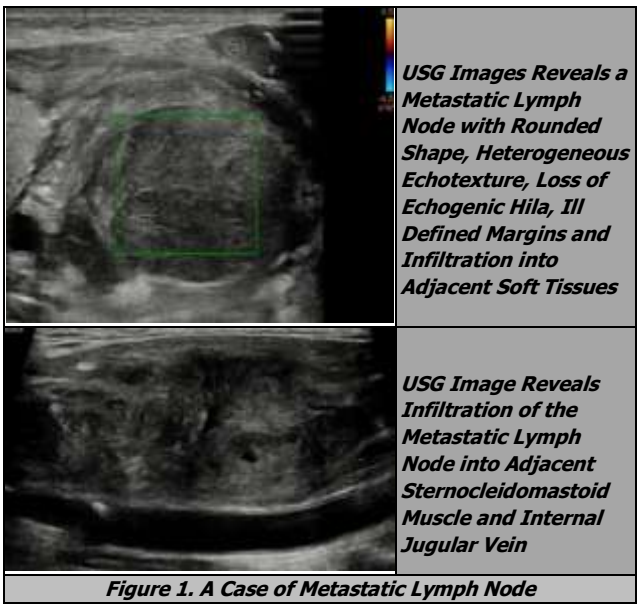
Table 1. Age and Gender Wise Distribution of Cases

Anatomical Location		No. of Cases	Percent %
Anterior triangle	Sub mandibular	61	27.4
	Carotid	30	24.7
Posterior triangle	Occipital	10	1.4
	Subclavian	9	32.9
Midline	Sub mental	5	11.0
	Muscular	5	2.7

Table 2. Location of Neck Mass on Ultrasonography

USG Diagnosis	No. of Cases	FNAC / HPE Diagnosis
Thyroglossal cyst	3	2 (1 case was diagnosed as suppurative lymph node in FNAC)
Abscess	13	9 (3 cases were diagnoses as tubercular and 1 was diagnosed as suppurative lymph node on FNAC)
Ranula	1	1
Lipoma	1	1
Dermoid	2	2
Epidermoid	2	2
Lymphangioma	3	2
Reactive lymph nodes	14	13 (1 case was diagnosed as suppurative node)
Suppurative node	6	5 (1 case was diagnosed as reactive lymph node)
Tubercular node	9	6 (2 cases were diagnosed to be suppurative and 1 was diagnosed as reactive lymph node)
Metastatic nodes	36	36
Salivary gland tumour	4	4 cases were diagnosed as pleomorphic adenoma
Neurogenic tumour	1	1
Soft tissue tumour	1	2 (1 case was diagnosed as fibromatous coli on USG, which was diagnosed on FNAC as benign fibroblastic tumour)

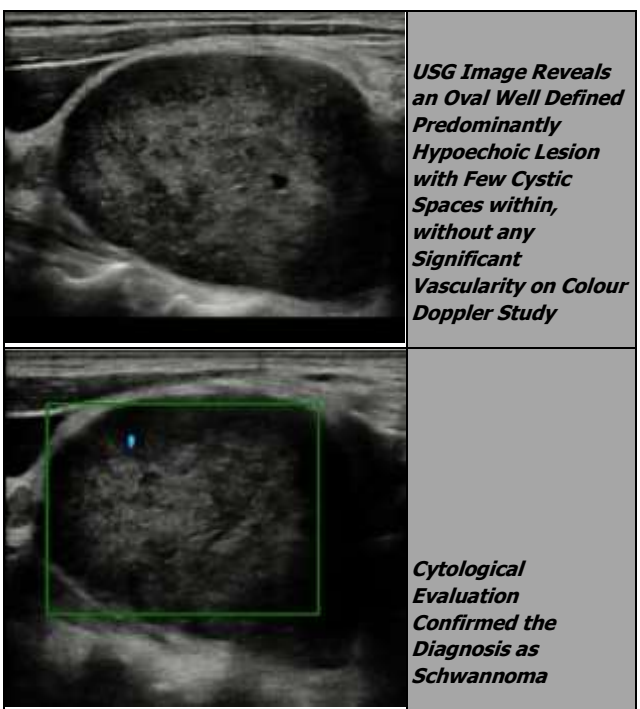
Table 3. Comparison of USG and FNAC / HPE Findings of Various Lesions



USG Images Reveals a Metastatic Lymph Node with Rounded Shape, Heterogeneous Echotexture, Loss of Echogenic Hila, Ill Defined Margins and Infiltration into Adjacent Soft Tissues

USG Image Reveals Infiltration of the Metastatic Lymph Node into Adjacent Sternocleidomastoid Muscle and Internal Jugular Vein

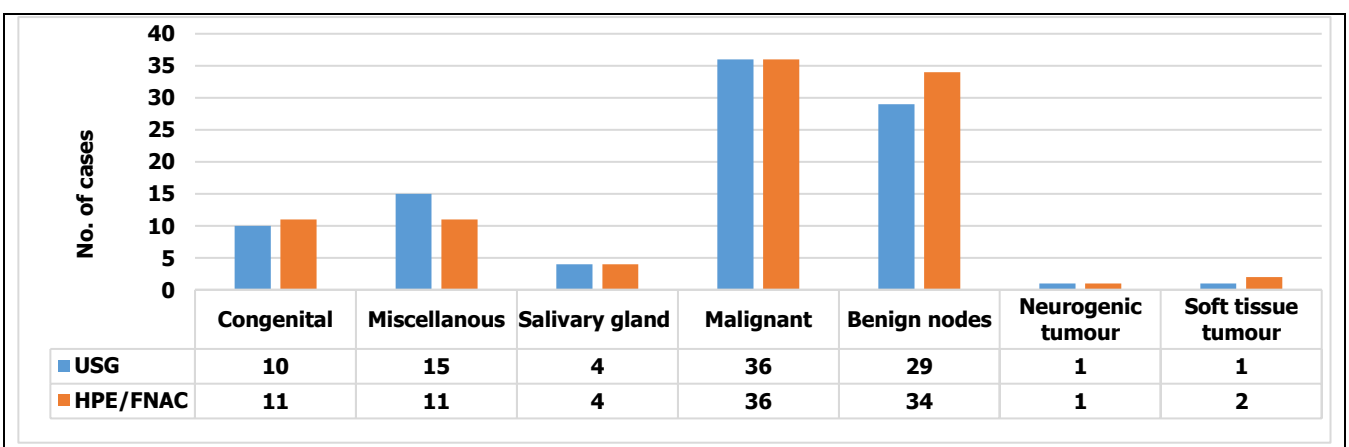
Figure 1. A Case of Metastatic Lymph Node



USG Image Reveals an Oval Well Defined Predominantly Hypoechoic Lesion with Few Cystic Spaces within, without any Significant Vascularity on Colour Doppler Study

Cytological Evaluation Confirmed the Diagnosis as Schwannoma

Figure 2. A Case of Neurogenic Tumour in Posterior Triangle of Neck in a 45 yr. Old Female



Graph 1. Correlation between USG and FNAC / HPE Findings

DISCUSSION

Of the 120 cases we studied the spectrum of disease pathology included cases of lymph nodes as the largest group (58 %) followed by (15 %) each of congenital and miscellaneous lesions, salivary gland disease (1 %), soft tissue tumour and neurogenic tumour (< 1 %).

Out of the total cases presenting with nodal pathology, 51 % were sonologically diagnosed to have metastatic aetiology. 98 % accuracy of USG grayscale imaging was noted in differentiating neoplastic from non-neoplastic lesions of the neck based on correlation with FNAC / HPE. Among the cystic lesions most of the lesions were developmental / congenital in origin.

100 % sensitivity and 90 % diagnostic accuracy was noted in detection of tubercular lymph node with USG evaluation; matted border and intranodal necrosis were the predominant feature. 90 % sensitivity and 97 % specificity are noted in detection of metastatic lymph nodes using Doppler parameters like vascularity pattern, resistive index and pulsatility index. 100 % sensitivity and 99.1 % accuracy of USG grayscale features was noted in differentiating cystic swellings from other benign cause of neck swellings. Among the cystic lesions most of the lesions were developmental / congenital in origin. One case was diagnosed as thyroglossal cyst on USG based on the location margins and internal echotexture, however it was ruled out as suppurative lymph node on FNAC evaluation. HPE could have been a better modality of diagnosis in this situation.

CONCLUSIONS

Considering the study results and observations it can be concluded that ultrasonography can be considered as the best initial investigation for the evaluation of various categories of neck swellings which include congenital, neoplastic and inflammatory swellings among various age groups. Ultrasound is one of the most valuable investigation tools available today to evaluate neck masses with respect to size, site, consistency and vascularity. It can be inferred that as a diagnostic tool in comparison to advanced imaging modality, USG stands as a non-invasive, cost effective readily available and repeatable technique. It is relatively easier to use and does not involve ionizing radiation. Congenital neck masses such as thyroglossal cysts, dermal inclusion cyst and cystic hygroma show a variety of sonographic features which aid in pre-operative assessment.

Colour Doppler imaging enables the assessment of vascularity of the lesion, as well as invasion of the great vessels of the neck by a growth or metastatic lymph node, which helps in deciding the inoperable cases. Ultrasound can differentiate aetiology of lymph node enlargement to a significant extent using the combination of characteristics such as increased size, intranodal necrosis, rounded shape, absence of an echogenic hilum, and peripheral or displaced vascularity. This study suggests that ultrasonography should be routinely performed as a part of evaluation of all patients presenting with palpable and nonpalpable head and neck swellings.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.

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