Ultrasound in the Diagnosis of Neck Masses

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Abstract

Introduction The role of ultrasonography (USG) in evalution of neck region is becoming increasingly important due to the availability of high frequency probes, which permit visualization of more subtle anatomical and pathological details.

Objectives To study the diagnostic accuracy of ultrasound in the diagnosis of neck masses, considering pathological diagnosis as gold standard and to study the various sonographic findings of the neck masses.

Methods All patients with visible or palpable neck masses referred from indoor or outdoor services of B.P. Koirala Insitutite of Health Science during the one- year period from 15th April 2003 to 14th April 2004 were subjected to US for examination.

Result Total hundred patients (70 female and 30 male)of neck swellings were subjected to USG scanning of the neck. Study shows 100 percent sensitive and 91 percent specific for the diagnosis of benign thyroid nodules with positive predicitive value (PPV) of 97 percent and negative predictive value(NPV) of 100 percent(p=0.0). For the diagnosis of the malignant thyroid nodule USG is 91percent sensitive and 100 percent specific with PPV of 100 percent and NPV of 97 percent(p=0.0). Simillary the USG diagnosis was 100 percent sensitive and 81percent specific for malignant lympnode with PPV of 81percent and NPV of 100 percent (p=0.0003).

Conclusion The study shows USG is a sensitive and specific imaging modality in the diagnostic work up of patients with neck masses.

Key words Ultrasound, Neck masses, Malignant thyroid nodules, Benign thyroid nodules.

Introduction

The role of USG in evaluation of neck region is becoming increasingly important due to the availability of high – frequency (7.5 to 15 MHZ) probes, which permit visualization of more subtle anatomical and pathological details. Neck Masses are any swellings or enlargements of the structures in the area between the inferior border of mandible and clavicle. The patient's age, the location, size and duration of mass are important pieces of information in the diagnosis of the neck masses.

In children most neck masses are benign. Almost 50 percent of all 2 yrs 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.[2]

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. High resolution B- mode sonography has improved in the past few years and has become a very valuable tool in the diagnosis of the disease of the head and neck. 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. It provides information about the site of origin and infiltration into the soft tissue or vessels and mass effects. It provides valuable diagnostic information with a high degree of diagnostic

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accuracy and useful in preparative evaluation of patients. On the basis of sonographic finding, selection of additional imaging modalities including CT and MR imaging can be done more judiciously[1]. The main objective of the study is to study the diagnostic accuracy of ultrasound in the diagnosis of neck masses, considering pathological diagnosis as gold standard and to study the various sonographic findings of the neck masses.

Materials and methods

All patients with visible or palpable neck masses referred from indoor or outdoor services of B.P. Koirala Insitutite of Health Science (BPKIHS) were examined with detailed history, local and general physical examination. All the cases of neck masses with "clinical impression" were then are subjected to US for examination.

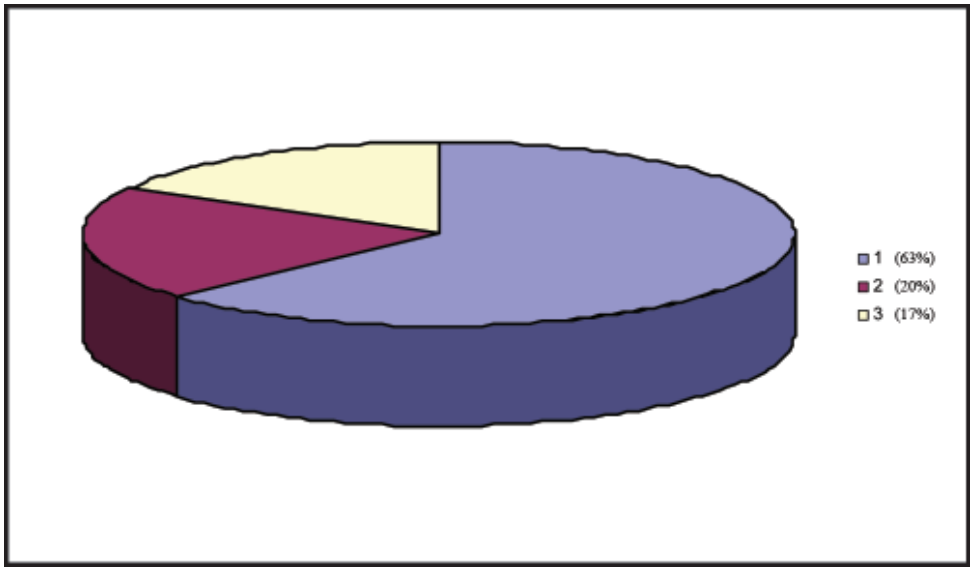
The US examination was done with high-resolution small parts transducers on SIEMENS Verso p.r.o using 7.5 Mhz linear probes. A systemic examination protocol were followed .The patient were examined in the supine position, with neck extended. A small pad placed under shoulder to provide better exposure of the neck, particularly in the patient with short, stocky habitus. It began with the examination of the thyroid gland where the instrument is adjusted and frequency and gain will be optimized. The examination were continued along the vascular sheath to the floor of mouth, tongue, salivary glands, and tonsil and then to the status of lymph nodes including nuchal accessory followed by the evaluation of transverse cervical esophagus. Color Doppler ultrasonography was used as and when required. The US finding was noted and ultrasonographic diagnosis was made. The patient was then be subjected to FNAC and if FNAC is not conclusive then biopsy was done and reported by pathologist. The cytopathological and/or histopathological examination reports of all patients were collected from the pathology department and were used as a gold standard to compare with USG diagnosis. Sensitivity, specificity, positive predictive value, negative predictive value and P value were calculated.

Results

During the one- year period from 15th April 2003 to 14th April 2004, 100 patients (70 female and 30 male) of neck swelling (age ranged from 2 month to 76 years) with clinical impression refer to the Department of radio diagnosis BPKIHS were undergone USG scanning of neck.

On the basis of the anatomical site of origin, the neck masses were classified into three main groups as thyroid masses, lymph nodal masses and other neck masses.

Fig 1: Anotomical distribution of neck masses.



1: thyroid masses 63 (63%)
2: lymph nodal masses 20 (20%)
3: other neck masses 17 (17%)
Total 100

On the basis of various USG finding USG diagnosis of the neck masses were given which were conformed by cytopathological/ histopathological examination.

The Thyroid masses were classified as nodular thyroid diseases and diffuse thyroid disease. The nodular thyroid diseases were again classified as solitary or multinodular. (see table 1)

Table 1: Type of thyroid masses and there occurrence

Thyroid Lesion	Female	Male	Total
Nodular thyroid disease	47 (88%)	6 (12%)	53
a. Solitary	20 (86%)	3 (14%)	23
b. multinodular	27 (90%)	3 (10%)	30
Diffuse thyroid disease	8 (80%)	2 (20%)	10

On the basis of various USG finding like internal contents, echogenicity, peripheral halo. Margin, calcification and Doppler flow pattern, the nodular thyroid disease was classified into benign and malignant nodules and compare with pathological finding. (see table 2)

Table 2: The sonographic features in the differentiation of benign from malignant thyroid nodules

	BENIGN NODULES	MALIGNANT NODULES
Solitary	22 (52%)	6 (54%)
Multiple	20 (47%)	5 (45%)
Internal contents		
a. purely cystic	2 (4%)	-
b. cystic with thin septa	1 (2%)	-
c. mixed solid &cystic	29 (69%)	2 (18%)
d. solid	10 (23%)	9 (81%)
Echogenicity		
a. hyperechoic	12 (28%)	1 (9%)
b. isoechoic	20 (47%)	2 (18%)
c. hypoechoic	10 (23%)	8 (72%)
Halo		
a. thin halo	42 (100%)	1 (9%)
b. thick incomplete halo	------	10 (90%)
Margin		
a. well defined	40 (95%)	1 (9%)
b. poorly defined	2 (4%)	10 (90%)
Calcification		
a. eggshell	1 (2%)	------
b. coarse	20 (47%)	1 (9%)
c. micro	------	3 (27%)
d. no calcification	20 (47%)	8 (72%)
Doppler		
a. peripheral flow	42 (100%)	4 (36%)
b.internal flow	------	7 (63%)
Enlarged cervical LN	---------	3 (27%)

In the study ,one case in which there was evidence of multiple hypoechoic areas with well defined margin and thin regular halo was given USG diagnosis of multinodular goiter, which on histopathological examination comes out to be papillary carcinoma of thyroid.

In the benign cause all were nodular colloid goiter (either solitary or multinodular). In the malignant causes 6 were papillary and 5 were follicular carcinoma. Anaplastic and medullary carcinomas were not found in the study.

In this study there were 10 cases of diffuse thyroid enlargement. The criteria taken for diffuse thyroid enlargement were anteroposterior dimension more than 10 mm.

USG diagnoses of the diffuse thyroid disease were given on the basis of various sonographic features like echogenicity, vascularity, multiple discrete hypoechoic micro nodules. USG diagnoses were conformed by pathological diagnosis. (see table 3)

Table 3: Sonographic finding of various causes of diffuse thyroid enlargement

	Hashimoto's	**de Quervain**	**Adenomatous**
Echogenicity			
coarse	3 (75%)	------	
hyperechoic	------	------	
isoechoic	------	------	2 (100%)
hypoechoic	4 (100%)	4 (100%)	
Vascularity			
normal	------	2 (50%)	2 (100%)
decrease	------	2 (50%)	
increase	4 (100%)	------	
Multiple discrete			
hypoechoic micro	4 (100%)	----------	1 (50%)
nodules			

In the study 20 cases of neck swelling were lymph nodal masses .In the evaluation of these nodal masses sonographic features taken into consideration were distribution, the size and shape, echogenic hilus, echogenicity, calcification, intranodal necrosis, nodal border, posterior enhancement, soft tissue edema, matting of the nodes.

With the help of these sonographic findings USG diagnosis of malignant or benign causes were given and these were conformed pathologically. (see table 4)

Table 4: The sonographic features in various causes of lymph nodal masses

	Metastasis	Lymphoma	TB adenitis	Reactive adenitis	Nonspecific adenitis
1. Shape					
RI < 1.5	7 (87%)	3 (100%)	2 (33%)	1 (50%)	------
RI > 2	1 (13%)	------	4 (66%)	1 (50%)	1 (100%)
2. Echogenicity					
anechoic	------	2 (66%)	1 (17%)	------	------
hypoechoic	8 (100%)	1 (33%)	5 (83%)	2 (100%)	1 (100%)
isoechoic	------	------	------	------	------
hyperechoic	------	------	------	------	------
homogenous	------	3 (100%)	1 (17%)	1 (50%)	1 (100%)
heterogeneous	8 (100%)	------	5 (83%)	1 (50%)	------
3. Hilus absent	8 (100%)	3 (100%)	6 (100%)	1 (50%)	1 (100%)
4. Calcification	3 (37%)	------	4 (66%)	------	------
5. Cystic necrosis	5 (62%)	------	3 (50%)	------	------
6. Nodal border					
sharp	7 (87%)	3 (100%)	------	2 (100%)	1 (100%)
unsharp	1 (13%)	------	6 (100%)	------	------
7. Posterior enhancement	------	3 (100%)	1 (16%)	------	------
8. Invasion / encasement	2 (25%)	------	1 (16%)	------	------
9. Matted	------	------	6 (100%)	------	------

NOTE: RI (roundness index) is ratio between the longitudinal and transverse diameter.

On the basis of various sonographic finding and their anatomical location USG diagnosis of neck masses other than thyroid and enlarged lymph node were made which were conformed by histopathological / cytopathological examination.

USG diagnosis of 5 cases in the study was lipomas. The sonographic findings consider for diagnosis were shape, echogenicity, presence of echogenic parallel lines, border, compressibility, posterior enhancement, and color flow pattern.

In the study 4 cases were sonographically diagnosed as thyroglossal cyst. The sonographic findings that were considered for diagnosis were site, wall, margin, internal architecture, posterior enhancement.

USG diagnosis of three cases in the study was cystic hygroma. The sonographic finding which was considered for diagnosis was multiloculated cystic areas. In the study two cases were multiloculated cystic mass with variable septa and one was anechoic with thin septa.

In the study two cases of neck masses, USG showed hypoechoic, homogenous sharply marinated area in parotid gland and given diagnosis of Pleomorphic adenoma. One case showed cystic changes also.

In the study two neck swelling were given diagnosis of Hemangioma. Both had several, small anechoic area with echogenic linear septation and calcification.

One case of neck swelling in the study undergone FNAC before USG, since on physical examination swelling was thought to be enlarged lymphnode.On USG there was heterogeneous solid mass at carotid bifurcation with increased vascularity.The USG diagnosis was carotid body tumor.

Discussion

Neck swelling is very common clinical condition. For the proper management of this condition, proper assessment of the neck swelling is very important. Palpation is the only clinically relevant method of examination and it is insensitive[3]. In the modern era USG has proved useful in imaging neck masses[4] Isolated case reports of USG features various neck masses have also appeared in the literature along with study regarding the usefulness of USG in diagnosis of neck masses. In the present study the sonographic appearance of various neck masses are analysed and compared with previous reports.

In the study Rojeski M T et al[5] found women being more frequently affected by nodular thyroid disease. In the present study also 88 percent are female.

Henneman et al[6] found in their study 80 percent of nodular thyroid disease is benign. Study by Solbiati et al[7] reported that no single sonographic criterion distinguishes benign thyroid nodules from malignant nodules with complete reliability. The fundamental anatomical features of thyroid nodule on high resolution sonography are

- internal consistency (solid, mixed solid and cystic, or purely cystic)
- echogenicity
- margin
- presence and pattern of calcification
- peripheral son lucent halo
- presence and distribution of blood flow singles[8].

In the study by Solbiati et al[7]showed 70 percent of benign thyroid nodules were solid with 30 percent exhibit various amount of cystic component. Cystic component usually present in benign lesion.Another study by Anurag et al[4]majority (56%) of malignant lesion were mixed consistency and 22 percent of papillary carcinoma had cystic changes. Various authors have documented the manifestation of papillary carcinoma in the form of predominantly cystic lesion. First such case was reported by Allen et al in 1979. other authors reporting such an appearance include simeone et al in 1982, Hatabu et al in 1991, Barki et al in 1992 and LuC et al in 1994. Hammer et al[8] reported varying amount of cystic changes in papillary carcinoma indistinguishable from benign cystic nodule. In present study majority of benign nodule are mixed (solid and cystic) i.e. 69 percent only solid are 23 percent, purely cystic are 4 percent and the less common being cystic with thin septa is only 2 percent. Present study shows 81percent of malignant nodules are solid and 18 percent are mixed. No case of purely cystic nodule proved to be malignant.1 out of 6 (16%) papillary carcinoma in the study shows cystic changes.

Variable echo pattern were reported in the literature for both malignant and benign thyroid nodule.Anurag et al [4]found in the study that 20 patients of malignant thyroid nodules 19 were hypoechoic and 1 is hyperechoic(papillary carcinoma). Solbiati et al[7]lso described most common pattern for malignant nodules being hypoechoic. In the present study 72 percent of malignant nodules are hypoechoic, 18 percent isoechoic and 9 percent hyperechoic.Histologically this hyperechoic nodule is papillary carcinoma. Hyperechoic papillary carcinoma although uncommon, have been reported in literature.In the present study benign nodules are isoechoic (47%), hyperechoic (28%) and less commonly 23 percent being hypoechoic.

Solbiati et a[7]eported that sharp, well defined margins are common in benign nodules as compare to irregular or poorly defined margins in malignant nodule. Present study shows 95 percent of benign nodule is with well defined margin and 90 percent of malignant nodule have poorly defined margin.

Solbiati et al[7]reported peripheral and eggshell calcification were more common and reliable features of benign nodule and microcalcification for malignant nodule. The high specificity of microcalcification in diagnosis of malignant (papillary and medullary) is well documented in literature.Based on various sonographic features microcalcification shows the highest accuracy (76%), specificity (93%),and positive predicative value(70%) for malignancy as single sign. however sensitivity is low (36%).In the study 27 percent of malignant nodule shows microcalcification and 9 percent shows coarse calcification.47 percent of benign nodule shows coarse calcification, 2 percent shows eggshell calcification .

Anurag et al[4]reported intralesional vascularity in all thyroid malignancies. various study done by Lagalla et al[9],Argali et al[10]emonstrated that 80 to 95 percent benign nodule display peripheral vascularity while 70 to 90 percent malignant nodule display internal vascularity with or without peripheral component. In the present study 100 percent of benign nodule show peripheral flow.63 percent of malignant nodule shows internal flow and 36 percent shows peripheral flow.

Anurag et al[4]reported 86 percent of papillary carcinoma have cervical lymphadenopathy.In the present study 27 percent of malignant nodule (all papillary carcinoma) shows enlarged lymphnode.

Overall in the present study regarding the nodular thyroid disease majority (79%) are benign nodules.

Benign nodules werepredominantly solitary (52%), mixed (69%), isoechoic (47%), well marinated (95%) with thin peripheral halo (100%) and coarse calcification (47%).on color Doppler they shows peripheral flow pattern. Malignant noduleswere predominantly solitary (54%), solid (81%), and hypoechoic (73%) poorly marinated(90%) ,with thick incomplete halo(90%) and microcalcification(27%)on color Doppler they shows internal flow(63%).cervical lymphnode metastasis wasfound in 27 percent cases.

Several thyroid disease werecharacterized by diffuse rather than focal involvement .Specific conditions that commonly produce such diffuse enlargement include chronic autoimmune lymphocytic(Hashimoto's) thyroiditis,subacute granulomatous thyroiditis (de Quervain's thyroiditis),colloid or adenomatous goiter and Grave's disease . In present study there wereno cases of Grave's disease.

The most common type of thyroiditis waschronic autoimmune lymphocytic (Hashimoto's) thyroiditis. Poyhonen and Lenko et al[11]eported gland enlargement with" patchy echopoorness"as the main finding. Bachrach et al[12]ound that 47 percent of the children with Hashimoto's thyroiditis had abnormalities which consists of nonhomogenous echopatterns without definite nodules. They reported that these features were indistinguishable from those found in children with iodine deficiency goiter. Yeh HC et al[13]ported sonographic appearance of Hashmoto's thyroiditis is diffuse glandular enlargement with homogenous but coarse parenchymal echotexture,generally more hypoechoic than normal thyroid gland. In the present study coarse echotexture is found in 75 and 100 percent are hypoechoic. Vascularity is increased in 100 percent cases. Multiple discrete micronodules noted in all the cases. One case of diffuse parenchymal inhomogenicity and micronodularty iscomes out to be adenomatous goiter. Literature also described that it is difficult to differentiate between these two condition.Bachrach et al[14]eported that sonographic finding of Hashimoto's thyroiditis were indistinguishable from adenomatous goiter.

Sub acute granulomatous thyroiditis is a spontaneously remitting inflammatory disease that is probably caused by viral infection. Brander A et al[21]in1989, Adams H. Jones et al[22] in 1990 and Birchall et al[23] in 1990 reported that sonographic appearance in this condition were enlarged gland with hypoechoic echotexture and decrease or normal vascularity.In the present study all the cases were hypoechoic and diffusely enlarged. Half of the cases had normal vascularity and other half of the cases had decreased vascularity

Adenomatous goiter wasalso important cause of diffuse thyroid disease. As described above sonographic features is very similar to Hashimoto's thyroiditis.. In the present study there wasdiffuse enlargement of the gland with isoechoic echotexture in 100 percent cases. Normal flow wasnoted in 50 percent cases and decreased flow in 50 percent cases.

In overall when thyroid gland wasdiffusely involved and enlarged, then its echotexture, vascularity and presence or absence of hypoechoic micronodule wasvery important to differentiate various pathology.

The majority of the normal lymphnode in the neck show an axial diameter of 2 to 5 mm with exception of jugulodigastric and jugulo- omohyoid lymph nodes, which are larger and reveal an axial diameter of 8 to 10 mm and a longitudinal diameter of 15 to 20mm.Normal lymphnode are difficult to detect because of their high echogenicity, which is similar to the surrounding fatty tissue[1]. In the evaluating the nodes the features looked at were size, shape, echogenic hilus, echogenicity, calcification, intranodal necrosis, nodal border, posterior enhancement, soft tissue edema and matted lymphnode.

The shape of the lymph node was assessed on the basis of roundness index (RI). It is short to long axes ratio[18]. Solbiatic et al[18]eported that RI has a higher degree of accuracy in differentiation between inflammatory and malignant lymph nodes. There study showed that RI>2 indicate inflammatory disease in 84 percent where as RI less than 1.5 favors metastatic involvement in 71percent cases. In the present study 87 percent of metastatic and 100 percent of lymphoma, RI is less than 1.5 where as 66 percent of tubercular adenitis, 50 percent of reactive adenitis, 100 percent of nonspecific adenitis have RI>2.

In the study by Ahuja et al[19]ajority of malignant nodes were hypoechoic and heterogeneous. However they found that hyperechoic metastatic nodes in papillary carcinoma of thyroid. In the present study 100 percent of metastatic nodes are hypoechoic and heterogeneous in which some of metastatic nodes are from papillary carcinoma. Dietmar et al[1]reported that lymph nodes were hypoechoic to anechoic and homogenous in lymphoma.In this study 66 percent of lymph node in lymphoma are anechoic and 33 percent are hypoechoic with 100 percent are homogenous. Baatenburg et al[20]eported the spectrum ranging from echogenic to anechoic lymphnode in tubercular adenitis. In the present study Tubercular nodes are 83 percent hypoechoic and heterogeneous, 17 percent are anechoic and homogenous . Ahuja et al[19] reported 100 percent lymph nodes hypoechoic and homogenous in reactive lymphadenitis. In present study only 50 percent of lymph nodes are hypoechoic in reactive adenitis.Dietmar et al[1]reported hypoechoic and homogenous nodes in non specific lymph adenitis. In the present study also 100 percent nodes are hypoechoic and homogenous.

Dietmar et al[1]reported loss of hilar definition in malignant lymph nodes.In the present study 100 percent of metastatic and 100 percent of lymph node in lymphoma also shows loss of hilar definition.Baatenburg et al[20] reported loss of hilar definition in tubercular adenitis in their study. In the present study 100 percent of tubercular adenitis shows loss of definition. Ahuja et al[19]eported that nodal hilar is preserved in reactive adenitis but in present study only 50 percent have preserved hilus.Dietmar et al[1]reported in their study that hilus is not always apparent in nonspecific adenitis. In present study hilus is absent in all the cases.

Som et a[21] described that metastatic tumoral calcification is uncommon and commonest likely primary neoplasm is papillary carcinoma of thyroid. In the present study 37 percent of metastatic lymphnode shows calcification (all cases from papillary carcinoma of thyroid). In the study by Majer et al[22]alcification was not noted in nodes from lymphoma. In the present study also no calcification noted in nodes from lymphoma. Study by Schwerk et a[23]howed calcification in 62 percent of TB adenitis .In the present study calcification is present in 66 percent of TB adenitis. Calcification in reactive adenitis and non specific adenitis is not reported in literature and in present study also it is not present.

Som et al[21] reported cystic necrosis in metastatic lymphnode from papillary carcinoma. In the present study 62 percent metastatic lymphnode shows cystic necrosis of which 66 percent are from papillary carcinoma of thyroid remaining other has unknown origion. Baatenburg et al[20]eported cystic necrosis in tubercular lymphnode. In the present study 50 percent of Tb lymph node shows cystic changes. Cystic changes are not reports in reactive and non specific lymph adenitis in literature. In present study also no cystic necrosis noted in these type of lymphadenitis.

The study by Ahuja et al[19] showed 100 percent of lymph nodes were matted and had irregular border in TB adenitis. In present study also 100 percent lymphnodewere matted and had irregular border. Dietmar et al[1] reported matted lymphnode in 66 percent cases.

Dietmar et al[1]eported 40 percent of cases of lymphoma had posterior enhancement .In present study 100 percent lymphoma shows posterior enhancement.

In overall malignant (metastatic and lymphoma) lymph node predominantly (62%) are spherical shape (RI<1.5) and inflammatory lymph node predominantly (66%) longitudinal in shape.

Metastatic lymph nodes are predominantly spherical (87%), hypoechoic (80%), sharply marinated (87%) with cystic necrosis (62%) and absent hilum (100%).Few may show calcification (37%) and great vessels encasement (25%). In lymphoma lymph nodeswere predominantly spherical (100%), anechoic with posterior enhancement (100%). calcification (66%) and absent hilum (100%).

Tubercular lymph nodeswere predominantly longitudinal (66%), hypoechoic (83%), heterogeneous (83%), matted (100%) with calcification (66%) and absent hilum (100%).

Reactive and nonspecific lymph adenitis waspredominantly longitudinal, hypoechoic, and sharply marginated.

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