

Original Research Article


Sensitivity of HRUSG in detection of neck masses

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Abstract

Background: Neck masses are any swelling or enlargement of the structures in the area between the inferior border of mandible and clavicle. Commonly presenting neck masses occur within lymph nodes, thyroid, parotid and other salivary glands.

Objective: To evaluate the sensitivity of HRUSG in detecting neck masses correctly and correlation with FNAC findings.

Materials and methods: It was a prospective and comparative case series study. The study was conducted in Department of Radiology, Tata Main Hospital, Jamshedpur over a period of 1.5 years. All patients of any age group presenting with a mass in the neck or patients in whom the mass was detected incidently on clinical examination were taken up for study. The study comprised of 50 patients referred from various department O.P.D.s/ wards of Tata Main Hospital. Patients lost to follow up were excluded from the study.

Results: A prospective study comprising of 50 patients was performed to evaluate the sonographic features in patients presenting with mass in the neck. Ultrasonographic findings were correlated with cytohistopathology. The study group comprised of patients ranging from 4 to 64 years of age. Maximum numbers of patients were aged between 21 to 30 years of age accounting for 15 (30%) of cases. Out of 50 patients, 26(52%) were male and 24(48%) were female. Out of 41 benign lesions thyroid gland accounted for 19 (46%) cases followed by lymph node accounting for 10 (24%) cases and developmental anomalies accounted for 5 (12%). Malignant lesions of the lymph node were found to be dominant, accounting for 6 cases (including both primary and secondary lymph node diseases) followed by thyroid which accounted for 2 cases. Thyroid gland was the most common site of involvement accounting for 21 cases (42%) followed by lymph node lesion 15 (30%).

Conclusion: High resolution ultrasound should be the imaging modality of choice in infants and children and for follow up of patients on treatment as it is non-invasive, non-ionizing and low cost modality.

Key words

Various Neck Masses, High Resolution Ultrasound, Fine Needle Aspiration, Cytohistopathology.

Introduction

Neck masses are any swelling or enlargement of the structures in the area between the inferior border of mandible and clavicle [1]. Commonly presenting neck masses occur within lymph nodes, thyroid, parotid and other salivary glands. Less common pathologies presenting as neck swellings are from thyroglossal cyst, brachial cleft cyst, carotid body tumor, cystic hygroma, pharyngeal pouch abnormalities and lump of skin appendage [2-4].

Ultrasonography has several advantages over other modalities as it is harmless, uses no ionizing radiation, is widely available, easy-to-use, non-invasive, inexpensive and unaffected by metal artifacts such as dental restorations. US are useful to determine if a mass is cystic or solid and Doppler US tells us if it is vascular [5-9].

Ultrasonography is the most common and most useful way to image the thyroid gland and its pathology, as recognized in guidelines for managing thyroid disorders published by the American thyroid Association [10]. Thyroid nodule is a common clinical problem. Epidemiologic studies have shown that the prevalence of palpable thyroid nodules is found in approximately 5% of women and in 1% of men living in iodine - sufficient parts of the world [11].

On the other hand, ultrasound (US) studies could detect thyroid nodules in 19-67% of selected individuals with higher frequencies mainly in women and elderly people [12]. The majority of patients with thyroid nodule can be managed conservatively and it justifies the effort to select better candidates for thyroidectomy. A number of clinical, US, and cytological parameters have

been previously studied; however, none of them have shown significant impact on clinical practice [10]. Molecular markers are promising but they have not yet been sufficiently validated to be used in clinical practice [13]. The role of clinical evaluation of patients who have thyroid nodule is to minimize the risk of overlooking thyroid cancer.

In children most neck masses are benign. Almost 50 percent of all 2 years old children have palpable cervical lymph nodes. Although more than 25 percent of malignant tumors in children are found in the head and neck region, less than 2 percent of suspicious head and neck masses are malignant. Lymphadenopathy from viral or bacterial throat infection is the most common cause of neck masses in the children [1].

Since there are so many potential causes of neck masses; it is important to proceed in logical and cost-effective manner for the proper diagnosis of neck masses. Sonography is commonly the first imaging modality after clinical examination. It is easily tolerated by patients without radiation and is inexpensive. It shows the origin of the lesion and differentiates whether it is cystic or solid. On the basis of sonographic finding selection of additional imaging modalities including CT and MRI can be done more judiciously [14].

Fine needle aspiration cytology (FNAC) is a simple, quick and cost effective method to sample superficial masses found in the neck. Masses located within the region of head and neck including salivary glands and thyroid masses can be readily diagnosed using this technique [15]. In the head and neck region, FNAC is of great value because of the multiplicity of accessible organs and

heterogeneous pathologies encountered. An early differentiation of benign from malignant pathology greatly influences the planned treatment [16].

Fine needle aspiration cytology can be performed under local anesthesia and is particularly useful if a neck lump is thought to be malignant. There is no evidence that the tumor spreads through the skin track created by the fine hypodermic needle used in this technique [17]. FNAC can be both diagnostic and therapeutic in cystic swellings [18]. Fine needle aspiration cytology is helpful for the diagnosis of salivary gland tumor where it can differentiate between a benign and malignant tumor with 90% accuracy [19]. FNAC is particularly helpful in the workup of cervical masses and nodules because biopsy of cervical adenopathies should be avoided until all diagnostic modalities have failed to establish diagnosis [20].

FNAC can be performed under palpation guidance with a high degree of accuracy (up to 85%). Ultrasound-guided FNAC has been reported to have higher accuracy than conventional FNAC [21]. Ultrasound guided FNAC is useful for patients in whom conventional FNAC was not successful; for patients with suspicious, non-palpable nodules; and for patients with a worrisome clinical history, such as significant neck irradiation. Approximately 60% of the non-diagnostic, palpation-guided nodule biopsies are reported to be diagnostic when repeated using ultrasound guidance [22].

In the present study, an attempt had been made to evaluate the efficacy of Ultrasonography in the process of arriving at the diagnosis of swelling in the head and neck region. Ultrasound diagnosis was compared with the pathological examination (considered gold standard in this study). Pathological examination was mostly based on FNAC. FNAC was taken under ultrasound guidance (USG-FNAC) to minimize sampling errors.

Aim and objectives

- To diagnose a neck mass as accurately as possible by high resolution sonography.
- To find the correlation of this mass with other structures.
- To do ultrasound guided FNAC for microscopic examination and final diagnosis.

Materials and methods

Selection criteria

All patients of any age group presenting with a mass in the neck or patients in whom the mass was detected incidentally on clinical examination were taken up for study. The study comprised of 50 patients referred from various departments, O.P.D's/ wards, of Tata Main Hospital.

Exclusion criteria

- Patients lost to follow up.
- Ultrasound guided FNAC was not done in patients with deranged coagulation profile.
- Known cases of thyroid disorders on treatment.

Machine specification

Ultrasound machines:

- LOGIQ PRO 5 (GE) with 10-12 MHz probe.
- SSD DYNAVIEW-II (Aloka, Tokyo) with 7.5 MHz probe

X-Ray machine for radiography: 1000 mA X-ray machine (Model-SIEMENS AXIOM ICONOS R 200).

Method

Sonographic examination: ultrasonographic examination of neck was performed using a linear/ sector/ convex probe with patient in supine position and a support given under shoulder to extend the neck slightly, longitudinal and transverse scans were performed. Special scans by changing the position of the patient were obtained whenever necessary. In case of thyroid gland: with the patient in a supine position the neck, was hyperextended. With

suprasternal notch as a baseline, serial transverse tomogram was made at 1 or 0.5 cm interval beginning at notch and passing cranially until the entire gland was studied.

Doppler examination: Following sonography, color flow imaging and spectral waveform analysis were performed. The color and pulsed Doppler parameters including wall filter, gate width, gain and velocity scale were optimized for detection of flow and calculation of impedance indices. Each tumor was imaged in multiple planes and evaluated with respect to the number and origin of vessels supplying the tumor, and the pattern of vascular branching within the tumor, the presence and degree of intratumoral blood flow. Intratumoral vascularity was graded on a four point scale:

Grade 0 = no intratumoral flow is detectable or vascular rim identified.

Grade 1 = occasional pixels of color was transiently present within the tumor parenchyma.

Grade 2 = vascular rim or a large feeder vessels in the periphery of the mass only; little or no blood flow is detectable in the central portions of the tumor.

Grade 3 = well-defined vascular rim surrounds the tumor; large feeder vessels are visible; flow is easily detectable throughout the tumor parenchyma.

Pattern of vascular branching within the tumor as seen on color Doppler imaging were characterized as either peripheral (basket-like) or central (branching) or mixed.

Angle-corrected frequency spectra were obtained from intratumoral vessels and evaluated for the presence of disturbed or turbulent blood flow. Peak systolic and end-diastolic velocities were measured the intratumoral vessels and the vascular impedance was estimated by calculating a resistive index (RI) and pulsatility index (PI).

Ultrasonographic and Doppler findings were correlated with clinical findings,

cytohistopathology and surgical findings or follow up as in TB patients.

FNAC (USG FNAC): With the free-hand method, the needle is inserted parallel to, or at an angle to the ultrasound beam and at a distance from the transducer, aiming at the lesion/nodule. Oblique to a perpendicular approach is simple and lacks complications. The needle shaft is not imaged with this technique but its tip is seen as a very bright spot when it crosses the plane of the scan. The tip of the needle must be within the lesion during aspiration. Employing Doppler technique to identify and avoid puncturing blood vessels in the region of a nodule provides a distinct advantage to reduce the amount of blood in the aspirate and facilitates interpretation of the cytology.

In few instances diagnosis was confirmed by clinical follow up like in cases of tuberculosis or other infective pathologies which were not operated or aspirated.

After complete collection of cases and analysis of results, data were further analyzed statistically and obtaining sensitivity, specificity, positive predictive and negative predictive values and accuracy for comparison.

Results

A total of fifty patients referred from various Departments particularly departments of general surgery, pediatric surgery; general medicine and pediatrics with clinically palpable or suspected neck mass were included in the study.

Clinical symptoms and signs in 50 patients with neck mass

Swelling in the neck was the most common presenting symptom (100% cases) followed by fever (40%), pain (30%) and associated Loss of appetite and weight was seen in 24% and 14% of patients respectively. 14% of patients presented with dysphagia difficulty and 10% with difficulty in breathing.

A palpable mass in the neck was present in all cases as it was the basic selection criteria. Tenderness was elicited in 18% of the cases. Movement on deglutition was observed in 22 cases (44%), which included 20 cases of thyroid swelling and 2 cases of thyroglossal cyst. Pressure effect due to the enlarged thyroid gland was elicited in 6% cases and compressibility of the swelling was elicited in 14% of cases.

Laboratory Parameters

Anemia was observed in 17 (34%) of cases, while 7 (14%) of patients had leukocytosis. Thyroid functions were normal in all 21 cases related to thyroid gland swelling. Mantoux test was positive in all patients of tuberculous cervical lymphadenitis out of which 2 patients revealed presence of acid fast bacilli on sputum microscopy.

Ancillary Radiological Investigations

The ancillary radiological investigations were carried out according to the individual case. X-ray soft tissue neck AP and lateral views were carried out in most of the patients except those who were very sick and neonates. Soft tissue swelling was seen in 8 cases (7 cases of multinodular goiter and in 1 case of anaplastic carcinoma thyroid). 3 cases of multinodular goiter and one case of anaplastic carcinoma with soft tissue swelling showed displacement of trachea and 3 cases showed calcification. Chest X-ray PA view was obtained in 40 patients which revealed evidence of pulmonary tuberculosis in 4 cases of cervical lymphadenitis and showed evidence of opacities with pleural effusion in 2 cases of metastasis to lymph node. Mediastinal widening was seen in 2 cases with cervical lymph node enlargement. Radionuclide study was done in one case of heterogenous thyroid enlargement with history of fall where MRI DL spine was suggestive of spinal metastasis scintigraphy was in favor of benign nature of thyroid enlargement as was ultrasound and proved by FNAC.

Thyroid gland was the most common site of involvement, accounting for 42% of the cases

followed by lymph node involvement in 32% of cases. Developmental anomalies and salivary gland diseases were seen in 10% of cases each (**Table – 1**).

Table – 1: Distribution of cases as per site of origin.

Site of origin	No. of cases	%
Thyroid	21	42%
Lymph node	16	32%
Salivary gland	5	10%
Developmental anomalies	5	10%
Mesenchymal	2	4%
Others	1	2%

Table – 2: Distribution of benign and malignant lesions.

Site of origin	Benign	Malignant
Thyroid	19	2
Lymph node	10	6
Salivary gland	5	0
Developmental anomalies	5	0
Mesenchymal	2	0
Others	1	0
Total	42	8
Percentage	84%	16%

Out of 42 benign lesions thyroid gland accounted for 19 (45%) cases followed by lymph node accounting for 10 (24%) cases and developmental anomalies accounted for 5 (12%). Malignant lesions of the lymph node were found to be dominant, accounting for 6 cases followed by thyroid gland which accounted for 2 cases (**Table – 2**).

Thyroid disorders were more in females in age group 21-40 years (15 cases) accounting for 30% of all neck masses and 71% of thyroid masses. Lymph nodes disease was more in young males, 21-30 years of age (7=5 TB & 2 lymphoma) and comprised 43% of all lymph node masses. Metastatic lymphadenopathy was more in elderly >45 years of age. Developmental disorders

presented in first decade mostly with an M/F ratio of 3:2 (Table – 3). (88%). Doppler study showed the vascularity and pattern of vascularity and was help full to reach diagnosis especially in thyroid masses and to know the nature of lymphadenopathy (Table – 4).

The ultrasonographic diagnosis was in agreement with the final diagnosis in 44 out of 50 cases

Table – 3: Age and sex distribution of cases-final diagnosis.

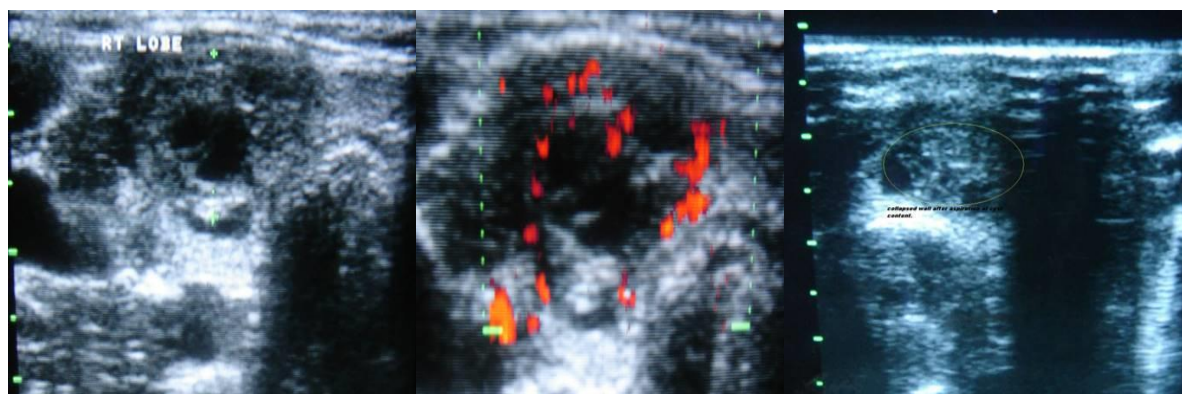
	0-10	11-20	21-30	31-40	41-50	51-60	>60	Total	M:F
Thyroid									
colloid goiter		1	3	6	2	2		14	5:9
Diffuse enlargement			1	2				3	0:3
Follicular lesion				2				2	0:2
Thyroid malignancy			1				1	2	0:2
Lymph node									
Tuberculosis	1	2	5	1				9	5:4
Reactive	1							1	1:0
Malignant		1	2		2		1	6	4:2
Salivary gland									
Abscess			1	2				3	3:0
Pleomorphic adenoma				1	1			2	2:0
Developmental									
Thyroglossal cyst	2							2	1:1
Branchial cyst		1						1	1:0
Cystic hygroma	1							1	1:0
Epidemoid		1						1	0:1
Mesenchymal									
Lipoma					1	1		2	2:0
others									
abscess floor of mouth					1			1	1:0
Total no.	5	6	13	14	7	3	2	50	26:24

Table – 4: Final diagnosis vs. HRUSG.

USG diagnosis	No. of cases(US)	Same on FNAC	Different	Final diag.
Thyroid				21
Colloid goiter	13	12	1 (Papillary ca.)	14
Diffuse enlargement	3	3		3
Follicular lesion	4	2	2(colloid goiter)	2
Thyroid malignancy	1	1		2
Lymph node				16
Tuberculous	10	9	1 (Hodgkin)	9
Reactive	2	1	1(NHL)	1
Malignant	4	4		6
Salivary gland				5
Abscess	3	3		3
Pleomorphic adenoma	1	1		2
Adenocarcinoma	1		1 (Adenoma)	0

Developmental				5
Thyroglossal cyst	2	2		2
Branchial cyst	1	1		1
Cystic hygroma	1	1		1
Epidermoid	1	1		1
USG diagnosis	No. of cases(US)	Same on FNAC	Different	Final diag.
Mesenchymal				2
Lipoma	2	2		2
Others				1
Floor of mouth abscess	1	1		1
Total no.	50	44	6	50

Figure - 2.1: (a) Solitary colloid nodule in right lobe of thyroid gland with incomplete peripheral hypo echoic halo and central degeneration with intra cystic septations. b) Doppler USG showing peripheral vascularity. c) Post FNA picture demonstrating collapsed nodule after aspirating the colloid material.



Thyroid gland lesions

Colloid Goiter: 14 Cases

A total of 21 thyroid cases (5 males and 16 females) were included in the study, among which 14 cases had uninodular or multinodular colloid goiter (**Figure - 2.1**). This group comprised 66.6% of all thyroid masses. Age distribution of cases was as, 6 cases in the age group of 31-40 years, 3 patients in the age group of 21-30 years, 2 cases were in each age group of 41-50 and 51-60 years and 1 case was seen in the age group of 11-20 years. All patients presented with clinical symptom of swelling of neck and 1 patient complained of dysphagia and difficulty in breathing due to pressure effect of enlarged thyroid gland. None of the patients had signs or symptoms of hypo or hyperthyroidism. Laboratory investigation revealed anemia in 7 cases. Thyroid function test were normal in all the 14 patients. Soft tissue X-ray of neck, AP and

lateral views were positive in 3 cases in the form of soft tissue swelling, calcification and/or lateral displacement of trachea (**Figure - 2.2**). FNAC revealed all the cases to be colloid goiter (**Table - 5**).

Figure - 2.2: Large MNG causing difficulty in breathing.

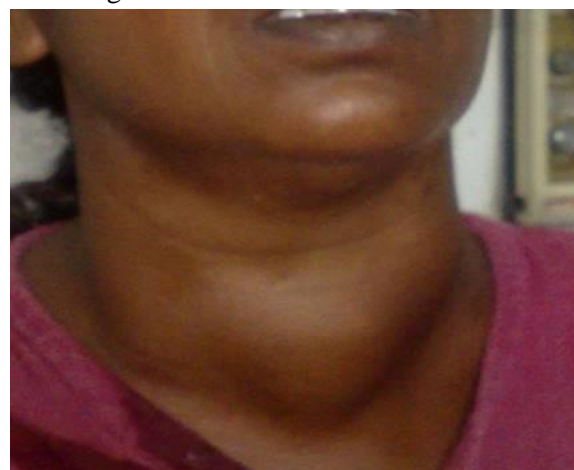


Table – 5: HRUSG Features of colloid goiter (14 cases).

USG Features	No. of cases	Percentage
Echogenicity		
Isoechoic	3	21%
Hypoechoic		
Hyperechoic	2	14%
Mixed	9	65%
Nodularity		
Solitary	9	64%
Multiple	5	36%
Calcification		
Coarse	5	36%
Punctate		
Halo		
Well defined complete	8	57%
Ill-defined incomplete	6	43%
Margins		
Well defined	10	71%
Ill defined	4	29%

Figure - 2.3: USG thyroid showing honey comb degeneration on thyroid nodule which is avascular, a well-defined peripheral halo can also be seen.

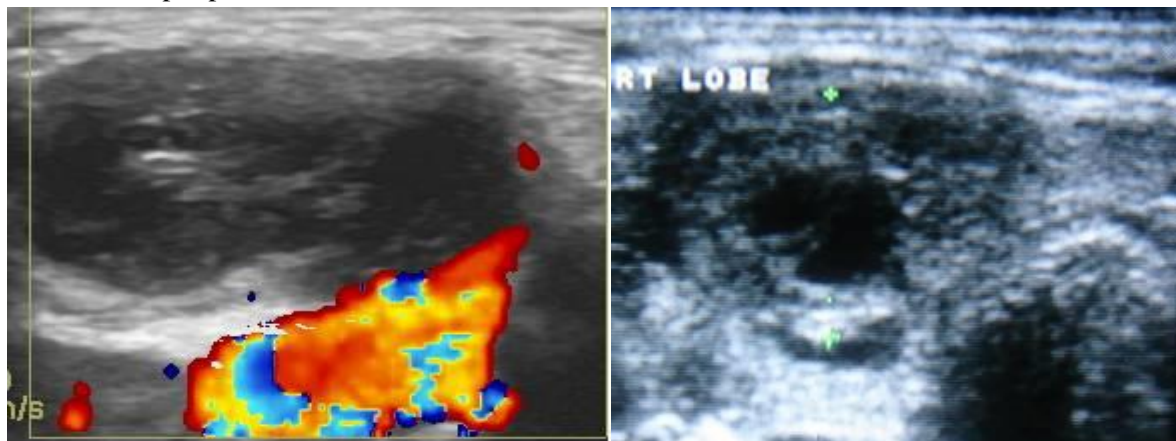


Figure - 2.4: a) Echogenic foci with comet tail artifact in colloid degeneration. B) Demonstrating avascularity of the nodule.

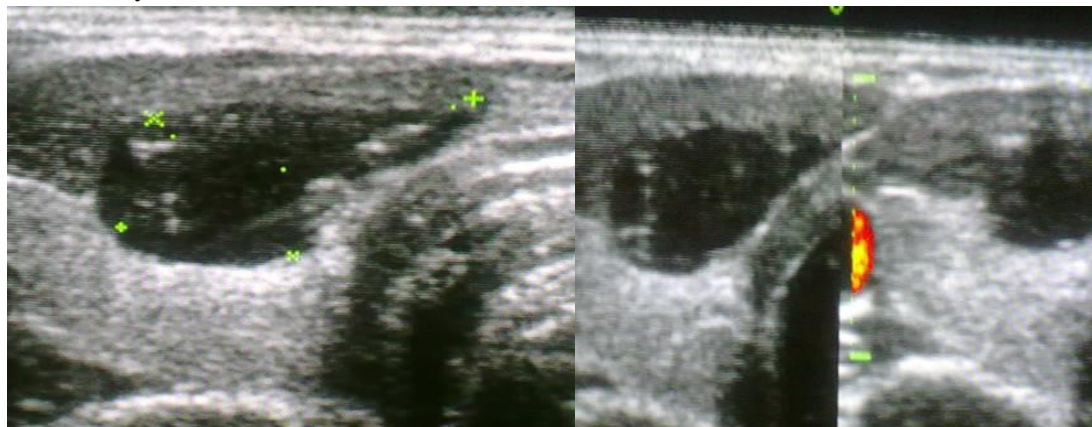


Figure - 2.5: HRUSG thyroid showing egg shell calcification of right thyroid nodule which was found to be colloid goiter on FNAC.

Figure - 2.6: showing peripheral vascularity in colloid nodule with high resistivity index of 0.87.

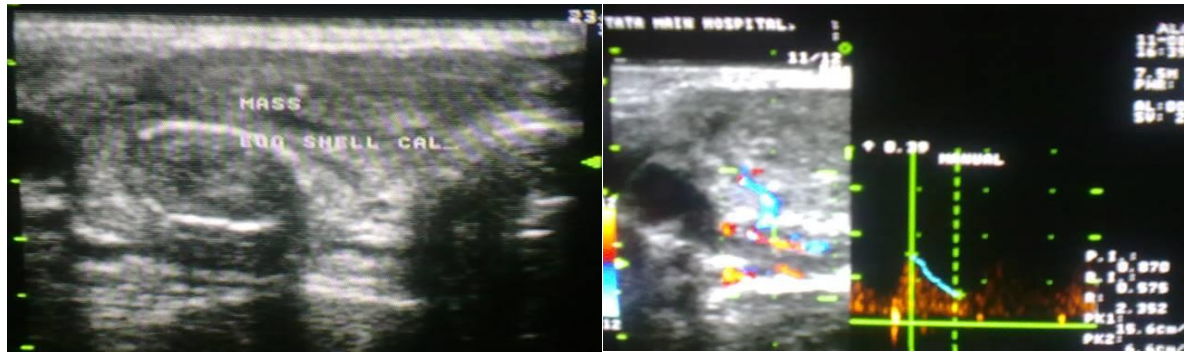


Table - 6: Doppler features of colloid goiters - 14cases.

Doppler features	No. of cases	Percentage
Grading of vascularity		
Gr 0	10	72%
Gr 1	4	28%
Gr 2		
Gr 3		
Pattern of vascularity		
Central	2	14%
Peripheral	2	14%
Mixed		

Figure - 2.7: Diffuse thyroid enlargement with few cystic and calcific foci, note increased central vascularity.

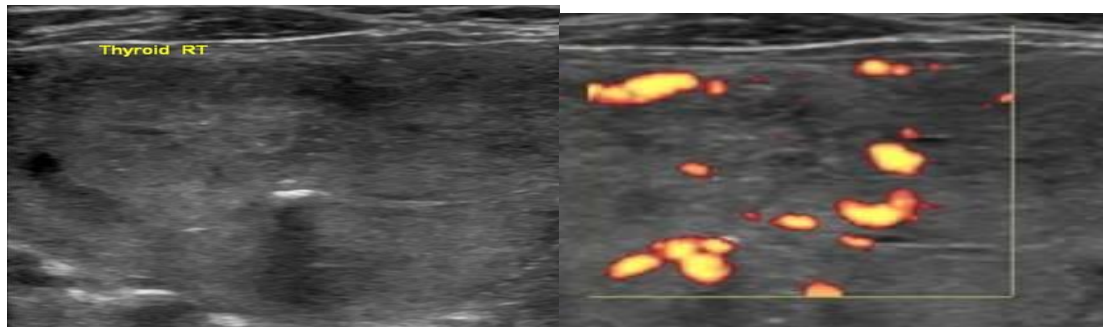


Figure - 2.8: a) & b), show hyper echoic thyroid masses with chaotic grade 2 vascularity. FNAC & post-operative biopsy confirmed follicular adenomas.

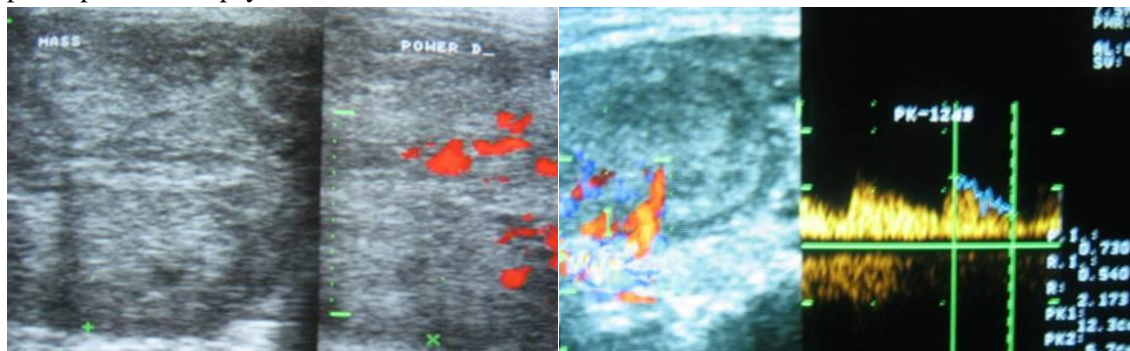


Figure - 2.9: Hypoechoic well defined nodule seen in right lobe of thyroid with few cystic areas, FNAC confirmed papillary carcinoma.



Table – 7: US feature in follicular lesions of thyroid.

F. lesion on US	US features	FNAC diag.
Case 1	Well defined, hyperechoic, halo, grade II vascularity, no cyst or calcification.	Follicular lesion
Case 2	Well defined, hyperechoic, halo, grade II vascularity, small cyst, no calcification seen.	Follicular lesion
Case 3	Well defined, hyperechoic, incomplete halo, grade II vascularity, cyst seen, calcification outside the nodule.	Colloid nodule
Case 4	Well defined, hyperechoic, halo, grade I vascularity, no cyst or calcification	Colloid nodule

The most common finding on grey scale examination was that of mixed echogenicity containing areas of degeneration and sponge like honey comb pattern (**Figure - 2.3**). Purely anechoic areas of serous or colloid degeneration were seen in 7 of 9 cases containing bright echogenic foci with comet tail artifacts (**Figure - 2.4**). Coarse calcifications were seen in 5 (36%) cases with characteristic egg shell calcifications seen in 2 cases (**Figure - 2.5**). Hypoechoic halo of 2-3mm was seen in all cases but it was well defined and complete only in 57% of cases including 3 cases with isoechoic nodules. Hypoechoic halo and well defined margins were mostly associated with nodules of size < 3cm. Multiple nodules (2 or above) were present in 5 (36 %) cases, seen in both lobes, which were not appreciated on clinical examination (**Table – 6**). Most of the nodules were avascular, 4 cases showed low vascularity mostly peripheral with $RI > 0.5$ (**Figure - 2.6**).

Diffuse Thyroid Enlargement: - 3 Cases

A 32 years old female patient presented with swelling in the neck of 3 month duration. No other symptoms were related to the swelling. Thyroid functions were found to be normal. USG revealed diffuse homogenous enlargement of both lobes of thyroid gland. The volume of right lobe thyroid was 37.5 ml and that of left lobe of thyroid was 30 ml. There was no evidence of any calcification within the gland or cervical lymphadenopathy. On Doppler evaluation the lesion was mildly vascular with grade 1 vascularity with central pattern of vascularity (**Figure - 2.7**). Two other cases also had similar features one 28 years and other 35 years old females. One of them had small areas of degeneration and calcification. The cut off limit for normal thyroid size and volume was taken as 25 ml in males and 20 ml in females. Goitrous enlargement (diffuse and nodular) of thyroid gland formed about 81% (17/21) of thyroid masses.

Follicular Adenoma: - 2 Cases

Follicular adenoma comprised 9.5% of thyroid masses in my study. Two cases were seen both females 33 and 36 years old. Both had a long standing history of mild asymmetrical thyroid enlargement (7years and 1 year). Nodules were palpable moving with deglutition, firm but not tender on palpation. Grey scale US showed enlarged thyroid lobes containing well margined haloed hyper echoic nodules of sizes 4x2 cm and 3.5x3 cm (**Figure - 2.8**). Nodule of size 4x2 cm had a small anechoic cystic area. Both had intrasubstance chaotic vascularity (grade II) with RI of 0.5-0.6. Internal calcific

foci and cervical adenopathy was not seen. Both cases under went US guided FNA which revealed follicular adenoma which were latter operated. Biopsy specimen showed the benign nature as capsule was not infiltrated. Two other cases were also diagnosed on HRUSG as follicular adenoma which on FNAC were found to be colloid nodules. Table 6 below summarizes the US features of 4 cases diagnosed follicular lesions on US (**Table - 7**).

Early colloid changes may show increased vascularity and appear hyperechoic.

Figure - 2.10: a) showing a heterogenous thyroid mass with calcifications. b) MRI of the same patient showing a large mass arising from left lobe displacing trachea towards right side. c) Doppler study shows low resistance (RI=0.1) central flow. Anaplastic carcinoma thyroid.

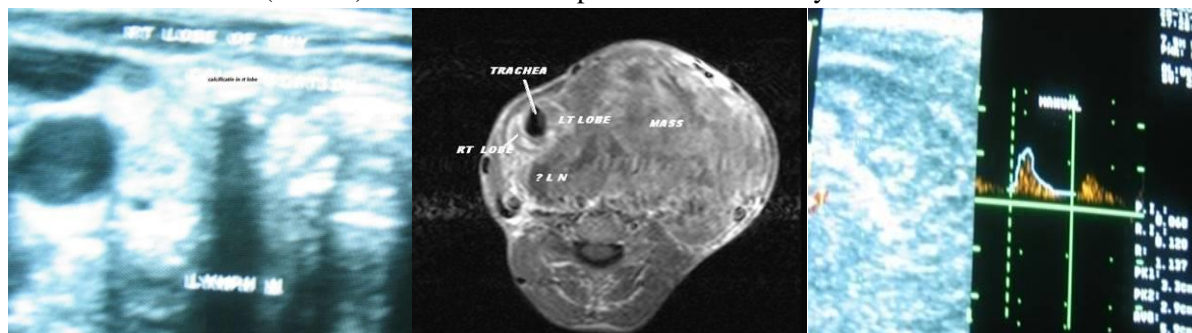


Figure - 2.11: Avascular necrotic node (upper left), x-ray chest (PA) of the same patient showing pulmonary Koch's (lower left). Right half above shows some matted nodes in different patients.

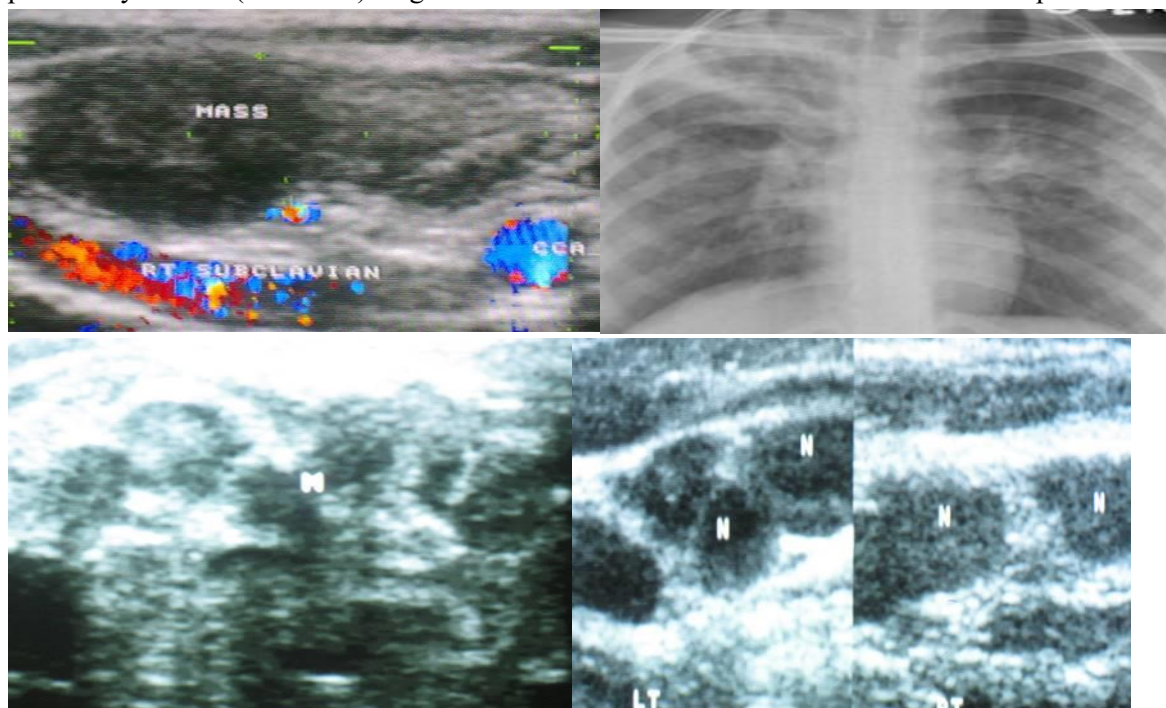


Figure - 2.12: showing multiple oval nodes with thick hilum in a child with Tonsillitis, reactionary nodes.

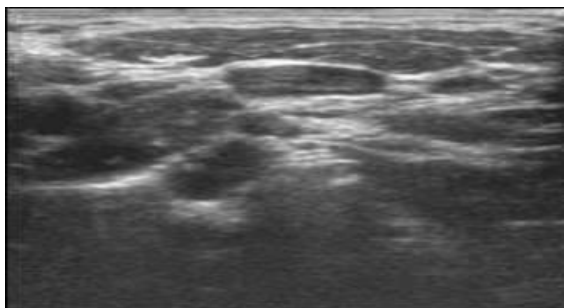


Figure - 2.13: a) Round hypoechoic node without a discernible hilum seen in a case of Hodgkin's lymphoma who was erroneously diagnosed as having granulomatous adenopathy. CDI of a node in NHL case.



Papillary Carcinoma Thyroid: - 1 Case

A 24 years old unmarried female patient studying in college presented with well-defined firm nodule in the right lobe of thyroid gland with associated loss of appetite and loss of weight for 7mth duration.

USG finding: - Well defined iso to hypoechoic nodule of size 1.5x0.8 cm in right lobe of thyroid. Nodule had a well-defined hypoechoic halo with internal cystic area. Doppler study showed grade I vascularity (**Figure - 2.9**). A diagnosis of colloid goiter was made on the basis of US features though it was considered suspicious. No enlarged lymph nodes were seen in neck. US guided FNA was done which latter revealed papillary carcinoma. So it was an atypical papillary carcinoma with no features of a typical one except for hypoechoogenicity.

Anaplastic Carcinoma: - 1 Case

A 60 yr. old female patient presented with large neck mass for over a year which had rapidly

increased in size for last 4 weeks causing dysphagia with difficult breathing and hoarse voice. Early FNAC was in favor of goitrous enlargement of thyroid.

USG:-10 cm mass on left side having heterogenous echopattern with areas of degeneration and amorphous calcifications. Doppler showed grade II vascularity with low resistance (RI 0.12), (**Figure - 2.10**)

Right lobe was normal in size and had calcific foci. A 3 cm hypoechoic lymph node was seen at level 4. There was retrosternal extension of the mass so lower limit could not be found. FNAC was repeated and MRI advised. FNAC was now suggestive of anaplastic thyroid carcinoma. MRI showed the hetregenous mass with its retrosternal extension (**Figure - 2.10**). Patient died within few days in the hospital. **Table – 8** shows US in detecting neoplastic thyroid lesions.

Table - 8: US in detecting neoplastic thyroid lesions (2 follicular, 1 papillary, 1 anaplastic) in 21 thyroid cases.

Test Result	Diseased	Non-diseased	Total
Positive	a (3)	b(2)	5
Negative	c(1)	d(15)	16
Total	4	17	21

$$\text{Sensitivity (True positive)} = \frac{a}{a+c} \times 100 = 75\%$$

$$\text{Specificity (True negative)} = \frac{d}{b+d} \times 100 = 88\%$$

$$\text{Positive Predictive Value} = \frac{a}{a+b} \times 100 = 60\%$$

$$\text{Negative Predictive Value} = \frac{d}{c+d} \times 100 = 94\%$$

$$\text{Accuracy} = \frac{a+d}{a+b+c+d} \times 100 = 86\%$$

Table - 9: Sonographic features in lymph node pathology.

S.N	Sonographic features	No. of Cases (16)			
		Reactive (1)	TB (9)	Lymphomatous (4)	Malignant (2)
1.	Level of involvement	II,III	III,IV,V	II,III,IV, V	II,III,IV,V
2.	Shape Oval Round	1	7,vary(2)	1 3	2
3.	Hilum Wide Narrow Absent	1	3 6	3 1	2
4.	Cortex Narrow Concentrically Wide Eccentrically wide	1	2 3	4	2
5.	Posterior enhancement		9	3	
6.	Echogenicity Isochoic Hypo echoic Hyper echoic Mixed	1	9	4	2
7.	Intranodal necrosis		6		
8.	Nodal borders Well defined Ill defined	1	5 4	4	2
9.	Calcification	-	-	-	-
10.	Matting	-	4	-	-

11.	Size (largest node) <1 cm 1-3 cm >3 cm	1	3 6	2 2	2
12.	Vascularity avascular Central Peripheral Mixed	1	6 3	1 3	2

Table - 10: Accuracy of HRUSG in finding malignant lymph node.

Test Result	Malignant	Non-malignant	Total
Positive	a (4)	b(0)	4
Negative	c(2)	d(10)	12
Total	6	10	16

$$\text{Sensitivity (True positive)} = \frac{a}{a+c} \times 100 = 66.6\%$$

$$\text{Specificity (True negative)} = \frac{d}{b+d} \times 100 = 100\%$$

$$\text{Positive Predictive Value} = \frac{a}{a+b} \times 100 = 100\%$$

$$\text{Negative Predictive Value} = \frac{d}{c+d} \times 100 = 83.3\%$$

$$\text{Accuracy} = \frac{a+d}{a+b+c+d} \times 100 = 87\%$$

Table – 11: HRUSG in detecting malignant lesions in salivary glands.

Test Result	True	False	Total
Positive	a (4)	b(1)	5
Negative	c (0)	d(0)	0
Total	4	1	5

$$\text{Sensitivity (True positive)} = \frac{a}{a+c} \times 100 = 100\%$$

$$\text{Positive Predictive Value} = \frac{a}{a+b} \times 100 = 80\%$$

$$\text{Accuracy} = \frac{a+d}{a+b+c+d} \times 100 = 80\%$$

Horvath E, et al. correlated Thyroid Imaging Reporting and Data System (TIRADS) with needle-biopsy results. In a sample of 1097 nodules (benign: 703; follicular lesions: 238; and

carcinoma: 156), the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were 88, 49, 49, 88, and 94%, respectively [23].

Ito Y, Amino N, et al. studied 1244 nodules identified by ultrasonography in 900 patients, stratified these nodules into classes 1 to 5. They found the positive predictive value of ultrasonographic evaluation of malignancy was 97.2% [24].

Lymph node Pathology (16 cases)

In 16 cases of cervical lymphadenopathy 9 (56%) had tuberculosis, 6 (37%) had malignant involvement of nodes and 1 (7%) case had reactionary lymphadenopathy.

Tuberculous Lymph nodes (Figure - 2.11) :- (9 cases)

9 Cases (5 males and 4 females) were included in the study with an age range of 5-40 years. Presenting symptoms were swellings in the neck, evening rise of temperature associated with night sweats and loss of appetite. Loss of weight was present in 3 cases. On clinical examination, soft to firm enlarged LN's were present on both sides of the neck. Evidence of matting was noted in 3 patients.

Reactive lymphadenopathy (Figure - 2.12) :- (1 case)

A 6 years male child presented with swelling in the right submandibular region associated with fever and pain on swallowing for 3 days. His laboratory parameters show leukocytosis. Patient was referred for USG with a clinical diagnosis of cervical lymphadenopathy and B/L tonsillitis.

Malignant lymphadenopathy (Figure - 2.13, 2.14) :- (6 cases)

The patients were in the age group of 12-67 years and majority was male. All patients had neck masses with history of loss of appetite and weight in 2 patients and one case had oral ulcers. This group consisted of 4 lymphomatous and 2 metastatic adenopathies. Among four lymphomas 3 were Hodgkin's lymphomas (age-12, 26 & 42 years) and 1 NHL (22 years). In two cases with metastatic cervical adenopathy one had oropharyngeal carcinoma (48 years) and other esophageal carcinoma (67 years). Sonographic

features in lymph node pathology were as per **Table – 9**.

Interpretation (common findings): -

So a reactive node was oval, isoechoic to muscles with a wide hilum showing vascularity.

Tuberculous nodes show- oval shape (7 of 9, 78%), absent hilum (67%), posterior enhancement (100%), anechoic to hypoechoic (100%), cystic necrosis (67%), 44% showed ill-defined borders and matting may be due to periadenitis and they were mostly avascular when present it was central/hilar. Distribution was in lower half of neck.

Lymphomatous nodes- all were hypoechoic and well defined. 75% were round with narrow hilum and posterior enhancement showing mixed vascularity. All had eccentrically thickened cortex. One NHL case had few oval shaped nodes showing hilum with mixed vascularity and were in the size range of 2-3 cm. patient had oral ulcers and pharyngitis so they were diagnosed as reactionary nodes which latter found to be NHL on biopsy with abdominal and mediastinal adenopathy.

Metastatic nodes- all were round, well defined, without a discernible hilum and had peripheral vascularity. All showed hypoechoic eccentrically thickened cortex. Accuracy of HRUSG in finding malignant lymph node was as per **Table – 10**.

Vassallo P, et al. found that eighty-two percent of nodes with L/S < 2, 81% with no hilus, and 70% with eccentric cortical widening were malignant, whereas 72% with L/S > or = 2, 86% with a wide hilus, and 91% with a narrow cortex were benign (sensitivity: 87%, specificity: 74%) [25].

A study has shown that an accuracy of 80% was achieved in an N0 population of patients with a known primary tumor (sensitivity 92%, specificity 63%) by using a ratio of more than 0.55 for the minimal/ maximum diameter [26].

In the only large series that has compared all the modalities- viz, ultrasound (US), US guided FNAC (USG FNAC), MRI & CT scan. US in combination with FNAC were most accurate. Accuracies of 86% (US), 100% (USG FNAC), 89% (CT) and 88% MRI were obtained [27].

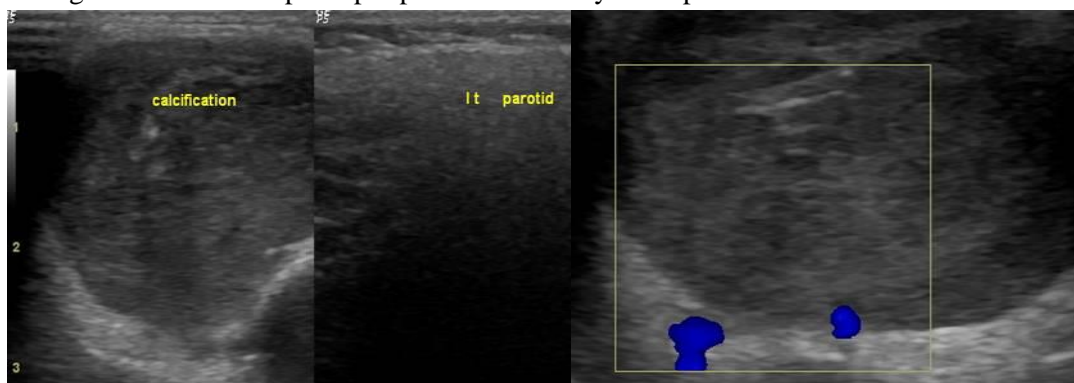
Figure - 2.14: submandibular abscess appearing hypoechoic (a) with increased vascularity in the peripheral solid part (b).



Figure - 2.15: showing sublingual gland abscess with necrosis and liquefaction (Ranula). b) shows swelling in the base of tongue (arrow) which protrudes in the neck (c).



Figure - 2.16: Well-defined hypoechoic mass with calcific foci. Posterior enhancement suggests through transmission. Sparse peripheral vascularity seen. parotid adenoma.



Salivary gland lesions (5 cases)

We studied 5 cases of salivary gland lesions 2 of submandibular gland abscess, 1 ranula and 2 cases of pleomorphic adenoma of parotids.

Salivary gland abscess (3 cases)

Submandibular abscess (2 cases) - A 33 year old male patient presented with pain and swelling in the region of the right submandibular gland along with fever for 10 days. On clinical examination right gland was enlarged. Tenderness was present. Skin over the swelling was normal with no local rise of temperature.

USG showed diffuse enlargement of right submandibular gland with mixed echogenicity, areas of necrosis with hyper echoic contents and fluid levels were noted (**Figure - 2.14**). Few small reactionary nodes were noted on the same side at the levels I, II and III. On Doppler the swelling was avascular at necrotic areas with

raised vascularity over peripheral solid portions and a diagnosis of abscess with hemorrhage was given which was matching with FNAC and operative diagnosis. Another similar lesion with more necrosis was seen in a 38 year old man again involving the right submandibular gland.

Figure - 2.17: shows a large ill-defined heterogeneous mass in deep lobe of left parotid gland, superficial lobe is normal. Arrow in left lower picture points to the neck mass. Looks like an adenoid carcinoma. FNAC & post op. biopsy confirmed it to be an adenoma.

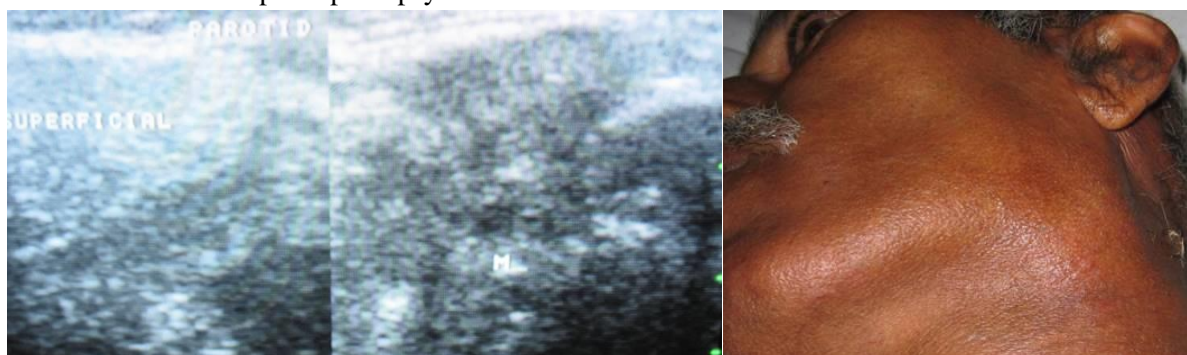
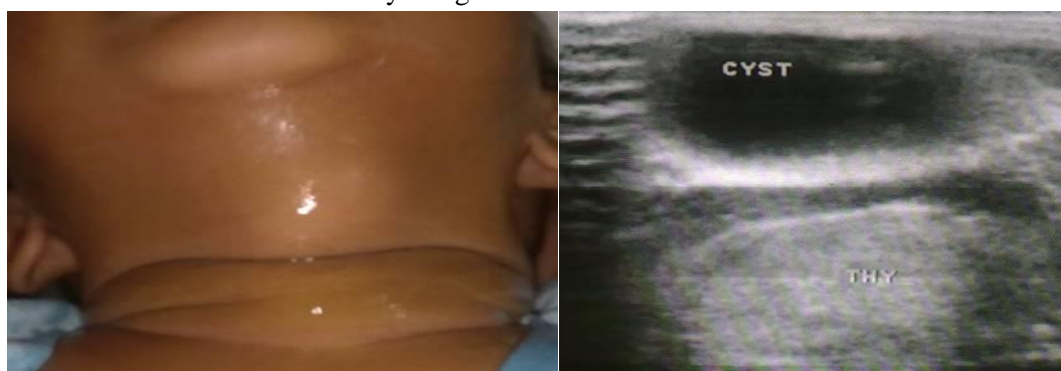


Figure - 2.18: (a) shows a small midline swelling; USG picture (b) shows a cystic mass with thin internal echoes anterior to the thyroid gland.



Sublingual gland abscess or infected ranula (1 case):- A 28 year old man presented with submental swelling more towards left side with associated fever. USG showed a hypoechoic lesion in submental region with anechoic rim of fluid (**Figure - 2.15**). Doppler study did not show any vascularity. It was diagnosed as infected sublingual gland abscess (ranula) which was confirmed when operated.

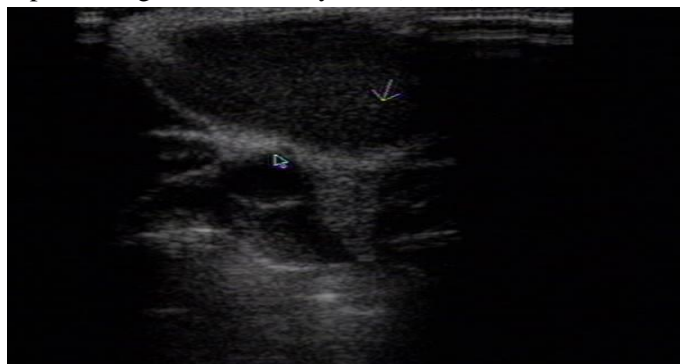
Pleomorphic adenoma (2 cases):-

A 40 years old patient presented with a painless swelling over the angle of left mandible region of

8 months duration which was insidious in onset and gradually progressive. On clinical examination a firm swelling over the angle of left mandible extending to preauricular area.

USG revealed a well demarcated ovoid hypoechoic lesion in left parotid. No evidence of any areas of cystic change, necrosis or calcification was noted (**Figure - 2.16**). No evidence of any significant cervical lymphadenopathy was seen. On CDI sparse peripheral vascularity was seen. FNAC revealed pleomorphic adenoma which was confirmed on histopathology.

Figure - 2.19: Branchial cyst, a well-defined cystic lesion (arrow head) with fine internal echoes representing cholesterol crystals (arrow).



Another male patient (44 years) had a painless slow growing swelling over a year located on the angle of left mandible extending 2 cm below the angle of mandible. On USG it was ill defined & heteroechoic with few areas of necrosis (**Figure - 2.17**), no vascularity was detected on Doppler scan. Multiple small oval nodes were seen on the same side of neck at the levels I & II. Malignant transformation of adenoma was suspected. FNAC showed it to be a pleomorphic adenoma.

One study in 39 patients with parotid or submaxillary tumors indicated that only 53.86% of the physical examinations were correct in their diagnosis compared to 87.18% of those done by ultrasound. Specificity and sensibility for malignancy was 96.43% and 81.81% respectively. These results were similar to those reported by other authors. HRUSG in detecting malignant lesions in salivary glands was as per **Table – 11**.

Zhang L, Zhang ZY stated that the differences between benign and malignant tumors were statistically significant in the shape of the tumor, the boundary echo and the posterior echo. The diagnostic accuracy, sensitivity and specificity were 82.1%, 63.2% and 87.7%, respectively, while the predicting diagnostic accuracy was 85.7% [28].

Swellings of developmental origin (5 cases)

Thyroglossal cyst: (2 cases)

The diagnosis of thyroglossal cyst was suggested in two cases on USG, a 2 year female child & a 9

year old male, who presented with a midline painless neck swelling (**Figure - 2.18**). This swelling was infrahyoid in location and showed movement on protrusion of tongue. There were no other clinical findings. The X-ray soft tissue neck AP and lateral view were normal.

On USG the 3X2X2 cm swelling was well defined thin walled, cystic in nature with few hypo echoic contents with well-defined posterior acoustic enhancement. No tract could be visualized in the neck leading to foramen cecum. On Doppler evaluation the swelling was avascular on both color and power Doppler evaluation.

On surgery a midline cyst with gelatinous contents with a tract leading to the base of tongue was seen proving the diagnosis to be thyroglossal cyst.

Branchial cyst: (1 case)

A 12 years old male patient presented with painless swelling in the left side of the neck for last 3 years. The swelling was increasing gradually in size. There were no features suggestive of any pressure effects. On examination the mass present in the left side of the neck at the junction of the upper third with lower two-third of the neck just at the anterior border of the sternocleidomastoid muscle anterior to the major vessels of the neck. The mass was firm in consistency and was free of the underlying structures. The overlying skin was normal.

Figure - 2.20: Cystic hygroma, a large multilocular cystic mass with low level echoes on ultrasound examination (left side). CECT neck in the same child shows the enhancing septae in the cystic mass.

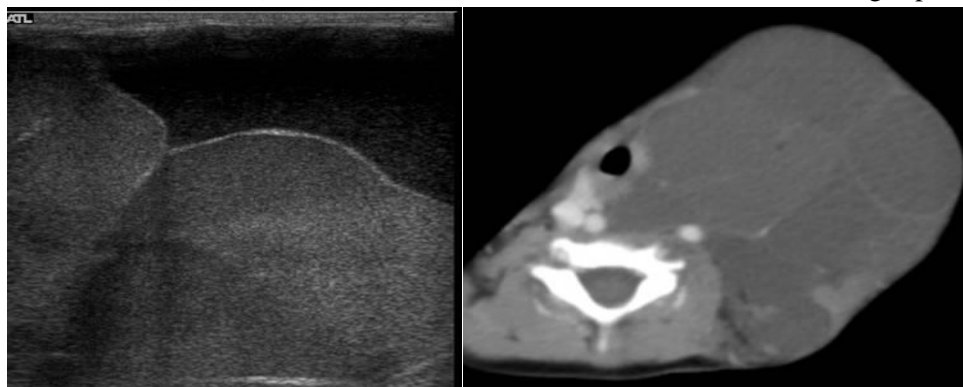


Figure - 2.21: a) shows a midline mass in suprasternal area. b) USG showing well defined echogenic mass below the thyroid showing no vascularity on Doppler (c). Epidermoid on FNAC & surgery.

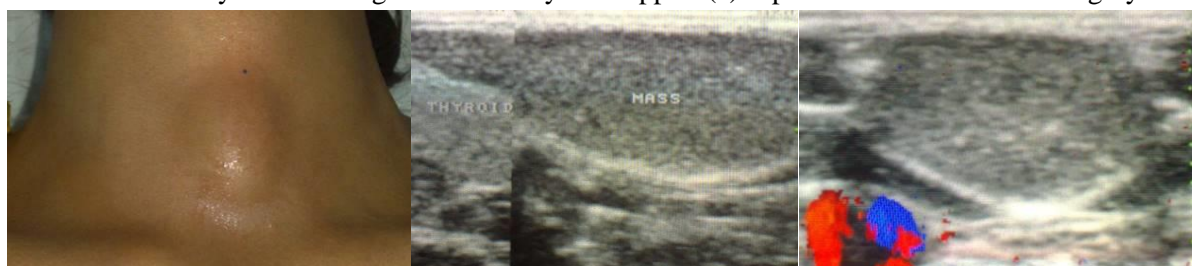


Figure - 2.23: Round swelling at the base of neck (left fig.), USG showing a mass relatively hyperechoic with linear echogenic lines at right angles to the USG beam. Lipoma on FNAC.



On USG examination the mass was thin walled cystic unilocular and homogeneously hypoechoic, showing few cholesterol crystals with comet tail artifacts (**Figure - 2.19**). On Doppler examination the mass was avascular. The diagnosis was confirmed on surgery.

Cystic hygroma (1 case):

A 4 year old male child presented with swelling in the right neck which was gradually increasing in size. There was no history of breathing difficulty or dysphagia. On clinical examination a soft smooth swelling was seen. Transillumination test was positive.

Examination of oral cavity was normal. Laboratory investigations revealed no significant abnormality.

Sonography revealed large multilocular cystic masses (**Figure - 2.20**) with septae and low level internal echoes. On Doppler no flow was seen in the cystic portion of the mass. Possibility of a cystic hygroma was suggested on USG and Doppler. FNAC and surgery done confirmed the USG/Doppler findings.

Epidermoid (1 case):-

A 17 year old girl presented with a small midline oval swelling in the suprasternal area of neck. No signs of inflammation or sepsis were noted clinically. Swelling was mobile in all directions but does not move with the deglutition or protrusion of tongue. No clinical or lab abnormalities were found. Patient came with clinical diagnosis of epidermoid cyst. USG neck showed a well-defined echogenic mass, echogenicity was thought to be because of sebaceous content, no flow on Doppler detected (**Figure - 2.21**). No associated adenopathy was seen and a diagnosis of epidermoid was given which was confirmed on FNAC and later on surgery.

D. Gianfelice, et al. studied 111 patients aged two days to 20 years with neck masses by ultrasound. Results were compared to subsequent histo-pathological or clinical diagnosis. They divided neck masses into two groups, a sonospecific group in which an accurate presurgical diagnosis was made in 92%, and a non-sonospecific group. The sonospecific group contained 48 patients and included thyroid masses, cystic hygromas, certain cases of adenopathy and a cervical myelomeningocele. The non-sonospecific group contained 63 patients and included a variety of neck masses such as dermoid cysts, branchial cleft cysts, and the majority of cases of adenopathy, hemangiomas, lymphangiomas and various other neoplastic masses. Sonography serves to delineate the extent of neck masses, define the relationship of the mass to the thyroid and major neck vessels and guide fine needle aspiration biopsy [29].

Mesenchymal

Lipoma: Two cases were studied both presented with a painless swelling in the neck one anterolaterally & other posteriorly at the base on neck for over years. The swellings were insidious in onset and gradually progressive. No other symptoms were related to the swelling. On clinical examination, a mobile compressible lump was seen posteriorly in the midline. Slip sign was positive. Laboratory investigations

were normal. Patients were referred for USG with a clinical diagnosis of lipoma.

In one case USG showed an oval well defined mass measuring 2 to 3 cm anteriorly on left side at the base of neck. The mass was seen to be relatively hyper echoic in with respect to sternocleidomastoid muscle with linear echogenic lines at right angles to the USG beam. There was no evidence of distal acoustic enhancement (**Figure - 2.22**). On Doppler there was no demonstrable vascularity. No evidence of any significant cervical lymphadenopathy was seen. A diagnosis of lipoma was made which was confirmed histopathologically.

In one study, 39 patients underwent sonographic evaluation of a soft-tissue mass followed by biopsy or resection was retrospectively evaluated. Two musculoskeletal radiologists (readers 1 and 2) reviewed the sonographic images, characterized the masses, and rated the level of confidence in the diagnosis of lipoma by using a five-point scale. A level of confidence was also rated for the prospective sonographic report, which was reviewed and designated as reader 3. Sensitivities were 52%, 40%, and 52%, and accuracies were 64%, 49%, and 64% for readers 1, 2, and 3, respectively [30].

Floor of mouth abscess: - (1 case)

A 46 year old man presented with submental swelling with fever, pain and dysphagia. Ultrasound showed a heterogenous ill-defined avascular mass mostly necrotic extending into the floor of mouth. There were associated reactive cervical (level I, II and III) nodes on both sides. A diagnosis of floor of mouth abscess (Ludwig's angina) was given. The pus was drained urgently in dental OT.

Roughly on average ultrasound is 92% accurate in diagnosing neck masses correctly. Ultrasound is almost 100% accurate in finding the origin of a neck mass and in localizing it with respect to other structures. Accuracy of USG and Doppler in predicting the nature of the mass in neck was as per **Table - 12**.

Table - 12: Accuracy of USG and Doppler in predicting the nature of the mass in neck.

	No. of cases	Final diagnosis		Correct on USG		Total correct	Accuracy %
		Benign	malignant	benign	malignant		
Thyroid gland	21	19	2	17	1	18	86
Lymph node	16	10	6	10	4	14	87
Salivary gland	5	5	-	4	-	4	80
Developmental	5	5	-	5	-	5	100
Mesenchymal	2	2	-	2	-	2	100
Others	1	1		1		1	100

Discussion

The present study was undertaken to find the efficacy of HRUSG in diagnosing neck masses, evaluate the sonographic features of neck masses and to correlate this diagnosis with histopathological diagnosis or post-operative findings/diagnosis.

A total of 50 patients referred from various departments of Tata Main Hospital constituted the study. The study group comprised of 26 male and 24 female patients with age ranging from 2 to 67 years of age. The maximum number of patients was between 21-40 years of age accounting for 54% of cases.

Of these 50 patients, 42 (84%) had benign lesions which includes inflammatory, degenerative, non-malignant and developmental conditions, the remaining 8 (16%) cases had malignant lesions which mostly include nodal diseases. 23(46% of all neck masses) patients had thyroid related diseases of which 14 patients (28%) had colloid goiter, 3 cases (6%) had diffuse thyroid enlargement, 2(4%) had follicular adenomas and, 2 cases had malignant thyroid neoplasm (1 papillary carcinoma and 1 anaplastic carcinoma) and 2 had thyroglossal cysts. 5 patients (10%) had salivary gland swellings presenting with neck mass which included 2 cases (4% of salivary gland masses) of pleomorphic adenoma of parotid gland, 2 cases of submandibular gland abscess and 1 case of sublingual gland abscess. 16 cases (32%) presented with cervical lymphadenopathy which comprised of 9 (18%) tuberculous cervical

lymphadenitis, 1(2%) reactive lymph node and 6 (12%) malignant lymph node. 5(10%) masses had Mesenchymal origin (2 lipoma, 1 cystic hygroma, 1 branchial cyst and 1 epidermoid) and 1 case (2%) had abscess in the floor of mouth.

Based on the clinical profile, an accurate diagnosis was possible in about 35 out of 50 cases (70%) included in this study. Triplex ultrasound was accurate in 44 cases (88%). The role of sonography and Doppler in detection, delineation and diagnosis of the different lesions is as follows.

Thyroid diseases:-

There was a high female preponderance in lesions of thyroid gland (76%). Adenomatous or colloid MNG is the most common cause of asymptomatic thyroid enlargement with an incidence of about 3% to 5% of the general population in developed countries (there is a higher incidence in endemic goiter regions in the world) [31]. It is universally acknowledged that nodular goiter of thyroid has a striking female preponderance with a ratio of 8:1 (Anderson's - 10th). Malignant lesions of thyroid also tend to occur more commonly in females [32]. The most common symptoms observed in this study were swelling in the neck (100%), pain (14%). fever (4%), loss of appetite and loss of weight. The most common clinical signs were palpable mass (100%) which was causing difficulty in swallowing in up to 20% of cases.

Laboratory investigations revealed presence of anemia in 20%. Thyroid function tests were found to be normal in all cases. It has been

reported that most patients with benign and malignant tumors of thyroid are euthyroid; a goiter may be euthyroid, hypothyroid, or hyperthyroid [33].

Colloid goiter

Present study included 14 (36%) patients of colloid goiter, 9 females and 5 male with an age range of 18-56 years. The most common presentation was swelling in the neck with 1 case complaining of dysphagia and difficulty in breathing due to pressure effects of the enlarged thyroid gland, all had multinodular goiter. Patients of MNG usually are older women, present with pressure effects due to enlarged thyroid gland [34].

Sonography revealed all solitary nodules to be iso-hyperechoic (mostly mixed) in echo texture showing nodular cystic changes with perinodular hypoechoic halo which was found to be thin and well defined. Halo was complete in 8 cases.

In view of the sonographic findings a diagnosis of colloid goiter was suggested in 10 cases with solitary thyroid nodule. Nine cases were same on FNAC but 1 case was shown to be papillary carcinoma which was relatively hypoechoic on sonography. So this also proves that hypoechoic nodules should not be left alone.

Iso to hyperechoic echo-texture, intranodular cystic changes with perinodular hypoechoic halo have been described as features of benign nodules [35]. This corresponded with the findings in my study. A hypoechoic rim is thought mainly to represent the nodular capsule and is a feature of benign nature [36].

In one study, the highest incidence of calcification was found in thyroid cancer (54%), followed by multinodular goiter (40%), solitary nodular goiter (14%), and follicular adenomas (12%). The authors reported that calcifications in a "solitary" nodule in a person younger than 40 years person should raise a strong suspicion of malignancy because of a relative cancer risk of

3.8 versus 2.5 in patients older than 40 years with calcified nodules [37].

In a study conducted by Solbiati, et al. [38] perinodular halo was far more frequent in benign than in malignant lesions (86% vs. 14%). They noticed a significant difference between incomplete and complete halo, the latter being more frequently although not exclusively, encountered in benign lesions. This was also seen in the present study. They concluded that sonographic diagnosis of solitary thyroid nodules should be mostly based upon the echo pattern compared with normal parenchyma. Hyperechoic and especially liquid nodules can be safely regarded as benign and therefore further diagnostic procedures and surgery is spared.

On Doppler a total of 4 cases were vascular out of the 14 cases and the entire vascular colloid goiters showed grade 1 vascularity except for 2 cases which showed slightly raised vascularity and were erroneously diagnosed as follicular lesions. The peripheral halo showed vascular signals in all cases. All the cases of colloid goiter showed a high resistance flow ($RI > 0.5$).

Recently various flow related parameters using color Doppler have suggested a possible role for these techniques. But overlap between values in benign and malignant nodules is extensive and further studies are needed [39].

Diffuse thyroid enlargement

Three cases of diffuse thyroid enlargement evaluated by sonography revealed the volume of individual thyroid gland lobes to be 25 ml to 34 ml in both lobes; the thyroid gland showed diffuse homogenous enlargement one showing few calcific foci. All cases were females in the age group of 21- 40 years. In view of the normal thyroid function tests and USG findings a diagnosis of diffuse thyroid enlargement (Diffuse goiter) were made.

Solbiati et al have shown that the volume of thyroid lobes up to 25 ml in men and 18 ml in women is considered as normal [40]. Diffuse

enlargement of the thyroid gland is secondary to goiter in 80% to 85% of cases with a female to male ratio of 3:1. Sonographically, a diffuse goiter is more echogenic than the normal gland, displaying intrinsic coarse structures with rounded poles.

As published in journal of ultrasound in medicine, 2004, Palpation revealed poor discrimination of smaller thyroid sizes as determined by ultrasonography. Stepwise linear regression (backward selection) revealed that of the 3 thyroid dimensions, only the latero-medial dimension of the thyroid lobe had a significant correlation to lobe volume, accounting for 82.5% of the variability in lobe volume. The lobe volume (in milliliters) is given by the lobe latero-medial dimension (in centimeters) multiplied by 13 minus a constant of 15 [41].

Follicular lesions of thyroid: Follicular adenoma comprised 9.5% of thyroid masses in my study. Two cases were seen both females 33 and 36 years old. Both had a long standing history of mild asymmetrical thyroid enlargement (7 years and 1 year). Grey scale US showed enlarged thyroid lobes containing well margined haloed hyper echogenic nodules. Both had intrasubstance chaotic vascularity (grade II) with RI of 0.5-0.6. Both were found to be benign on post-operative histopathological examination of biopsy specimen. Follicular adenomas are most commonly solitary and cytological differentiation from a follicular carcinoma is not possible on aspirates obtained from FNAB. The Scandinavian cytopathologists recommended that all thyroid aspirates containing abundant follicular cells be grouped into one category called "follicular neoplasms," indicating that the cytological differentiation between benign and malignant follicular neoplasms is not possible [42].

On Doppler imaging, the majority (80-90%) of benign follicular lesions show perinodular blood flow signals (type II vascularity) whereas 90% of malignant follicular lesions have a type III

vascularity in over 90% of cases, as was also seen in our cases.

Two other cases were also diagnosed on HRUSG as follicular adenoma which on FNAC were found to be goiter nodules. Both of them were hyperechoic with increased vascularity but had incomplete halos.

Thyroid Carcinoma:

Two cases were detected both were females one young lady who had papillary carcinoma and other elderly who had anaplastic carcinoma.

Papillary carcinoma: A 24 year old female patient presented with swelling in the neck with loss of appetite and weight. Thyroid function test was normal. Soft tissue x-ray neck AP and lateral view was done and no abnormality was detected. On sonography well defined iso to hypoechoic nodule was detected. Nodule had a well-defined hypoechoic halo with few small internal cystic areas. Doppler study showed grade I peripheral vascularity. No associated adenopathy was detected in the neck. A diagnosis of colloid goiter was made on the basis of US features though it was considered suspicious. US guided FNA was done which latter revealed papillary carcinoma. So it was an atypical papillary carcinoma with only feature in favor of malignancy being reduced echo pattern.

In a study done by Solbiati, et al. [40] most malignancies were found among hypoechoic nodules (63%); moreover 95% of hypoechoic lesions were found to be adenomas or malignancies at surgery. In our case the thyroid malignancies were heterogeneous or hypoechoic.

Papillary carcinoma is the most common malignancy of thyroid, accounting for 60-70% of all thyroid malignancies [43]. The majority of patients are females, and it is the most frequent cancer in young individuals. The 20 year survival rate is reported to be as high as 90% [44].

Sonographically papillary carcinomas are hypoechoic lesions, rarely of mixed or

isoechogenic character. It has been analyzed that papillary carcinoma is more common in upper pole of the lobes whereas medullary carcinoma is situated in upper and middle part of the lobes [45]. Small punctate calcifications are considered characteristic of papillary or medullary carcinomas [46].

Anaplastic carcinoma: A 60 years old female patient with a long standing neck mass which has rapidly increased in size for last 4 weeks causing dysphagia with difficult breathing and hoarse voice. Early FNAC was in favour of goiter. Sonography this time showed a large mass on left side having heterogeneous echopattern with areas of degeneration and amorphous calcifications; it was involving the whole left lobe. Doppler showed grade II vascularity with low resistance (RI 0.12). There was associated cervical adenopathy; nodes were hypoechoic with similar vascularity as seen in thyroid mass. FNAC confirmed our diagnosis of anaplastic carcinoma. MRI showed the heterogenous mass with retrosternal extension pushing the trachea towards right side. In 47% of cases the anaplastic ca. develops within the substrate of goiters and may arise from papillary and follicular thyroid cancers [47], as was our case with previous long standing goiter.

Anaplastic carcinoma is one of the most aggressive head and neck cancers and has a grave prognosis. It accounts for 15%–20% of all thyroid cancers. The diagnosis is suspected clinically with rapid growth in a long-standing thyroid nodule. Patients frequently present with signs and symptoms of airway compression. Sonographically they are hypoechoic diffusely involving the entire lobe or gland with ill-defined margin, areas of necrosis and nodal or distant metastases. Extracapsular spread and vascular invasion is seen in about one third of patients [48].

Lymph node diseases:

Total of 16 lymph nodes were studied 9 tuberculous (56.5%), 1 reactive (6%) and 6 (37.5%) malignant.

Tuberculous cervical lymphadenopathy:

Present study included 9 patients, 5 male and 4 females with age range of 5-40 years. The chief symptoms observed were multiple swellings in the neck, evening rise of temperature associated with night sweats and loss of appetite. Loss of weight was present in 6 patients. Clinical examination revealed matting of lymph nodes in 3 patients. Mantoux test was positive in all cases whereas sputum microscopy for acid fast bacilli was positive in 2 cases. Chest X-ray revealed tuberculous lesions in 2 cases.

On sonography, the predominant pattern seen in 7 patients was hypoechoic oval nodes with L/S ratio > 2 in majority of lymph nodes. Matting was observed in 4 patients and echogenic hilum was absent in lymph nodes where intranodal necrosis (6 cases) was seen. Posterior enhancement was noted in all cases. Three patient nodes showed Grade I while others had avascular nodes. The only pattern of vascularity seen was of central vascularity in vascular nodes or no vascularity in nodes with significant necrosis.

Based on sonographic findings a diagnosis of tuberculosis cervical lymphadenitis was made in 10 cases which were confirmed by FNAC in 9 cases and one was found to be Hodgkin's nodal disease.

Sonographic features that favored tuberculous lymphadenitis were an L/S ratio of >2 , abnormal surrounding soft tissues heterogeneity, intranodal cystic necrosis, matting and posterior enhancement. This is also apparent from our study [49].

Reactive lymphadenopathy

A 6 yr. old male child was diagnosed having reactive lymphadenitis with B/L tonsillitis. Sonography revealed a solitary hypoechoic lymph node with central echogenic wide hilum, narrow cortex and L/S ratio > 2 in submandibular regions on both sides. On Doppler evaluation the swelling showed grade I vascularity which improved to grade 2 on power Doppler study.

The pattern of vascularity was hilar. Based on USG findings a diagnosis of reactive lymphadenopathy was given and the patient was treated with a course of antibiotics following which patient showed clinical and sonographic improvement.

Pierre Vassallo et al observed that an $L/S \geq 2$ is a stronger criterion for benign disease than an $L/S < 2$ for malignant disease. This was seen in our case. He also noted that nodes with a narrow cortex turned out to be benign in 91% and malignant in 9%. In the same study he observed that nodes with wide oval central hila were benign in 86% and 67% of those with a slit like narrow hilus were malignant [50].

Malignant lymphadenopathy

A total of 6 patients with this diagnosis were included in the study. The patients were in the age group of 12-67 years and all were male. On examination the lymph nodes involved were upper and mid jugulodigastric and supraclavicular nodes. The swellings were firm to hard in consistency in all the cases. The x-ray chest and AP and lateral views of neck were normal in all the cases. Out of 6 cases 4 had primary lymph node diseases and 2 had secondary involvement (metastatic).

On USG 5 cases showed rounded contour i.e. a roundness index (L/S ratio) of less than 2 and one case showed nodes with more oval shape i.e. most of the nodes had roundness index of 2 or more. Thin hilum was noted in 3 cases of lymphoma (proved later) and not seen in rest of 3 cases (one lymphoma and 2 metastatic). All showed hypoechoic eccentrically thickened cortex and had well defined border. On Doppler evaluation the lymph nodes were vascular in all cases with 3 cases having mixed vascularity and 3 having peripheral vascularity.

Pierre Vassallo et al observed that an $L/S \geq 2$ is a stronger criterion for benign disease than an $L/S < 2$ for malignant disease [50]. Nodes with no hilus have been reported to be malignant in 76% to 92% of cases [51].

Most benign lymphadenopathies (87%) and tuberculous lymphadenopathies (72%) revealed an avascular or hilar vascular pattern. Vascular patterns of most of the metastatic lymphadenopathy (90%) were of spotted (26%), peripheral (11%) or mixed (53%) type. The vascularity indices (RI, PI) of metastatic lymphadenopathy were significantly higher than those of tuberculosis and benign lymphadenopathies. A possible reason for this extraordinary high resistance was that, within the restriction of the nodal capsule, tumor load might exert mechanical pressure on the preexisting vessels [52].

Salivary gland lesions:

Abscess: Three cases of salivary gland abscesses were found, two of submandibular gland and one sublingual gland. All cases came with fever, pain and tenderness over the area involved. USG showed diffuse enlargement of the submandibular gland with mixed echogenicity, areas of necrosis with hyper echoic contents and fluid levels were noted. Few small reactionary nodes were noted on the same side at the levels I, II & III. On Doppler the masses were predominantly avascular with mildly increased vascularity over peripheral solid part.

According to Kushner DC and Weber AL about 2/3 of suppurative sialadenitis are associated with postoperative period and occur in debilitated, dehydrated patients, usually with poor oral hygiene [53]. My patients had no operative or chronic disease history, though they had bad oral hygiene with tobacco eating habit.

Pleomorphic adenoma:

Two cases of pleomorphic adenoma of left parotid gland were found in two patients both in 5th decade, who presented with long standing swellings in the parotid region. On ultrasound one was hypoechoic well defined but other was more heterogeneous and larger with ill-defined borders. Both showed increased vascularity on CDI. One was diagnosed as adenoma which was confirmed on FNAC and other (heterogeneous)

was diagnosed as a malignant transformation on US but it was later found to be benign on FNAC.

Lesions larger than 3cm are more prone to cystic or hemorrhagic degeneration which modify the internal architecture and may also exhibit ill-defined edges, thus making differentiation from a malignant lesion difficult. Calcification may also occur in longstanding tumour. The colour Doppler pattern of pleomorphic adenoma is variable but commonly shows increased peripheral vessels mainly venous in nature [54].

USG appearance of a solid tumor does not predict its benign or malignant nature and USG guided FNAC of the primary tumor as well neck nodes be performed to determine the nature of a mass, as was also proved by our second case which on ultrasound looked like a malignant change because of its ill-defined borders and heteroechogenicity, but was proved to be benign tumor on FNAC [55].

Masses of developmental origin:

Thyroglossal cyst: The diagnosis of thyroglossal cyst was suggested in two cases on USG (2 & 9 year old) who presented with a midline painless neck swelling. Both were located in infra hyoid region with movement on tongue protrusion and deglutition. They were diagnosed clinically also and had typical US features. Both were operated and diagnosis was confirmed.

The sonographic characteristics of thyroglossal duct cysts have been studied by several groups who report a spectrum of findings [56].

Branchial cyst: A 12 years old male patient presented with swelling in the left side of the neck. On examination the mass was present in the left side of the neck at the junction of the upper third with lower two-third of the neck just at the anterior border of the sternocleidomastoid muscle. On USG examination the mass was thin walled cystic in nature and no internal contents were seen. On Doppler examination the mass was avascular. Branchial cyst was suspected

clinically as well as on US and was confirmed latter on operation.

Sonographic evaluation demonstrates a variable appearance, ranging from a thin-walled, discrete anechoic mass with posterior acoustic enhancement typical for cystic structures to a more complex cystic mass. Occasionally the branchial cleft cysts may contain cholesterol crystals resulting in debris. In the setting of infection or hemorrhage, the cyst wall may become thickened and irregular with increasing heterogeneity of the echotexture [57].

Cystic Hygroma: 4 year old male child presented with swelling in the neck which was gradually increasing in size. Sonography revealed large multilocular cystic masses with septae and low level internal echoes. On Doppler no flow was seen in the cystic portion of the mass.

Lymphatic malformations (cystic hygroma) are congenital malformations resulting from blockage of the lymphatic ducts. Regardless of the mechanism, the lymphatic ducts become either partially or totally separated from venous channels. Approximately 60% to 70% of lymphangiomas are present at birth, and most are evident in the first 2 years of life. A cystic hygroma is easily identified by ultrasound as an anechoic or mixed echoic mass with septae of variable thicknesses. These cysts tend to intertwine themselves around surrounding structures, necessitating CT and MRI to identify the exact margins of the mass and its relationship to proximal structures [58].

Epidermoid cyst: A 17 year old girl presented with a small midline oval swelling in the suprasternal area of neck. USG neck showed a well-defined echogenic cystic mass, echogenicity was thought to be because of sebaceous content, no flow on Doppler detected (MC sr. 47).

The dermoid is similar to the epidermoid but contains mesodermal derivatives including hair, sebaceous glands, and sweat glands. These cysts

can be difficult to distinguish from thyroglossal duct cysts on physical as well as on sonographic evaluation. Dermoid cysts tend to be suprahyoid in location in contrast to the thyroglossal duct cysts, which are more commonly infrahyoid. The epidermoid inclusion cyst may be more laterally located. The more common sonographic features include a well-circumscribed echogenic mass. Dermoid cysts may demonstrate a more heterogeneous echotexture, depending on the internal contents of the cyst [59].

Mesenchymal lesions

Lipoma: Two cases were studied both presented with a painless swelling in the neck one anterolaterally & other posteriorly at the base on neck for over years. The swellings were insidious in onset and gradually progressive. Sonography demonstrated a well-defined oval mass which was hyperechoic in relation to SCM muscle in the anterior triangle of neck with linear echogenic lines at right angles to the USG beam. There was no evidence of any distal enhancement seen. No evidence of any flow was seen on Doppler ultrasonography. Histopathology reports confirmed the USG diagnosis of lipoma.

In a study conducted by Ahuja et al 1998 [60] although 76% of lipoma in neck were hyperechoic, 16% were found to be hypoechoic relative to adjacent muscle and show no flow on color Doppler imaging, contain linear echogenic lines at right angles to the USG beam and display no distal enhancement or attenuation (100%).

Floor of mouth abscess:

A 46 year old man presented with submental swelling with fever, pain and dysphagia. The swelling was tender with cystic feel. Overlying skin showed signs of inflammation. Ultrasound showed a heterogenous ill-defined avascular mass mostly necrotic extending into the floor of mouth with associated reactive cervical adenopathy. This was clinically diagnosed as Ludwig's angina, though patient had no difficulty in breathing. Patient showed complete recovery 1 week post drainage and antibiotics.

Conclusion

Ultrasound was useful in demonstrating the origin of masses, their size, shape, internal composition, nature and extent of the lesion in most of the cases. USG appearance was virtually diagnostic in cases of colloid goiter, thyroid neoplasms, developmental masses, salivary gland diseases. USG was also found to be virtually diagnostic in cases of Mesenchymal lesions (lipoma, cystic hygroma). Ultrasound coupled with Doppler was found to be useful in differentiating benign and malignant causes of lymphadenopathy and in differentiating cystic hygroma from hemangioma.

It was possible to reach a correct diagnosis in 44 (88%) of the 50 total cases based on ultrasonography. The cases which were diagnosed incorrectly on USG were a case of papillary carcinoma thyroid which was diagnosed as colloid nodule, two cases of colloid nodules which were diagnosed as follicular lesions, two cases of lymphomas which were diagnosed as reactionary nodes (latter found to be NHL) and tuberculous nodes (latter found to be HL) and one case of pleomorphic adenoma which was diagnosed as malignant transformation. However, in these cases USG was helpful in directing further diagnostic work up. The overall accuracy of ultrasonography in our study was found to be 92%.

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