CERVICAL LYMPHADENOPATHY – USG & CT CORRELATION

By

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DISSERTATION SUBMITTED TO

DOCTOR OF MEDICINE
In
RADIO-DIAGNOSIS

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2019

ABSTRACT

BACKGROUND AND OBJECTIVES

Cervical lymphadenopathy is one of the commonest presentations of underlying pathology of the head and neck region which has large number of differential diagnosis like infections (specific and non-specific), neoplasms, in immune deficiency disorders and also in rare disorders like inflammatory pseudotumour (plasma cell granuloma) and Kikuchi-Fujimoto disease. USG and CT are the important imaging modalities help in early identification and diagnosis of cervical lymphadenopathy and initiation of the theraphy.

SOURCE OF DATA

The study will be done on patients presenting with neck masses or with clinical suspected cases of cervical lymphadenopathy attending the OPD or admitted in various wards B.L.D.E.U's Shri. B.M. Patil Medical College Hospital and Research Centre, Vijayapur will be enrolled for the study. They would be subjected to USG and C.T. (plain and contrast) evaluation.

AIMS AND OBJECTIVES

1. To characterize the various pathologies of lymph node.
2. To study ultrasonography and colour Doppler pattern in various pathologies of lymph node.
3. To study the extent and enhancement pattern using MDCT of various pathologies.
4. To co relate USG and CT findings.

METHODS AND MATERIAL

The study will be done on patients presenting with neck masses or with clinical suspected cases of cervical lymphadenopathy attending the OPD or admitted in various wards B.L.D.E.U's Shri. B.M. Patil Medical College Hospital and Research Centre, Vijayapur will be enrolled for the study. They would be subjected to USG and C.T. (plain and contrast) evaluation.

RESULTS

In our study, 30 cases of cervical lymphadenopathy were undertaken as a part of our study and subjected to USG and CT examination. The following results were obtained –

- Sensitivity of USG to assess true positive cases for pathologies of cervical lymphadenopathy was more (94.7%) with respect to sensitivity of CT (89.4%)
- Specificity of USG to assess true negative cases for pathologies of cervical lymphadenopathy was more (81.82%) with respect to sensitivity of CT (63.64%)
- Accuracy for USG was more (90%) than CT scan (80%) for detection of pathologies in cervical lymphadenopathy.

CONCLUSION

High resolution grey scale sonographic with color Doppler examination proved to be a valuable primary and very sensitive investigation to identify lymph nodes and helps to differentiate neoplastic (malignant/ metastatic) from non-neoplastic (reactive and tubercular) lymph node sand very sensitive in evaluation of intranodal architecture & vascularity. The diagnostic performances of US was better than CT , though US and CT combined are superior to US alone for evaluation of

cervical lymphadenopathy in patients by a level-by-level analysis. CT may be used as a complementary method in addition to US for evaluation of cervical lymphadenopathy and for differentiation of pathologies of lymph nodes.

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INTRODUCTION

Diseases of lymph node have been known for a very long time. There are around eight hundred lymph nodes (L.N.) in our body out of which more than three hundred are present in the neck, so cervical lymphadenopathy is a condition commonly encountered by the clinicians. Palpable lymphadenopathy is common in children, with studies showing a prevalence of 55% in children aged 6– 12 months.[1]

The term Lymphadenopathy refers to nodes that are abnormal in size, consistency or number.[2] Cervical lymphadenopathy is one of the commonest presentations of underlying pathology of the head and neck region which has large number of differential diagnosis like neoplasms, infections (specific and non-specific), in immune deficiency disorders and also in rare disorders like Inflammatory Pseudotumour (plasma cell granuloma) and Kikuchi-Fujimoto disease. Larsson suggested that 38-45% of normal children have palpable cervical lymphadenopathy[3] while Park says that 90% of children aged 4-8 years old have normal cervical lymphadenopathy.[4]

Innovation in medicine is a continuous process. Use of the fine needle aspiration (FNA) for diagnosis of palpable lesions is a classic example of the same. Persistent enlargement of the lymph node needs detailed evaluation and investigations to explore an underlying pathology. Clinically, even though reasonably accurate diagnosis can be made, for confirmation of the diagnosis, histopathological examinations are necessary. This can be done by FNAC procedure, as it is simple, quick, easy and cheap procedure and requires only a specialist input (cytologist)[5]

In India, tuberculosis accounts for major health problem owing to economic and social constraints. The human immunodeficiency virus (HIV) epidemic has furthur resulted in increase in the total incidence of tuberculosis and an increased

miliary, disseminated, and extrapulmonary tuberculosis cases including lymphadenitis.[6]

Fine needle aspiration (FNA) is the standard workup modality in the case of neck mass and can be used for both cytology and culture (in conditions where suspected infectious neck mass does not show response to conventional antibiotic therapy). If FNA is unsuccessful or if sufficient information is not obtained from an initial FNA, the FNA should be repeated before open biopsy.[7]

Various diagnostic modalities like fine needle aspiration cytology, ultrasonography (USG), computerized tomography and PET CT neck are now available to diagnose underlying disease in cervical lymphadenitis. These investigating tools have high sensitivity and specificity for cervical lymphadenopathy. Diagnostic importance and applicability of these investigations also varies with demographic profile of patient such as age, sex and socioeconomic condition. It is necessary to have a firm clinical plan while investigating and managing cervical lymphadenopathy.

Etiology and clinical presentation of cervical lymphadenopathy is certainly different in different groups of population. Understanding prevalent conditions and presentations of lymphadenopathy in population will make it possible to establish sound clinical protocol in evaluation and diagnosis of this condition preventing delay in treatment.

Most head and neck tumours results in cervical lymphadenopathy. About 80% of upper aerodigestive mucosal malignancy cases will have cervical lymph nodal metastasis resulting in cervical lymphadenopathy depending on the primary site. The occurrence of this nodal metastasis has an important prognostic effect on the

management of these cases. Therefore cervical lymphadenopathy due to nodal metastases from underlying primaries accounts for common clinical problem.

The appropriate management of the cervical lymph nodes requires a good understanding of the incidence, patterns, and prognostic implications of nodal metastasis.

Patients with a wide range of clinical presentation and disease states are often referred for imaging, although evaluation and staging of head and neck cancer is the most common indication. In addition to metastatic squamous carcinoma of the upper aerodigestive tract, the differential diagnosis of enlarged cervical lymph nodes includes the following: bacterial, mycobacterial and viral infections, granulomatous conditions such as sarcoidosis, primary and secondary involvement in lymphoma; other metastatic neoplasms such as from breast and lung, as well as more uncommon conditions such as sinus histiocytosis, eosinophilic granuloma, Kimura's disease, and Kikuchi's disease.

Ultrasound is very useful imaging modality in evaluation of cervical lymphadenopathy . Gray-scale ultrasonography is commonly used imaging modality in the evaluation of the size, shape, number, borders, matting, internal architectures, adjacent soft-tissue edema and other structural changes in cervical lymph nodes. Even though both color doppler and power Doppler sonography are commonly used, 3D ultrasonography is not commonly used to evaluate the intranodal vascular study.

After introduction of the high-resolution linear transducer, US proved to be more sensitive than clinical examination in lymph nodes detection. The improvement in equipment, the definition of normal lymph node US, and the development of new US techniques increased the utility of this imaging method for superficial lymphadenopathy examination.

Today, ultrasound is considered to be the imaging method of choice for peripheral lymph node evaluation. One of the differentiating criteria between benign and malignant nodes is elasticity of node. Conventional elastography has been used to differentiate benign and malignant cervical lymph nodes. However, there are certain disadvantages like low sensitivity and specificity of B mode ultrasound and conventional elastography.[8,9]

Ultrasound is also very useful for USG-guided biopsies of non palpable/ small lesions which are superficially located and for obtaining biopsies of indeterminate soft tissue masses in the treated/ irridated neck. Studies have shown that US-guided fine-needle aspiration of lymph nodes can be useful in staging.[10,11] The positive predictive value of USG-guided biopsies is high; however, the negative predictive value and its inability to rule out micro-metastases is problematic issues. Some studies have suggested that color Doppler ultrasound can be used to distinguish between metastatic deposits and inflammatory neck nodes [12,13,14] Even though the results are quiet reliable, the results appear to be operator dependent. Also, newer techniques like ultrasound elastography are being studied for possible future clinical applications.[9]

Computed tomography (CT) gives good and improved soft tissue detail. The vascularity of the lesion as well as its relation to vascular structures can be assesed with contrast enhanced studies. CT can also give tissue attenuation values (HU values) giving a fair idea about the nature of the lesion. CT is most useful for evaluation of large masses where it can define the entire extent of the lesion in the neck and an extension outside the neck.

CT also depicts the skeletal involvement very well. The improved visualization of the neck structures far outweighs the radiation risk involved with it.

There is extensive study and documentation of ultrasound and CT evaluation of other parts of the body but the neck imaging has received relatively less attention.

Detailed evaluation of the anatomy and pathology of the neck and thoracic inlet in now possible due to advances in cross-sectional imaging, including conventional and helical /spiral CT and multidetector (MDCT) and MR imaging. The major structures including the trachea, larynx, thyroid gland and parathyroid glands as well as the vessels, lymph node chains, nerves and supporting muscles are identified on the basis of their appearance and due to contrast fat tissue planes surrounding the soft tissues. To properly interpret pathologic processes, a thorough knowledge/understanding of the normal cross-sectional anatomy is important. Pathologic processes include both solid and cystic masses. Enlarged lymph nodes constitute the most of the solid masses. In contrast, cystic masses are of variable pathology, and their characteristic locations with respect to normal neck anatomy and appearances allow a confident diagnosis to be made from a brief differential diagnostic spectrum.

Radiologists must be familiar with the simplified level classification system currently used by both pathologists and head and neck surgeons when they report on the involvement of cervical nodes in radical neck dissection specimens.

Hence the present study was undertaken at our tertiary care centre on patients presenting with neck masses or with clinical suspected cases of cervical lymphadenopathy attending the OPD or admitted in various wards **B.L.D.E.U's Shri. B.M. Patil Medical College Hospital and Research Centre, Vijayapur.**

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REVIEW OF LITERATURE

Historical Review

The earliest report of obtaining material for microscopy by needle technique was employed by Kun in 1847 who described it as "new instrument for the diagnosis of tumours". After this, followed sporadic reports of this technique, In 1883 Leydon used needle aspiration to obtain cells to isolate pneumonic microorganisms.

In 1904, Greig and Gray diagnosed trypanosomiasis in aspirates of cervical lymph node from patients with sleeping sickness in Ugand.[15] In 1904, their findings were reported in a British Medical Journal memorandum by Captain Bruce (later of Brucellosis fame). After that there were many other reports of a similar technique to puncture and diagnose lymph nodes infected by leishmaniasis and secondary syphilis.[16] In the mid-1920s attempts were made in New York and Chicago to use large needle (1.2-3.0mm) aspiration for a variety of sites ranging through lymph nodes, breast and prostate but over time the dimension of 1mm or less has come to be accepted as the definition of thin‟ or fine‟.[17] A systematic and detailed study on FNA was carried out by Hayes Martin a head and neck surgeon and James Ewing, the chief pathologist at the New York Memorial Hospital in the late 1920s. Their experience comprising 2500 tumors annually was documented by Fred Stewart (a histopathologist) who then enunciated the fundamental principles regarding the philosophy of aspiration biopsy and importance of the need for close clinical and pathological co-relation. However, full confidence in the procedure was never achieved and this period coincided with a fierce controversy over the reliability and risks of open biopsy in surgical practice, which clinicians feared the risk of increased tumour spread. However, even as their fears were laid to rest, the popularity of needle

aspiration waned to such an extent that by the 1960s the technique was all but obsolete in the USA.[18,19]

Interest in the procedure was resurrected by Europeans in the mid-1950s. In contrast to Martin and Stewart who used thicker calibre (18 gauge) needles, the technique was popularized by the European workers employing thin needles (22 gauge and higher) with an external diameter of 0.6mm or less. This is the technique is known today as the fine needle aspiration (FNA) cytology. The sheer volume, histopathological correlation, follow-up information, along with superbly illustrated publications provided an ethos within the medical profession to allow the technique to be practised widely. Their practice invented a novel specialty of clinical cytologist‟ who would examine the patient, aspirate the lesion, prepare and read the slide and arrange subsequent onward referral. They thus provided a model for FNA services for the rest of the world such that it is now part of all sophisticated pathology departments

ANATOMY

EMBRYOLOGY OF LYMPHATICS:

The first sign of lymphatic system are seen in the form of a number of endothelium lined lymph sacs. They are now regarded to be predominantly independent formations from mesenchyme.

The lymphatic system begins its development later than the cardiovascular system and does not appear until the fifth week of gestation.

Six primary lymph sacs can be recognized. The right and left (paired) jugular sacs lie near the junction of future‟ internal jugular and subclavian veins.[20,21]

The right and left posterior (or iliac) sacs lie around the corresponding common iliac veins. The retroperitoneal sac (unpaired) lies in relation to the root of mesentery.

The sixth sac (unpaired) is the cisterna chyli. It lies in the midline some distance caudal to the retroperitoneal sac.

Lymph vessels are formed either by extension from small lymph vessels or may form de novo, and extend into various tissues. Ultimately all the sacs except the cisterna chyli are invaded by the connective tissue (mesenchymal cell) and lymphocytes and are converted into lymph nodes. Other mesenchymal cells give rise to the capsule and connective tissue framework of the lymph node.[22]

The thoracic duct is derived from the right and left channels that connect the cistern chili to the corresponding jugular sac. The two channels anastomose across the midline. The thoracic duct is formed from the caudal part of the right channel, the anastomosis between right and left channels, and the cranial part of left channel. The cranial part of right channel becomes the right lymphatic duct.[20]

The lymphocytes are derived originally from the stem cells in the yolk sac mesenchyme and later from the liver and spleen. The lymphocytes eventually enter the bone marrow where they divide to form lymphoblasts.69 Lymph nodules do not appear in the lymph nodes until just before and/or after birth. The palatine tonsils develop from the second pair of pharyngeal arches. The tubal / pharyngeal / lingual tonsils develop from lymphoid tissues around Eustachian tube openings / nasopharynx / root of the tongue respectively.[22]

NORMAL HISTOLOGY OF LYMPH NODE:

Normal lymph node consists of following parts:

a) Capsule: Composed of fibrous tissue. It supports the nodal contents.

b) Lymphatic sinuses:

1. Sub capsular sinuses.
2. Medullary sinus.
3. Inter medullary sinus.

All of them are rich in macrophages, lymphocytes, plasma cells and immunoblasts. The function of these sinuses is filtration of lymph node and antigenic binding. Cancer cells are first arrested in the sub capsular sinus.

c) Cortical area: Lymphoid follicles with germinal centers represent the B cell associated with humoral immunity. There are three types of lymphocytes in the germinal centers:

1. Small: Mature form and circulating.
2. Large: Activated lymphoblast.
3. Medium: Transitional phase between small and large types.

d. Para cortical Area: Represents the thymus dependant or T cell area and is the site of cellular immunity.

e. Medullary cords: sites of plasma cell proliferation. Some variation occurs in normal lymph node structure under physiological circumstances. Size of the node varies with site, age, and antigenic stimulation. In advanced age there is generalized atrophy of lymphoid tissue; lymph nodes shrinks in size and germinal centers are few. Nodes become infiltrated with adipose tissue and variable degree of fine fibrosis occurs in old age.

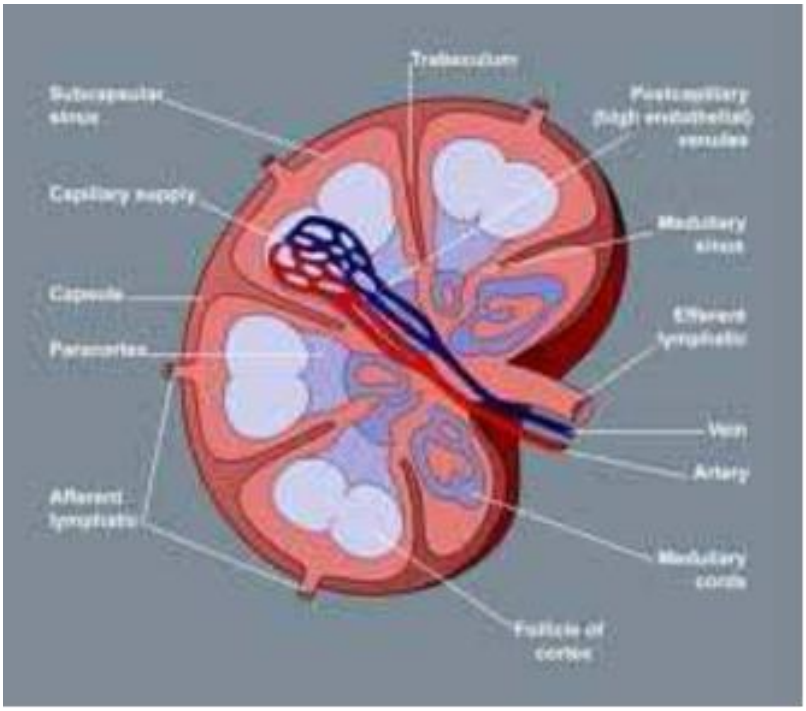


Fig 1. Cut section of Lymph node

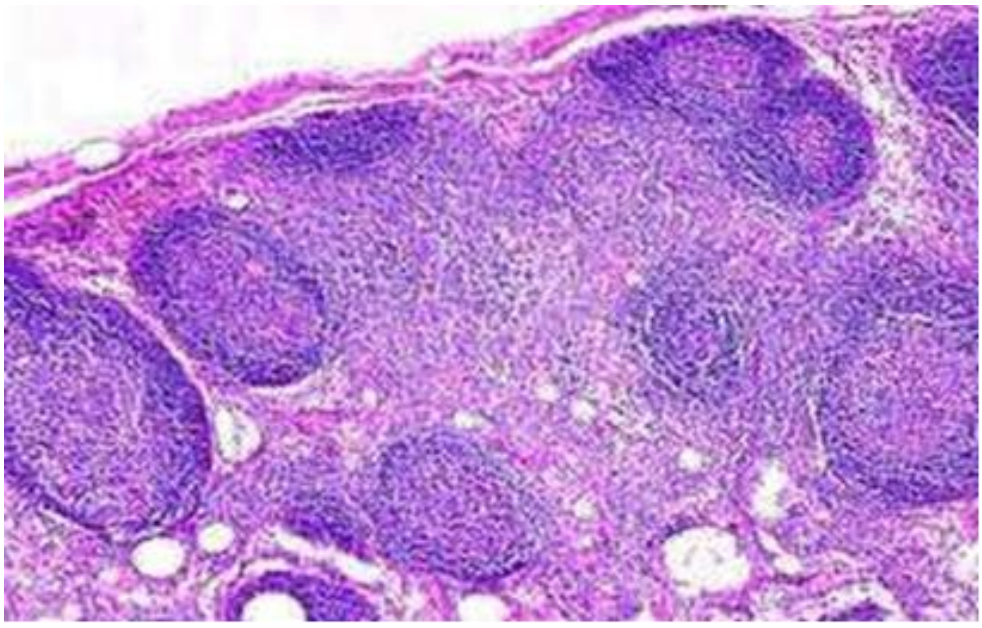


Fig 2.Histological picture of cervical lymph node

FUNCTIONS OF CERVICAL LYMPH NODES:

1. They produce and supply lymphocytes to the blood.
2. They make screening of the lymph drainage of head and neck region by means of phagocytosis and also serve a defensive role against bacterial infection.
3. They act as mechanical filters and temporarily stop the spread of cancer cells, as cancer cells have to penetrate the lymph nodes from where they spread to different parts of the body.
4. They carry out immunological responses by elaboration of antibodies.

Classification of cervical lymph node:[23,24]

The original classification system of cervical lymph nodes was developed by Rouviere in 1938. In 1981; Shah recommended that cervical nodes can be classified in a simpler fashion based on levels. Since then the direction of nodal classification has transformed from a purely anatomical process to a mapping guide for therapy. The latest classification has been created by American Joint Committee on Cancer and the American Academy Of Otorhinolaryngology-Head and Neck Surgery which is given below:

TABLE NO.1 CLASSIFICATION OF CERVICAL LYMPH NODE

S.No.	Level of lymph node	Location	Area drained
1.	Level I	Submental and Submandibular nodes.	
	Ia	Submental nodes.	Drains floor of mouth, lower lip and ventral tongue
	Ib	Submandibular nodes.	Drains subsites in the oral cavity
2.	Level II	Forms the upper jugular group of nodes.	Drains the oropharynx, larynx, hypopharynx, and parotid
	Level IIa	Level IIa lies anteroinferior to spinal accesary nerve.	
	Level IIb	Postero superior. The IIb subzone also known as the submascular recess.	
3.	Level III	Middle jugular nodes.	Drains the larynx and pharynx
4.	Level IV	Lower jugular group of nodes	Drain larynx and hypopharyx.
5.	Level V	Posterior triangle group of nodes.	Drain other lymphatic‟s region in the neck
	Va	Superior to the inferior belly of omohyoid muscle along the accessory nerve.	Drain the nasopharynx
	Vb	Lies inferior to omohyoid muscle.	Contain nodes related to the thyrocervical trunk which drain thyroid gland.
6.	Level VI	Anterior or central group of nodes. This includes the paratracheal,perithyroid, perithyroid and delphian nodes.	These nodes are at greatest risk for harboring metastases from cancers arising from the thyroid gland, glottic and subglottic larynx, apex of the piriform sinus, and cervical esophagus.
7.	Level VII	This corresponds to superior mediastinal tissue.	

Definition of Lymphadenopathy:

Lymphadenopathy can be defined as LNs that are abnormal in size, consistency or number.2 fortunately, the majority of patients presenting with peripheral lymphadenopathy have easily identifiable causes that are benign or self-limiting.

There are two types of Lymphadenopathy. They are-

1. Localized lymphadenopathy - if only one group of LN involved.
2. Generalized lymphadenopathy- is the enlargement of more than three noncontiguous lymph node regions (i.e. cervical and axillary) and is the result of systemic disease.

Cervical lymphadenopathy is commonest lymphadenopathy encountered in clinical practice. It is usually defined as presence of cervical lymph node measuring more than 1 cm. Pandey A et al (2012).[25]

A pathological or abnormal lymph node is commonly quoted to be > 1 cm however in the pediatric population >2cm is considered abnormal.[26]

Cervical lymphadenitis is defined as enlarged, inflamed, and tender lymph node(s) of the neck. Cervical lymphadenopathy refers simply to enlarged lymph node(s) of the neck. However, the two terms often are used interchangeably.

Based on duration cervical lymphadenopathy is further classified as

1. Acute lymphadenopathy: 2 weeks duration.
2. Subacute lymphadenopathy: 2- 6 weeks duration.
3. Chronic lymphadenopathy: Any cervical lymphadenopathy that does not resolve by 6 weeks.(Sambandan T et al).[27]

Aetiology of Cervical Lymphadenopathy:

I. Inflammatory

1. Acute lymphadenitis

(a) Non-specific

(b) Specific –e.g. Infectious mononucleosis and Cat scratch disease

2. Chronic lymphadenitis

(a) Non-specific

(b) Specific – e.g. Tuberculosis, HIV

II. Neoplastic

Malignant cervical lymphadenopathy

1. Primary – Lymphomas/ leukemia‟s
2. Secondary –Squamous cell carcinoma from larynx, pharynx, upper 1/3rd of cheek, scalp, tongue
3. Known primary. d) Occult primary.

III. Miscellaneous

- Drug induced
- Sub-acute Necrotising Lymphadenitis (Kikuchi‟s disease)

A) Chronic Non-specific Lymphadenitis[28]:

Chronic nonspecific lymphadenitis is the chronic inflammation of lymph node. This variety is also called as reactive lymphoid hyperplasia. The etiological factor can be any antigen which stimulates the lymphoid tissue. This is called as nonspecific because the histological nature of the node does not suggest the etiological factor.

This occur secondary to chronic scalp infection chronic tonsillitis and chronic tracheobronchitis.

Common infecting organisms are staphylococcus and streptococci of low grade virulence but inorganic particles like dust and carbon particles may also be causative factors. According to Boyd, over 90% of chronically inflamed nodes are seen in cervical region. The nodes are enlarged due to chronic dental sepsis, septic tonsils, chronic sinusitis and non-healing ulcers in mouth.

Pathology of lymph node: [29]

The lymph node in chronic nonspecific lymphadenitis shows following features.

1. Follicular Hyperplasia
2. Paracortical Hyperplasia
3. Sinus Histiocytosis

Incidence:

Pamra et al in (1974)[29] reported that the incidence of chronic nonspecific adenitis as 19.3% in their study of tuberculous cervical lymphadenopathy. Iqbal et al (2009)21 in their study of 220 cases of cervical lymphadenopathy found only 25 (11.3%) cases of chronic nonspecific lymphadenitis.

Pamra et al in (1974) 20 found chronic nonspecific lymphadenitis more common in 1st and 2nd decades of life.

Sex:

Darnal HK et al (2005)[29] found that male to female ratio 1:1 for chronic nonspecific lymphadenitis in his study of 344 patients.

Common Lymph node Involved:

The groups of lymph node commonly involved are submandibular, submental and jugulodiagrastic lymph nodes. Darnal HK et al (2005)22 found major histological type is follicular hyperplasia (74%) and remaining sinus histocytosis.

B) CHRONIC SPECIFIC LYMPHADENITIS:

Cervical lymphadenopathy caused by specific diseases like Tuberculosis, Syphilis, HIV etc. is grouped as chronic specific lymphadenitis.

Lymphnode Biopsy

Rather than open biopsy of a cervical lymph node, Fine needle aspiration is preferable because it is simple, quick procedure, no tumour spread and no inconvenient scar to distort future surgical intervention. Open biopsy can be done when a diagnosis of malignancy cannot be made by needle biopsy, provided it can be followed by a frozen section and a concomitant definitive neck dissection if preoperative positive histological diagnosis is obtained.[30]

Patterns of lymphatic drainage can be altered by open cervical lymph node biopsy for up to 1 year following surgery but does not result in a poor prognosis provided early and adequate treatment is subsequently given.[31,32]

It has been said that diagnosis of FNA should only be attempted when pathologist is cognizant of the details of clinical history, physical examination and results of other laboratory tests. These will compensate for the short comings of the FNA in demonstrating the architectural arrangement of the tissues than do histological sections. Clinical data serves as safe guard in interpretation of FNA and pathologist should not be biased.

The technique of fine needle aspiration biopsy has gained popularity over the past 30 years. Lesions of the head and neck region being readily accessible, are particular amenable to diagnosis by FNA. In terms of patient care, the greatest benefit of needle biopsy derives from the speed with which the reports are available, so that early diagnosis and future management can be planned within a few hours of consultation. In addition FNA is easy to perform, accurate and cost effective.

Selection of the lymph nodes to be biopsied is of great importance. Axillary or cervical nodes are more likely to be informative in cases of generalized lymphadenopathy. Whenever possible largest lymph node is biopsied.

The lymph nodes should be carefully dissected with their capsule intact and sent fresh to pathologist for histopathology. The biopsy is useful in differentiating benign from malignant lesion, Hodgkins from chronic non– specific lymphadenitis and where the FNAC results are not conclusive.

Open neck biopsy is rarely needed in case of malignancy or secondaries in the neck. There are potential problems in performing open neck biopsy in a head and neck cancer patient. Some studies have shown a worsened prognosis if neck biopsy is done. Transaction of lymphatics may be the cause of this worse prognosis. Another problem with open neck biopsy is that the focus tends to be on neck mass and not on a search for the primary tumour.

Finally subsequent neck dissection may be compromised by skin incision used for biopsy as well as by scarring which makes dissection more difficult. Therefore open biopsy should be done only where results are inconclusive even after repeat FNA.

FNA is the study of cellular samples obtained through a fine needle under negative pressure. The technique is relatively painless and inexpensive. When performed by well-trained pathologists / surgeons / clinicians and reported by experienced pathologists, it can provide unequivocal diagnosis in most of the situations.

Evaluation of Cervical Lymph Nodes by Sonography

Normal and Reactive Lymph Nodes

Cervical lymph nodes are usually classified into eight regions. Normal and reactive lymph nodes are usually found in parotid, submandibular, upper cervical and posterior triangle region. On gray-scale sonography, normal and reactive nodes appear to be hypoechoic in comparison with adjacent muscles and are oval (short axis–to–long axis ratio [S/L] < 0.5) except for parotid & submandibular nodes, which are usually round (S/L ≥ 0.5), and to have an echogenic hilus.[33] 9mm is the upper limit in minimal axial diameter of normal and reactive nodes for subdigastric and submandibular nodes and 8 mm for other cervical nodes.[34]

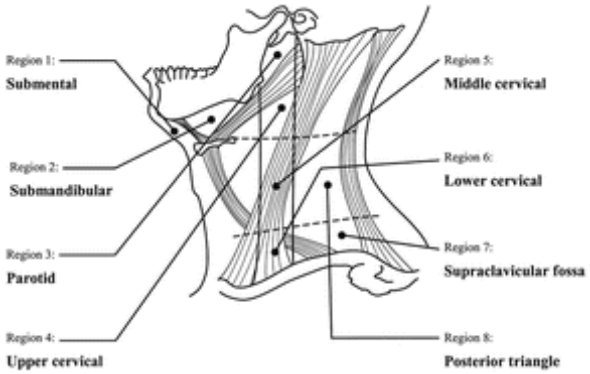


Fig 3 Schematic representation of classification of levels of cervical lymph nodes

Schematic representation of neck showing classification of levels of cervical lymph nodes in sonography examinations. Source Anil T. Ahuja and Michael Ying. Sonographic Evaluation of Cervical Lymph Nodes. American Journal of Roentgenology. 2005;184: 1691-1699.

On color Doppler, power Doppler, and 3D sonography, normal cervical nodes show hilar vascularity or appear avascular, and reactive nodes predominantly show hilar vascularity. On spectral Doppler sonography, normal and reactive nodes usually show low vascular resistance (resistive index [RI] and pulsatility index [PI]. Low vascular resistance in reactive lymph nodes can be explained as inflammation causes

increase in blood flow velocity due to vasodilatation given that high blood flow velocity is always associated with a lower vascular resistance.

Malignant Lymph Nodes

Malignant lymph nodes include metastatic and lymphomatous nodes. On grayscale sonography, metastatic nodes are usually round, hypoechoic and shows loss of central echogenic hilus. Coagulation necrosis may be found in metastatic nodes, which appears as a demarcated echogenic focus. Another useful sign to indicate focal tumor infiltration is eccentric cortical hypertrophy. Lymph nodes with cystic necrosis are suggestive of malignancy, commonly seen in metastatic nodes from squamous cell carcinoma primaries. Extracapsular spread is suspected when a proven metastatic lymph node has illdefined borders and is associated with poor prognosis. Metastatic nodes from papillary thyroid carcinoma may have punctate calcifications.[12] appear hyperechoic compared with adjacent muscles. Lymph nodes appears to be round, hypoechoic, and without echogenic hilus and tend to show intranodal reticulation[35] in cases of non-Hodgkin's and Hodgkin's lymphoma.

Metastatic and lymphomatous nodes usually show perihilar mixed vascularity on color Doppler, power Doppler and 3D ultrasonography. Malignant lymph nodes tend to have high RI and PI values[12] on spectral Doppler sonography. In metastatic nodes, tumor cells grow , spread and replace a large portion of the lymph node compressing the blood vessels within the nodes, which results in an increase in vascular resistance.

In differentiating metastatic and reactive nodes, gray-scale ultrasonography has a sensitivity of about 95% and a specificity of 83%[36]. when gray-scale sonography is equivocal, color Doppler or power Doppler ultrasonography sonography is useful essential diagnostic modality.

Tuberculous Lymph Nodes

On gray-scale ultrasonography, tubercular lymph nodes tend to be round, hypoechoic, without echogenic hilus and tend to show nodal matting, intranodal cystic necrosis and adjacent soft-tissue edema.[12] The intravascular distribution of tuberculous nodes is varied and resembles benign and malignant nodes. However, there is high incidence of intranodal cystic necrosis which displaces the vessels in tuberculous lymph nodes[37.]

Unusual Lymphadenopathy

Diseases such as Kikuchi's disease (histiocytic necrotizing lymphadenitis), Kimura's disease (eosinophilic hyperplastic lymphogranuloma), and Rosai-Dorfman disease (sinus histiocytosis with massive lymphadenopathy) may show benign and inflammatory lymphadenopathy in the neck. Kikuchi's disease is a self-limiting and benign lymphadenitis usually affecting cervical nodes. Kimura's disease is an autoimmune eosinophilic granulomatous disorder with generalized lymphadenopathy. Rosai-Dorfman disease is a rare idiopathic benign histiocytic proliferation, and massive lymphadenopathy is usually seen in the neck region with predominant sinusoidal histiocyte infiltration.

On sonography, lymph nodes in Kikuchi's and Kimura's diseases have similar appearance to that of reactive nodes, appearing hypoechoic with an echogenic hilus. Lymph nodes are usually oval in patients with Kikuchi's disease and round in patients with Kimura's disease. Lymph nodes in patients with Kimura's disease and Kikuchi's disease tend to show hilar vascularity on power Doppler sonography[38,39]. Lymph nodes appear similar to malignant nodes in patients with Rosai-Dorfman disease, which are round, hypoechoic, and without echogenic hilus (Fig. 14A). In Rosai-Dorfman disease, involved lymph nodes show peripheral or mixed vascularity[38] on

power Doppler sonography as seen in cases of malignant nodes. Because of the similarities of the sonographic appearance of these unusual lymphadenopathies with that of reactive or malignant nodes, the diagnosis is still based on histology.

GREY SCALE ULTRASOUND EVALUATION OF LYMPH NODES

Size-

Although larger nodes are seen in cases of malignancy/metastatic nodes, reactive nodes, at times can be as large as metastatic nodes. Therefore, different cut-offs of the nodal size to differentiate between reactive and metastatic nodes have been reported. Therefore, even though size of lymph node is useful for serial monitoring for progression and treatment response, nodal size alone cannot be used as a sole criteria to distinguish reactive from malignant/metastatic lymphadenopathy.

Shape –

Metastatic lymph nodes tend to be round in shape with a short to long axes ratio (S/L ratio) > 0.5, while reactive or benign lymph nodes are elliptical in shape. Even though the round shape represents a metastatic lymph node and oval shape helps to identify reactive or benign nodes, the shape of the lymph node should not be used alone as the sole criterion of nodal assessment as normal sub- mandibular and parotid nodes are also round.[40]

Metastatic lymph nodes tend to have sharp borders, while benign lymph nodes usually have unsharp borders. Increase in the acoustic impedance difference between intranodal and surrounding tissues is seen in cases of metastatic nodes due to intranodal tumor infiltration resulting in sharp border. However in advanced stages, metastatic nodes may demonstrate ill- defined borders, indicating extracapsular spread.

Echogenicity –

Metastatic lymph nodes are predominantly hypoechoic relative to the adjacent musculature. However, hyperechoic metastatic nodes are noted in cases of papillary carcinoma of the thyroid, which is believed to be due to the intranodal thyroglobulin deposition originating from primary tumor.[41]

Echogenic Hilum

The presence of a central echogenic hilum is usually considered to be a sign of benignity. Although the echogenic hilum is seen in normal anatomy of lymph nodes or reactive lymph nodes, it is also possible to see it in some cases of early nodal malignancy, because the medullary lymphatic sinuses have not been sufficiently disrupted to eradicate it. As an echogenic hilum can be seen both in normal and abnormal nodes, the sole criterion of presence/absence of an echogenic hilus should not considered in the evaluation of cervical lymph nodes.

Calcification:

Nodal calcification in metastatic nodes is generally rare, but it is commonly encountered in metastatic nodes from medullary thyriod carcinoma and papillary thyroid carcinoma.[42] Calcifications can also be found in irradiated lymphnodes or after chemotherapy.

Intranodal necrosis

Nodal necrosis is usually a late event in tumor invasion of lympnodes, and it may appear as a echogenic area (coagulation necrosis) or a cystic area (cystic necrosis). Cystic necrosis is usually seen in metastatic nodes from squamous cell carcinoma, tuberculous nodes and metastatic nodes from papillary thyroid carcinoma and appears as an echolucent area within the lymph nodes. Coagulation necrosis may

be found in both malignant and inflammatory nodes[12] and appears as an echogenic focus within the lymph nodes on ultrasonography.

Other features

Matting and adjacent soft tissue edema are ancillary features that help in ultrasound evaluation of cervical lymphadenopathy. As lymph node matting is common in TB, it is an useful distinguishing feature of tuberculosis from other diseases/ conditions affecting lymph nodes. Adjacent soft tissue edema produced either due to tumor infiltration or as an inflammatory response to adjacent disease.is usually seen in metastatic and granulomatous lymph nodes.

Color Doppler US has also been used as an important tool in differentiating benign and malignant/metastatic lymphnodes. Normal and reactive lymph nodes tend to show hilar vascularity or appear apparently avascular.[43] However peripheral or mixed (presence of both peripheral and hilar) vascularity is seen in metastatic nodes and also common in lymphomatous nodes. Presence of peripheral vascularity, irrespective of the presence of hilar vascularity is highly suggestive of malignancy. Tumour angiogenesis and desmoplastic reaction or recruitment of capsular vessels [44,45] is seen in malignant lymph nodes which results in the vascular changes in malignant nodes. The vascular pattern of tuberculous nodes varies on Doppler sonography, and simulates both benign and malignant conditions.[46]

Elastography is technique in sonography that can provide additional information about tissue stiffness that was previously not available which can aid differentiate between benign and malignant lesions.

PRINCIPLES OF ELASTOGRAPHY

To understand the physics behind sonoelastography, knowledge of few terminologies is essential.

Stress-

Stress is defined as force per unit area. Unit of stress is Pascal or pounds per square inch. Stress can be due to compression which acts perpendicular to the surface and causes shortening of the object. Sheer stress acts parallel to the surface and causes deformation.

Strain-

Strain is defined as the spatial rate of change of displacement when an object is com- pressed by external force. Longitudinal strain like compression causes change in the length of the object. Shear strain causes changes in the angles.

Elasticity-

Property of materials to return back to its original form after stress is removed is known as elasticity. Elastic materials strain immediately when stressed and also return back to their original position.

Hooke's law states that stress is proportional to the strain within an objects limit.

Young's modulus

is the ration of stress over strain and has the same unit as stress. Young's modulus measures tissue's resistance to compression. Softer tissues like fat undergo more deformation when stress is applied. Harder tissues like muscle and fibrous tissue resist strain and thus have a higher Young's modulus.

Poisson's ratio-

poisons ratio is the ratio of lateral contraction per unit breadth to longitudinal extension per unit length. Poisson's ratio for normal soft tissue is 0.5.

Shear Modulus-

Shear Modulus or modulus of rigidity is a ratio between shear stress and shear strain.

TYPES OF ELASTOGRAPHY

In elastography stress can be applied exogenously by transducer compression, vibrators or acoustic radiation force.

Elasticity evaluation modes currently used are

1) Strain elastography(Compression elastography)
2) Shear wave elastography(SWE)

MULTIDETECTOR CT (MDCT): Lymph node imaging

Technique

Computed tomography (CT) is performed with the patient in supine position and quiet respiration.[47-50] Mild hyperextension of the neck by placing a pad beneath the patients scapulae provides images 90^{o} to the long axis of the neck and therefore minimizes dental artifacts. Scans are obtained using 3–5 mm or thinner continious slices. Multidetector CT (MDCT) affords optimal imaging in a single breath-hold, minimizing misregistration and maximizing contrast enhancement which provides improved visualization of small anatomic structures. For studying the enhancement of vascular structures, intravenous contrast material is a prerequisite. Its use helps in differentiation lymph nodes from vessels and pathology characterization.

The neck is divided into two spaces according to the classic surgical approach into the anterior and posterior triangles. The anterior triangle contains hypopharynx, larynx, trachea, esophagus, thyroid, parathyroid and salivary glands as well as the carotid sheath, lymph nodes and nerves. Anterior triangle is superiorly bordered by the mandible and posterolaterally by the sternocleidomastoid muscle. The anterior

triangle is subdivided into suprahyoid and infrahyoid portions by the hyoid bone. The suprahyoid portion contains submandibular and sublingual salivary glands and associated nodes and it provides support for the floor of the mouth. The infrahyoid portion contains the remaining components. The posterior triangle is anteriorly bounded by sternocleidomastoid muscle and by the trapezius posteriorly. The space includes the hypoglossal nerve, vessels, and nodes and is primarily filled with fat tissue.

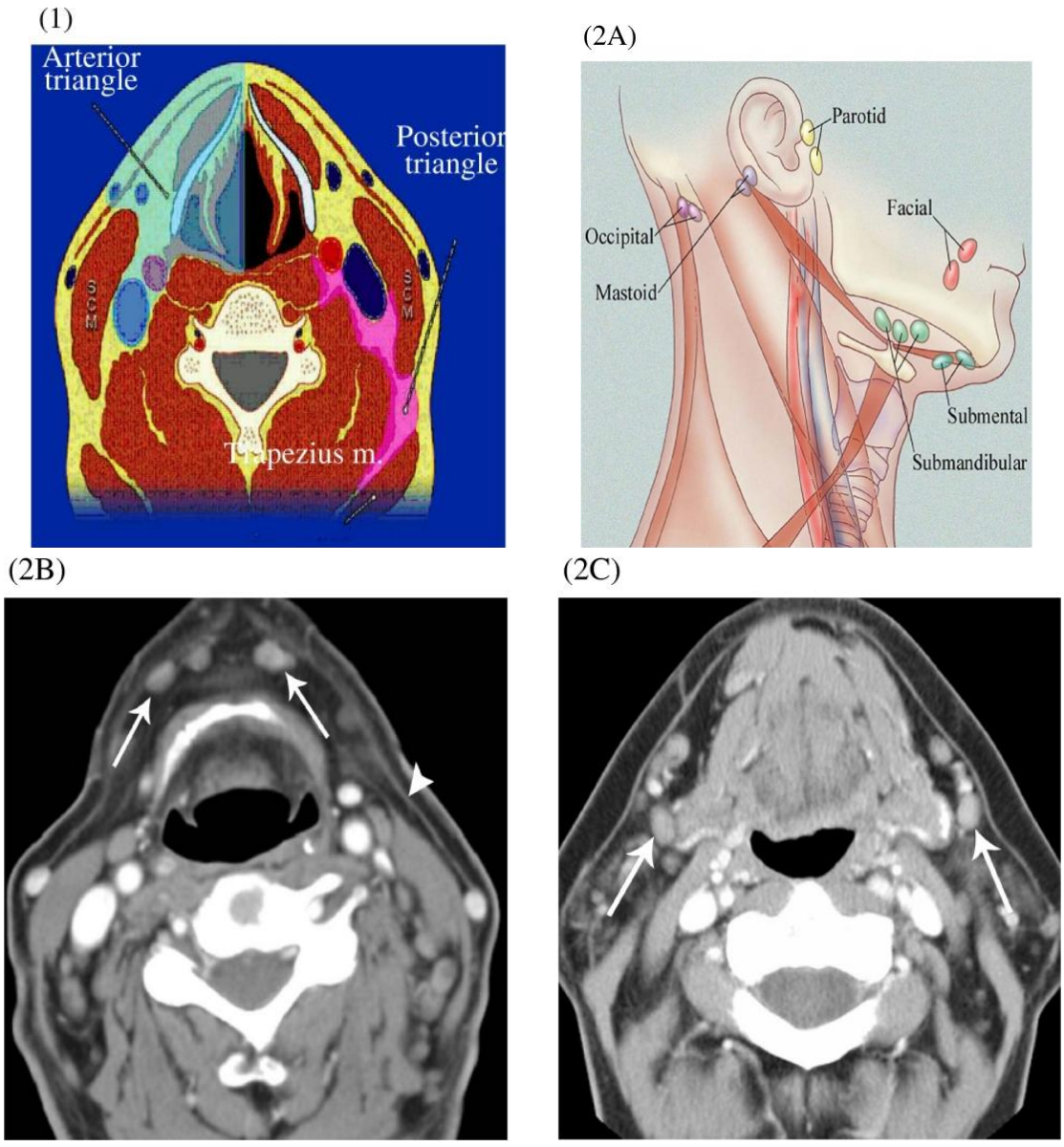


Fig 4. MDCT technique of cervical lymph node imaging.

(1) Cross-sectional diagram showing anterior and posterior triangles of the neck. (2) (A) Collar nodes. There are six (I–VI) major nodal groups at the junction of the head and neck. The anterior group consists of the facial, submental, and submandibular nodes and the posterior group consists of the carotid, mastoid and occipital group. They form a collar of rather superficial nodes. (B) CT section at the level of the hyoid bone. Multiple non-specific submental nodes (arrow) deep to the platysmal muscle (arrowhead). (C) Scattered submandibular sub-centimeter nonspecific nodes seen lateral to the submandibular glands (arrows).

Normal lymph nodes of the neck

The location of the various lymph node groups of the neck is most clearly understood using a simplification of the Rouviere classification.[51] For staging tumor extent, the nodal classification is very important. Lymph nodes of the neck may be divided into 10 major groups.[52-64]

The first six groups (I–VI) are usually accessible to palpation on physical examination as they are are quite superficial and are commonly adressed to as collar nodes: occipital, mastoid, parotid, submandibular, submental and facial.

Two groups of nodes lie deep within this lymphoid collar and are not accessible to clinical examination. Pathologic enlargement (>1.5 cm) allows detection. These nodes—groups VII, sublingual, and VIII, retropharyngeal—are often the site of metastases from carcinoma of the nasopharynx, the base of the tongue and the tonsils.

The anterior cervical group (IX) consists of superficial and deep components. Primary tumors in the thyroid, larynx and lung metastatize to these nodes.

The lateral cervical nodes (group X) are also composed of superficial and deep chains. This important deep group of nodes consists of three chains that form a

triangle. The anterior portion is the internal jugular chain, the posterior portion is the spinal accessory chain, and the inferior component is the transverse cervical chain. Of these groups, the most important in staging head and neck tumors are the nodes along the internal jugular chain.

TABLE NO. 2 1997 AJCC NODAL (N) STAGING SYSTEMS FOR CERVICAL LYMPH NODES

Level	**Classification criteria**
NX	The regional lymph nodes cannot be clinically assessed.
N0	No presence of regional metastatic lymph nodes
N1	Single ipsilateral lymph node metastasis less than or equal to 3 cm in greatest dimension
N2	Single ipsilateral lymph node metastasis that is between 3 and 6 cm in greatest dimension; multiple ipsilateral
	lymph nodes, not greater than 6 cm in greatest dimension; or bilateral or contralateral lymph nodes, none of
	which are greater than 6 cm in greatest dimension
N2a	Single ipsilateral lymph node metastasis with greatest dimension between 3 and 6 cm
N2b	Multiple ipsilateral lymph nodes, not greater than 6 cm in greatest dimension
N2c	Contralateral or bilateral lymph nodes, not greater than 6 cm in greatest dimension
N3	Lymph nodes metastasis more than 6 cm in greatest dimension

Imaging-based classification for abnormal nodes

An imaging-based nodal classification for the evaluation of metastatic neck adenopathy was produced recently based on the results of a study. To create a nodal classification, imaging landmarks were identified similar to that of the American Joint Committee on Cancer and the American Academy of Otolaryngology—Head and

Neck Surgery.[58,64-69] . As the Imaging identifies clinically silent nodes, it was chosen as a pivotal study. A roman numeral is used to define the levels referenced to anatomic names, such as supraclavicular, retropharyngeal, carotid, facial, occipital, postauricular, and other superficial nodes; these anatomic terms are still widely used. Improved precision and reproducibility to the staging of head and neck diseases.is produced by this classification.

TABLE NO.3 CLINICAL CLASSIFICATION OF NECK LYMPH NODES

t	**Definition of nodes**
I	Above hyoid bone
	Below mylohyoid muscle
	Anterior to back of submandibular gland
IA	Between medial margins of anterior bellies of digastric muscles
	Previously classified as submental nodes
IB	Posterolateral to level IA nodes
	Previously classified as submandibular nodes
II	From Skull base to level of lower body of hyoid bone
	Posterior to back of submandibular gland
	Anterior to back of sternocleidomastoid muscle
IIA	Anterior, lateral, medial, or posterior to internal jugular vein
	Inseparable from internal jugular vein (if posterior to vein)
	Previously classified as upper internal jugular nodes
IIB	Posterior to internal jugular vein with pat plane separating nodes and vein
	Previously classified as upper spinal accessory nodes
III	From level of lower body of hyoid bone to level of lower cricoid cartilage arch

t	**Definition of nodes**
	Anterior to back of sternocleidomastoid muscle
	Previously known as mid jugular nodes
IV	From level of lower cricoid cartilage arch to level of clavicle
	Anterior to line connecting back of sternocleidomastoid muscle and posterolateral margin of anterior scalene muscle
	Lateral to carotid arteries
	Previously known as low jugular nodes
V	Posterior to back of sternocleidomastoid muscle from skull base to level of lower cricoid arch
	From level of lower cricoid arch to level of clavicle as seen on each axial scan
	Posterior to line connecting back of sternocleidomastoid muscle and posterolateral margin of anterior scalene muscle
	Anterior to anterior edge of trapezius muscle
VA	From skull base to level of bottom of cricoid cartilage arch
	Posterior to back of sternocleidomastoid muscle
	Previously known as upper level V nodes
VB	From level of lower cricoid arch to level of clavicle as seen on each axial scan
	Posterior to line connecting back of sternocleidomastoid muscle and posterolateral margin of anterior scalene muscle
	Previously known as lower level V nodes
VI	Between carotid arteries from level of lower body of hyoid bone to level superior to top of manubrium
	Previously known as visceral nodes
VII	Between carotid arteries below level of top of manubrium
	Caudal to level of innominate vein

t	Definition of nodes
	Previously known as superior mediastinal nodes
Supraclavicular	At or caudal to level of clavicle as seen on each axial scan
	Above and medial to ribs
Retropharyngeal	Within 2 cm of skull base and medial to internal carotid arteries

Nodal disease

In patients with head and neck malignancies, clinical examination alone is not accurate in staging nodal disease. Therefore,in patients with occult metastases, prophylactic X-ray therapy can be used.

On high-quality scans, normal neck lymphnodes may be identified. So criteria to define lymphadenopathy have been established:

1. a discrete mass great than 1.0–1.5 cm;
2. an ill-defined mass in a lymph node area;
3. multiple nodes of 6–15 mm; and
4. obliteration of tissue planes around vessels in a nonirradiated neck. A nodal mass with central low density is specifically indicative of tumor necrosis.[51-54]

Less commonly, primary neoplasms (fibroma, sarcoma),neurovascular tumors (paraganglioma, neurofibroma, hemangioma), trauma (hematoma), congenital lesions (teratoma, ectopic thyroid), lesions of the bone (plasmacytoma, aneurysmal bone cyst), and infection constitute the nonnodal solid masses. Specific imaging features aid the differential diagnosis. Masses occuring in the carotid space and consistently showing early and persistently dense enhancement indicates carotid body tumor (paragangliomas). An intrinsically high CT attenuation and high intensity on T1-weighted magnetic resonance (MR) imaging are characteristics of acute hematomas.

Metastases are located in the expected site of the major lymph node chains of the neck.

In summary, careful analysis of nodes in the neck and knowledge of the various compartments is critical in the assessment and staging of primary head and neck malignancies.

Cervical nodes classification system

Rouviere classified cervical nodes into a collar of nodes surrounding the upper aerodigestive tract (submental, facial, submandibular, parotid, mastoid, occipital and retropharyngeal) and two groups along the long axis of the neck (anterior cervical and postero-lateral cervical groups).[70] Surgeons, however, make use of the simplified level system advocated by Shah et al. at the Memorial Sloan-Kettering Cancer Center, New York.[64,71]

TABLE NO. 4 SIMPLIFIED NUMERICAL CLASSIFICATION SYSTEM

Level	**Location**
IA	Submental lymph nodes
IB	Submandibular lymph nodes
II	Internal jugular (deep cervical) chain from the base of the skull to the inferior border of the hyoid bone
III	Internal jugular (deep cervical) chain from the hyoid bone to the inferior border of the cricoid arch
IV	Internal jugular (deep cervical) chain between the inferior border of the cricoid arch and the supraclavicular fossa
V	Posterior triangle or spinal accessory nodes
VI	Central compartment nodes from the hyoid bone to the suprasternal notch
VII	Nodes inferior to the suprasternal notch in the upper mediastinum

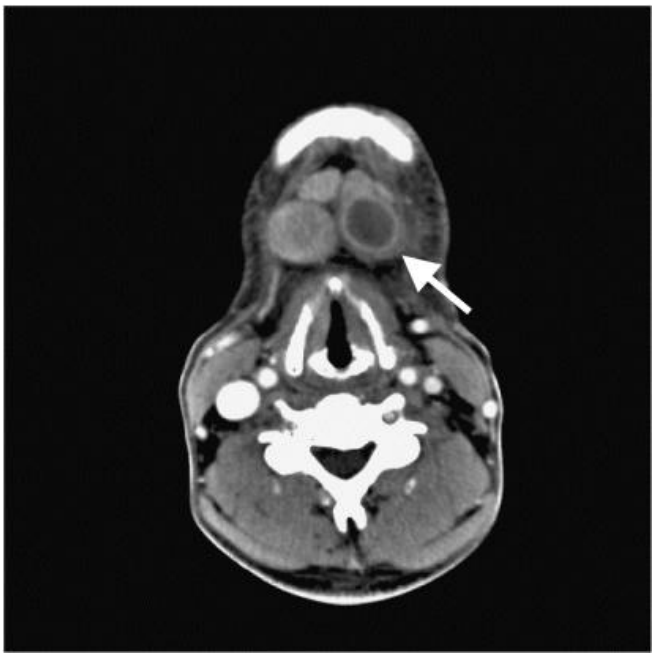


Fig 5 .CECT showing multiple enlarged submental nodes. The presence of nodal necrosis is indicated by arrow.

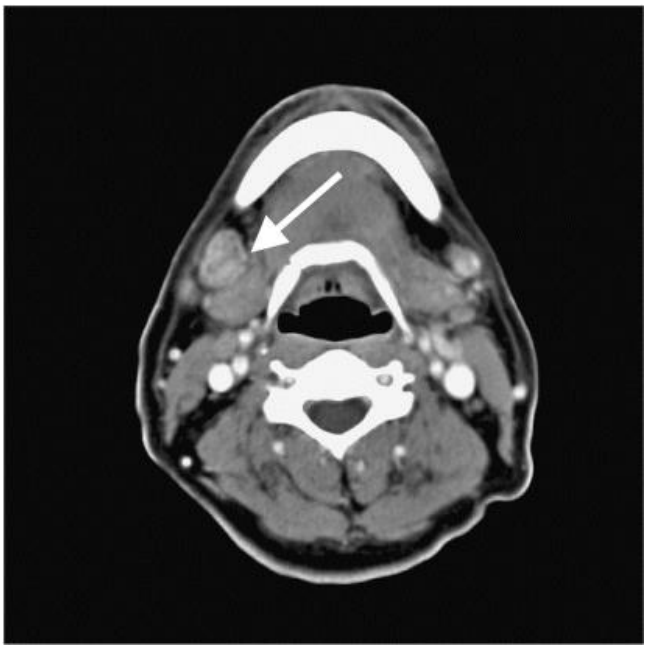


Fig 6.CECT shows an enlarged right submandibular (Group IB) lymph node indicated by arrow.

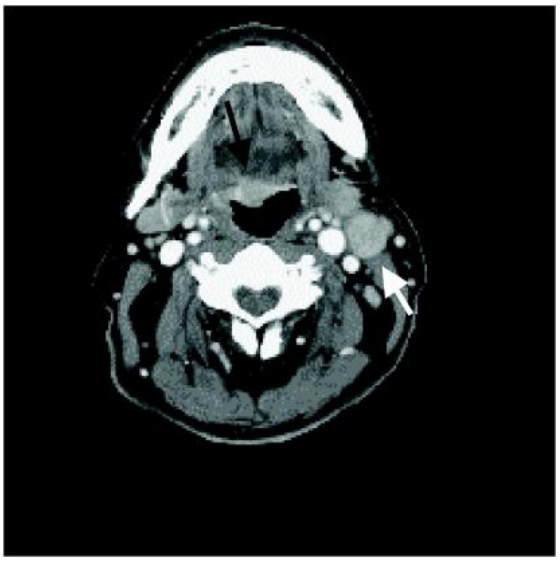


Fig 7.CECT shows left level II lymphadenopathy (internal jugular nodes) above the level of the hyoid bone. Note the carcinoma (black arrow) in the tongue base.

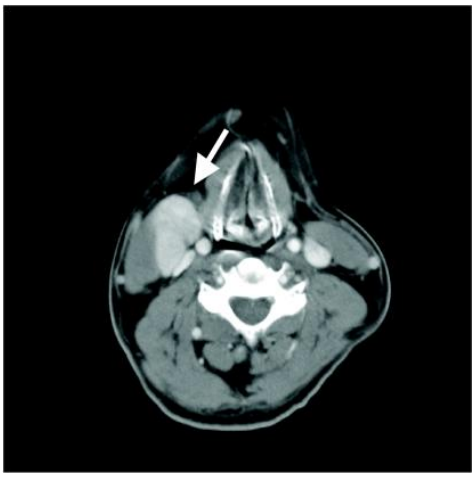


Fig 8.CECT showing a intensly enhancing right enlarged level III node (arrow). located between the hyoid bone and cricoid cartilage.

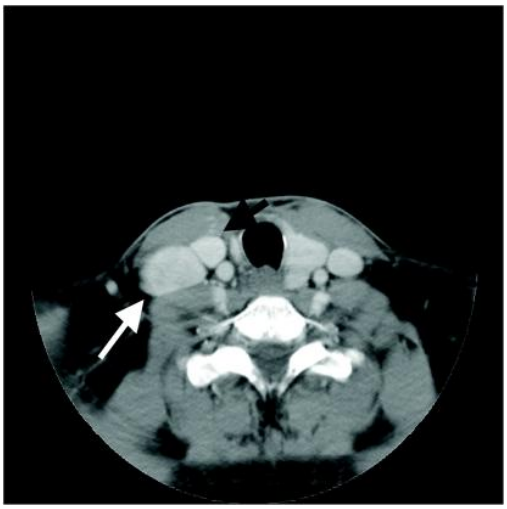


Fig 9.CECT showing a right enlarged level IV lymph node mimicking a vessel. Note the previous resected right thyroid lobe because of papillary carcinoma and the jugular vein (black arrow).

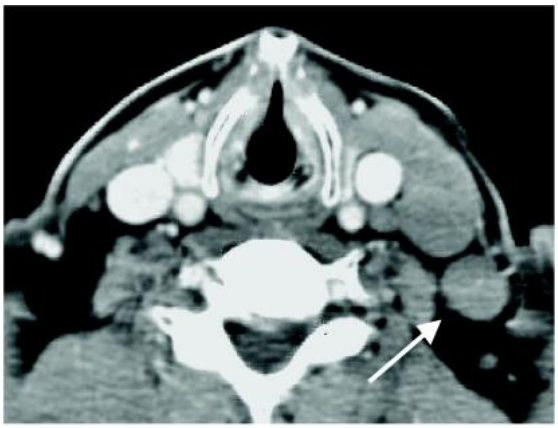


Fig 10.CECT showing an enlarged level V (arrow). Level V nodes are located in the posterior triangle seen posterior to the posterior margin of the sternocleidomastoid muscle.

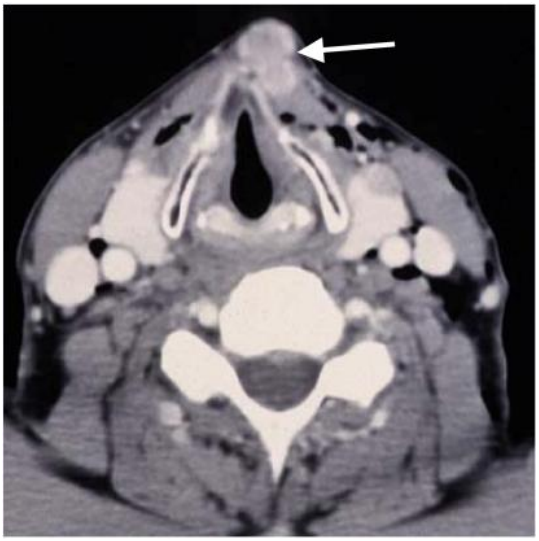


Fig 11.CECT showing enlargement of level VI nodes (arrow). Level VI nodes (located anteriorly and centrally) are found adjacent to the thyroid gland, thyroid cartilage, larynx and oesophagus.

The facial, parotid, mastoid, occipital and retropharyngeal are not included in the simplified level classification system because the level system was first introduced within the framework of neck dissection and these nodes are not normally included in the surgical procedure.

Clinical significance of metastatic cervical lymphadenopathy

Single most important prognostic factor in squamous cell carcinoma (SCC) of the head and neck is nodal metastasis, the presence of which denotes poor prognosis. Extracapsular spread is another worsening prognostic factor. The level of nodal metastasis, and the number and size of nodes are also significant and these factors correlate with distant metastasis.[72-75]

Imaging cervical nodes

Nodes larger than 10 mm are conventionally considered abnormal. However, 20% of nodes larger than 10 mm has no metastatic deposits and show only hyperplasia histologically. On the other hand, 23% of nodes showing extracapsular

spread measure less than 10 mm.[54] Irrespective of size, the presence of nodal necrosis points towards metastatic involvement.

Nodal necrosis may be confused in two conditions. Firstly, on computed tomography (CT), fat deposition may produce a low attenuation focus in the suspected node. Because of partial volume averaging, density measurements are of limited value in small lesions. The location of the low attenuation focus is important because fat is usually deposited around the hilum and necrosis is generally central. Secondly, suppurative nodes frequently show central low attenuation areas indicating the pus formation. The presence of inflammation around these nodes produce irregular and ill-defined margins.

Extracapsular spread is common with all metastatic nodes. About 60% of all metastatic nodes show extracapsular spread. When the nodes appear matted or the nodal outline appears streaky extracapsular spread is likely. Imaging is not very sensitive and approximately 45% of all histologically verified nodes with extracapsular spread are not seen on CT.[54]

The role of imaging

The main roles of imaging are

1. To confirm the N0 status of the neck,
2. To document lymphadenopathy,
3. To assess the regional extent of disease and relation to neurovascular structures, &
4. Follow-up for nodal surveillance.

One of the greatest challenges in the management of lymph nodal metastasis is the issue of clinical N0 disease. Very high rates of occult metastasis are seen in some primary lesions (oral cavity 41%; oropharynx 36%; hypopharynx 36%; and

supraglottic tumours 29%).[76] Most surgeons will perform elective neck dissection if there is more than a 20% chance of occult metastasis. In these patients, neck dissection will be done when the primary lesion is excised even if imaging shows no lymphadenopathy.

Malignancies originating from the parotid gland, maxillary sinus or glottic carcinomas are examples of other primary sites with low occult metastatic disease rates (typically less than a 5% chance of having occult metastasis). These patients will be spared neck dissection if the lymph nodes are not radiologically enlarged.

Extracapsular spread invading the carotid sheath renders the patient a non-surgical candidate. Due of high mortality and morbidity rates, most surgeons will not operate when involvement of carotid artery is present. Therefore, detection of involvement of carotid artery is of crucial importance. The accuracy of imaging is disappointing with respect to this. A large area of contact between a nodal mass and the carotid artery on imaging studies proves negative for invasion during surgery. On the other hand, some patients with small areas of contact on imaging were found to have invasion of adventitial layer. Yousem et al. reported that the presence of more than 270^0 of circumferential involvement of the carotid artery was highly suggestive of unresectability.[77]

In the follow-up of patients, imaging plays a very important role. The indurated soft tissues following surgery or radiation therapy or both, make neck palpation difficult. Hence imaging helps in identifying the enlarged nodes easily, especially when serial follow-up studies detect nodal enlargement before it becomes palpable.

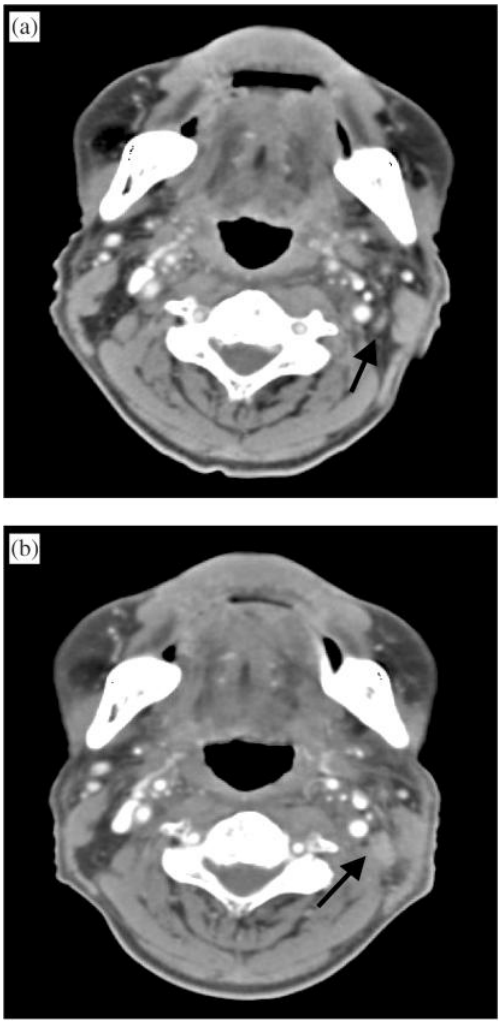


Fig 12 (a) Contrast-enhanced CT shows no significant cervical lymphadenopathy following neck irradiation for nasopharyngeal cancer. Note the innocuous looking lymph node (arrow). (b) Follow-up (1 year later) shows definite enlargement of cervical node (arrow). The node was not palpable because of its size, its location beneath the sternocleidomastoid muscle and the irradiation-induced neck induration.

In summary, radiologists should be familiar with the anatomical distribution of cervical nodes and Imaging reports should therefore document lymphadenopathy using a common classification system to facilitate communication. Radiologists should also be familiar with prognostic implications of nodal metastasis, the limitations of imaging and their role in the detection of lymphadenopathy.

Pratap V et al[78] in 2013 evaluated palpable neck masses with US and CT, and also compared their efficacy. The authors found on examination distribution of lesions was found to be Inflamatory-17.5%, Developmental- 7.5%, Thyroid masses-30%, Mesenchymal-10%, Neural 5%, Vascular-5%, Bone5%, Lymph nodes-10%, & Salivary gland mass-10%. 2. The Male to Female ratio in the present study = 1.22:1 The authors concluded that Ultrasound complimented coupled with Computed Tomography is of immense help in the diagnosis and better management of palpable neck masses.

Thakkar DK et al[79] in 2015 evaluated the role of MDCT for the detection and characterization of various neck lesions and characterization of lymph nodes as benign or malignant. The authors found male preponderance (66%), with females accounting for 34% of total cases. 34/100 (34%) were of malignant etiology, 24 (24%) were of benign etiology, 33(33%) inflammatory etiology, 6(6%) were congenital and 3(3%) were of vascular etiology. The main differentiating features between benign and malignant lesions were well-defined margins and fat plane for benign lesions. Cystic hygroma (3/6=50%) was most common congenital lesions, IJV thrombosis (2/3=66.67%) in vascular lesions, retropharyngeal abscess (6/33=18.18%) in inflammatory lesions. Goiter (5/24=20.83%) predominated followed by parathyroid adenoma (4/24=16.67%) in benign lesions. In malignant etiology, metastatic lymph nodes were seen in (7/34=20.58%), primary malignancy could be detected in 24/34 (70.58%) cases. Visceral space (31%) was the most commonly involved neck space. The CT imaging diagnosis was confirmed with biopsy, FNAC, surgery, or by pathognomic imaging findings on contrast enhanced CT. The authors concluded that

MDCT proved to be a very useful non- invasive tool in accurately diagnosing and characterizing neck lesions.

MATERIAL AND METHODS

A hospital based prospective observational study was done at our tertiary care centre on patients presenting with neck masses or with clinical suspected cases of cervical lymphadenopathy in **B.L.D.E.U's Shri. B.M. Patil Medical College Hospital and Research Centre, Vijayapur.**

Study design: A hospital based prospective observational study

Study Duration: 1 year

Study area:

The study was done at our tertiary care in the Department of Radiodiagnosis, B.L.D.E.U's Shri. B.M. Patil Medical College Hospital and Research Centre, Vijayapur.

Study population:

30 patients on patients presenting with neck masses or with clinical suspected cases of cervical lymphadenopathy in the Department of Radiodiagnosis, B.L.D.E.U's Shri. B.M. Patil Medical College Hospital and Research Centre, Vijayapur who fulfilled the inclusion criteria.

Sample size: 30 patients

Inclusion criteria:

Patients who have presented with

- Clinically palpable neck swelling
- Symptomatic presentation.
- Known cases of malignancies.

Exclusion criteria:

- Post operative patients.
- Patients with contraindications to intravenous administration to contrast medium.
- Pregnant females

METHODOLOGY

The study was done in the Department of Radiodiagnosis, of our college after due permission from the Institutional Ethics Committee and Review Board and after taking written Informed Consent from the patients.

After approval from the Institutional Ethical Committee, valid informed consent was taken. Once the patients were enrolled for the study, a thorough history and physical examination was done as per proforma. An informed consent was taken in written from patients or patient's attendant.

Patients with eligible inclusion criteria are considered and will undergo following method of procedures.

30 cases are intended to be taken up within the study period.

All patients included in the study will undergo ultrasonography of neck with high frequency (12 to 3 MHz).

The machines which will be used in the study are SIEMENS ACUSON X700 and PHILIPS HD11-XE.

32 slice Siemen's MDCT machine is used with IV contrast calculated as per kg weight.

Images are acquired with a section thickness of 2.0–2.5 mm and a reconstruction interval of 1.0–1.5 mm.

Common ultrasound scan planes used in the examination of cervical nodes in different regions of the neck.

Submental	Transverse
Submandibular	Transverse
Parotid	Transverse and longitudinal
Upper cervical	Transverse

Middle cervical	Transverse
Lower cervical	Transverse
Supraclavicular fossa	Transverse
Posterior triangle	Transverse and longitudinal

The criteria followed to differentiate various pathologies of lymph nodes:

- **RELEVANT EXAMINATION FINDINGS**:

  Palpation of lymph nodes for

  Size

  Location

  Consistency.

  Number

  Mobility

  Presence of any local changes like redness, discharge or sinus formation.

- **RADIOLOGICAL FINDINGS :**

B scan criteria criterion

Size

Shape

Hilum

Echogenicity

Margins

Structural changes

– focal cortical nodules

– intranodal necrosis

– reticulation

– calcification

– matting

Soft tissue edema

Doppler criteria

Flow

Vessel location

Vascular pedicles

Vascular pattern

CT SCAN CRITERIA

Size

Shape

Extent

Margins

Enhancement pattern

Structural changes

Reactive and tubercular lymph nodes are included under non-neoplastic etiology. Lymph nodes which are oval in shape, presence of central echogenic hilum, homogenous echotexture, L/S ratio >2, and presence of hilar vascularity were considered as reactive lymphadenopathy.

Hypoechoic nodes, round in shape with loss of echogenic hilum, intranodal necrosis, nodal matting and adjacent soft tissue edema were considered tubercular lymphadenitis.

Round shape, absence of echogenic hilum, heterogenous echotexture, sharp borders, L/S ratio <2, peripheral or mixed pattern of nodal vascularity, displacement of nodal vessels, and focal absence of perfusion were considered in detecting neoplastic lymph nodes.

MDCT

Imaging was done during quiet breathing. Puffed cheek technique was used to outline gingivobuccal sulcus in suspected cases of Ca buccal mucosa. Valsalva's maneuver with phonation was use to distend pyriform sinuses. Region from skull base to clavicles was covered during non contrast and contrast enhanced CTscan. Parameters used were– patient position being 'head first supine'; scan type was axial/helical; table speed = 81.2 mm/sec; scan length depending on area covered; scan time being 5-6 secs; collimation = 64 x 0.625 mms; slice thickness = 3mms; pitch = 1.026; rotation time = 0.50 secs; field of view = 250-300 mms; voltage = 120 kVs; current = 160-180 mAs; Image matrix = 512 x 512; CT does length volume (CTDLVol) = 5.4 mGys.

The CT findings were analyzed for location, margins of the lesion, density on plain study, enhancement pattern, presence of calcification and necrosis, extension into adjoining structures, presence or absence of vascular and bone involvement and presence or absence of metastasis in malignant lesions.

STATISTICAL ANALYSIS

Quantitative data is presented with the help of Mean and Standard deviation. Comparison among the study groups is done with the help of unpaired t test as per results of normality test. Qualitative data is presented with the help of frequency and percentage table. Association among the study groups is assessed with the help of Fisher test, student 't' test and Chi-Square test. 'p' value less than 0.05 is taken as significant**.**

Pearson's chi-squared test-

$$\mathrm{X}^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

Where X2 = Pearson's cumulative test statistic.

Oi = an observed frequency;

Ei = an expected frequency, asserted by the null hypothesis;

n = the number of cells in the table.

The following statistical significance tests would be applied:

1. T test were used to compare two independent groups of continuous data.
2. The “Chi square test” were used to compare categorical data.
3. Test of significance for difference of proportions “|Z|- Test”
4. For finding correlation coefficient “Karl Pearson Correlation Coefficient” was used.
5. 2×2 diagnostic table were used for calculating sensitivity, specificity, positive predictive value, negative predictive value, etc.

Finally the calculated valuewere compared with the tabulated value at particular degree of freedom and find the level of significance. A “p-value” is considered non-significant if >0.05 and significant if < 0.05. The results were presented in terms of sensitivity, specificity, predictive values, and accuracy. P value was estimated using Fisher's exact test.

Results were graphically represented where deemed necessary.

Appropriate statistical software, including but not restricted to MS Excel, SPSS ver. 20 will be used for statistical analysis. Graphical representation will be done in MS Excel 2010.

OBSERVATIONS AND RESULTS

TABLE 5: DISTRIBUTION OF CASES ACCORDING TO AGE

Most of the study population were from age group 21 to 40 years (30%) and 41 to 60 years (30%). The mean age was 39.47 ±20.59 years.

AGE (YRS)	N	%
≤20	7	23.3
21-40	9	30
41-60	9	30
61-80	5	16.7
TOTAL	30	100

	Min	Max	Mean	SD
AGE (yrs)	6	75	39.47	20.59

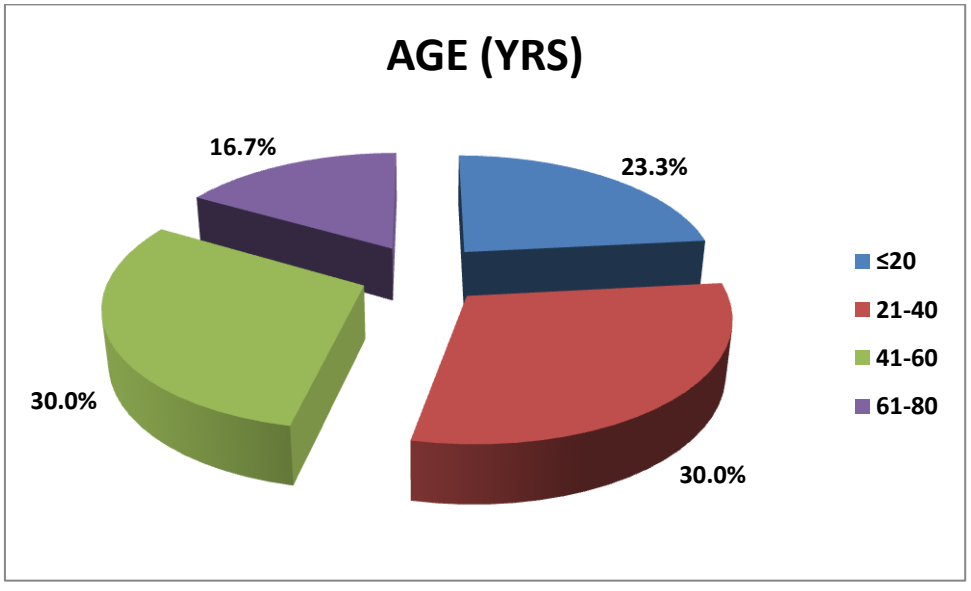


Fig 13: DISTRIBUTION OF CASES ACCORDING TO AGE

TABLE 6: DISTRIBUTION OF CASES ACCORDING TO SEX

Most of the cases were female (66.7%) while males were 33.3%. Ratio of male: Female was 1:2

SEX	N	%
MALE	10	33.3
FEMALE	20	66.7
TOTAL	30	100

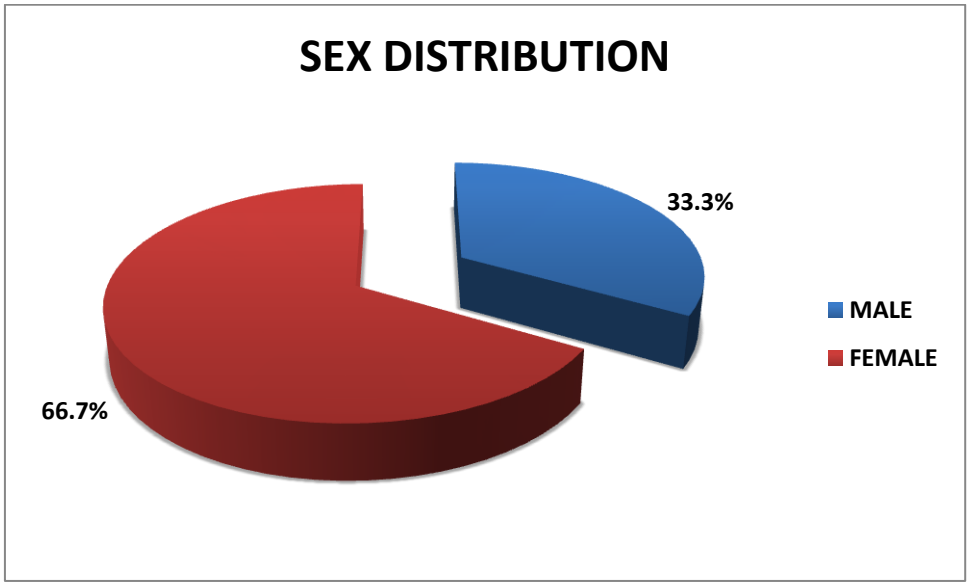


Fig 14: DISTRIBUTION OF CASES ACCORDING TO SEX

TABLE 7: ASSOCIATION OF AGE AND SEX

No significant association was found between age and gender of cases. 30% females of age group less than 20 years and 30% of females of age group 21 to 40 years had pathologies of cervical lymphadenopathy.

Age (yrs)	MALE		FEMALE		p value
	N	%	N	%	
≤20	1	10.0%	6	30.0%	0.627
21-40	3	30.0%	6	30.0%	
41-60	4	40.0%	5	25.0%	
61-80	2	20.0%	3	15.0%	
Total	10	100.0%	20	100.0%	

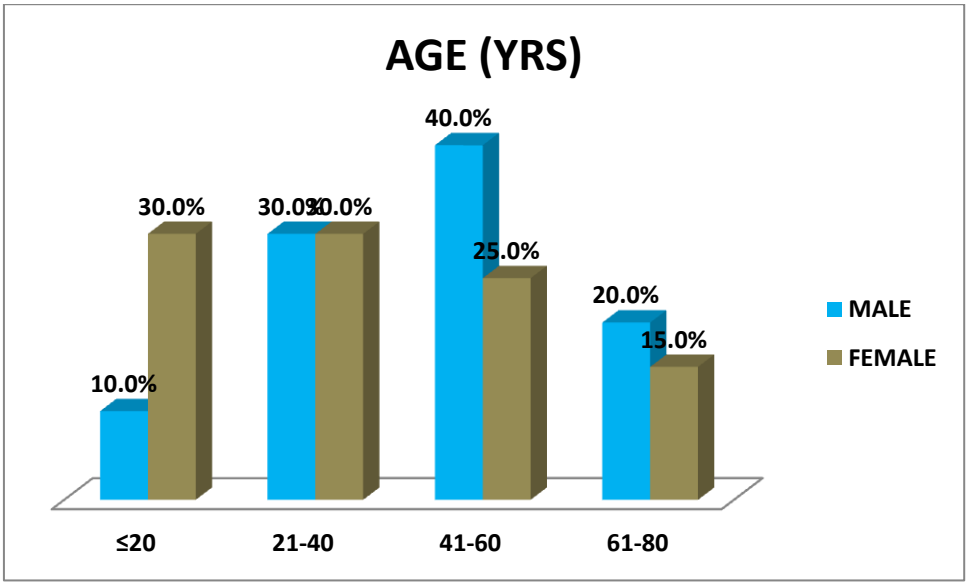


Fig 15: ASSOCIATION OF AGE AND SEX

TABLE 8: DISTRIBUTION OF LOCATION ACCORDING TO USG

According to USG most of the cases had cervical lymphadenopathy pathologies at level III (90%) followed by 76.7% at level II, and 70 % at level IV,

LOCATION	N	%
I	14	46.7
II	23	76.7
III	27	90.0
IV	21	70.0
V	11	36.7
VI	0	0.0
VII	0	0.0

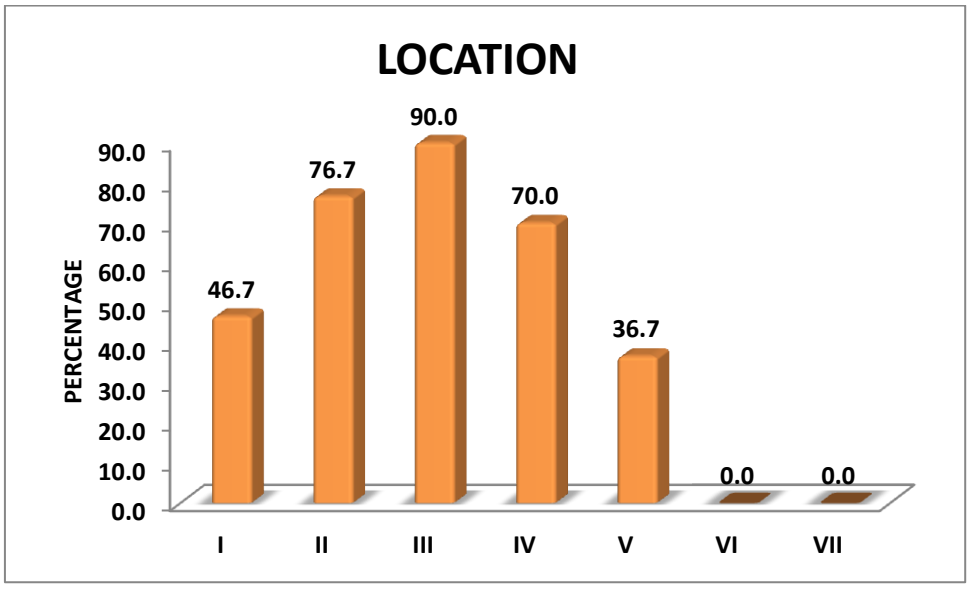


Fig 16: DISTRIBUTION OF LOCATION ACCORDING TO USG

TABLE 9: DISTRIBUTION OF SHAPE & NUMBER ACCORDING TO USG

According to USG most of the cervical lymphadenopathy pathologies were having oval shape (70%) followed by round (16.7%)

SHAPE & NUMBER	N	%
IRREGULAR	4	13.3
OVAL	21	70
ROUND	5	16.7
TOTAL	30	100

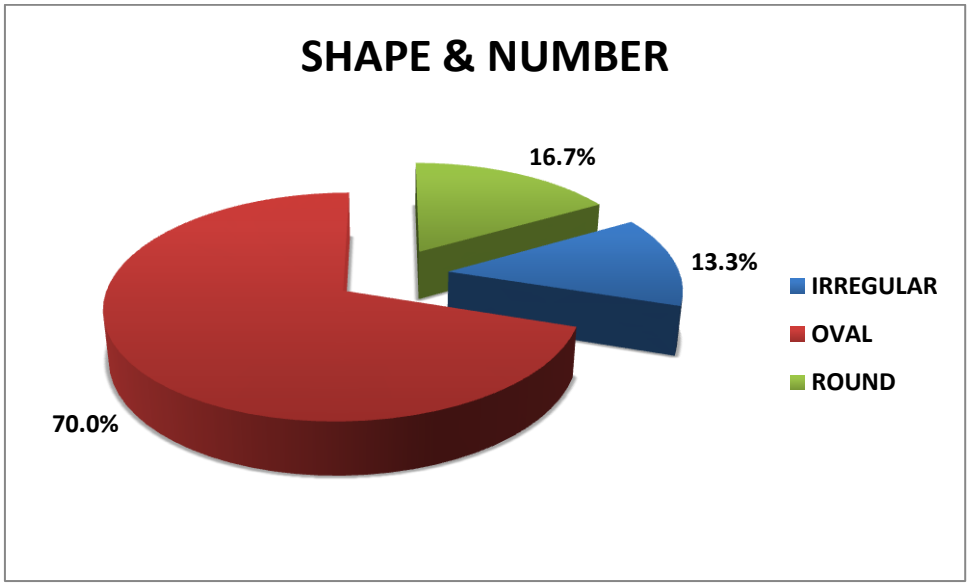


Fig 17: DISTRIBUTION OF SHAPE & NUMBER ACCORDING TO USG

TABLE 10: DISTRIBUTION OF DIAMETER ACCORDING TO USG

	Min	Max	Mean	SD
DIAMETER (mm) USG	12	85	22.20	13.81

Mean diameter according to USG was 22.2±13.81 mm observed in pathologies of cervical lymphadenopathy.

TABLE 11: DISTRIBUTION OF BORDER ACCORDING TO USG

According to USG most of the cervical lymphadenopathy were having regular border (63.3%) followed by irregular borders (36.7%)

BORDER	N	%
IRREGULAR	11	36.7
REGULAR	19	63.3
TOTAL	30	100

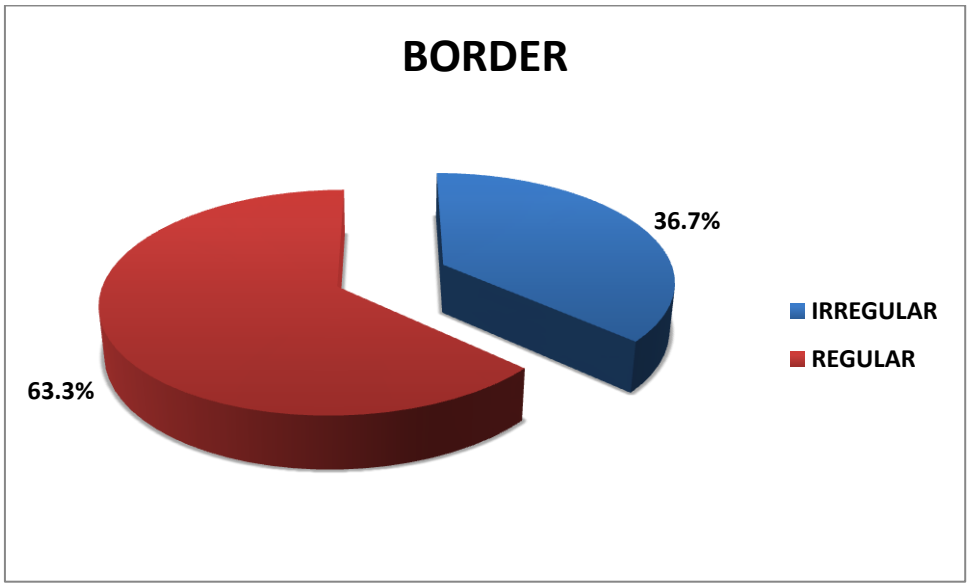


Fig 18: DISTRIBUTION OF BORDER ACCORDING TO USG

TABLE 12: DISTRIBUTION OF ECHOGENECITY ACCORDING TO USG

ECHOGENECITY	N	%
HETEROECHOIC	15	50
HOMOGENOUS	12	40
HYPOECHOIC	3	10
TOTAL	30	100

According to USG echogenecity was hetroechoic in most of the cases (50%) followed by homogenous echogenecity (40%)

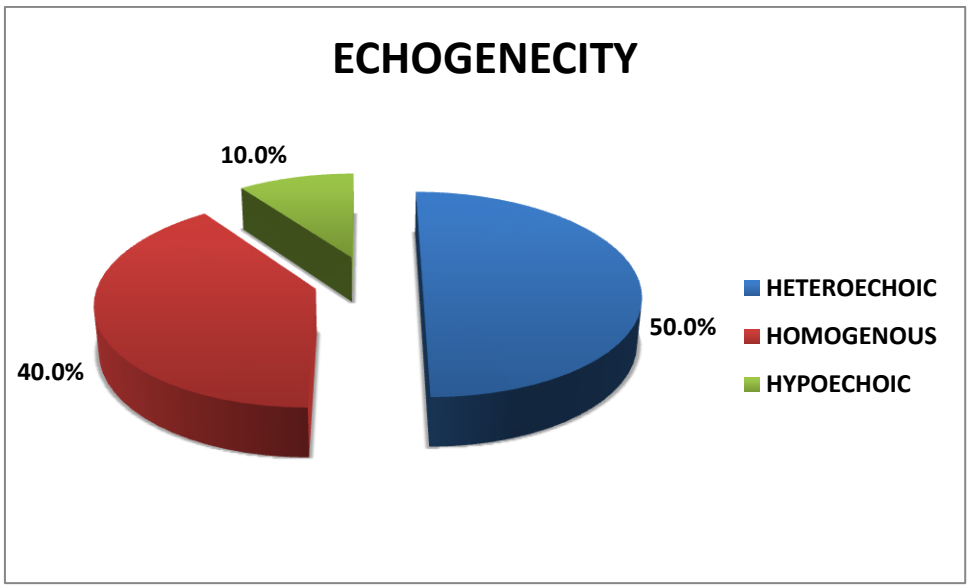


Fig 19: DISTRIBUTION OF ECHOGENECITY ACCORDING TO USG

TABLE 13: DISTRIBUTION OF ECHOGENIC HILUM ACCORDING TO USG

ECHOGENIC HILUM	N	%
ABSENT	8	26.7
PRESENT	22	73.3
TOTAL	30	100

According to USG, echogenic hilum was absent in 26.7% cases.

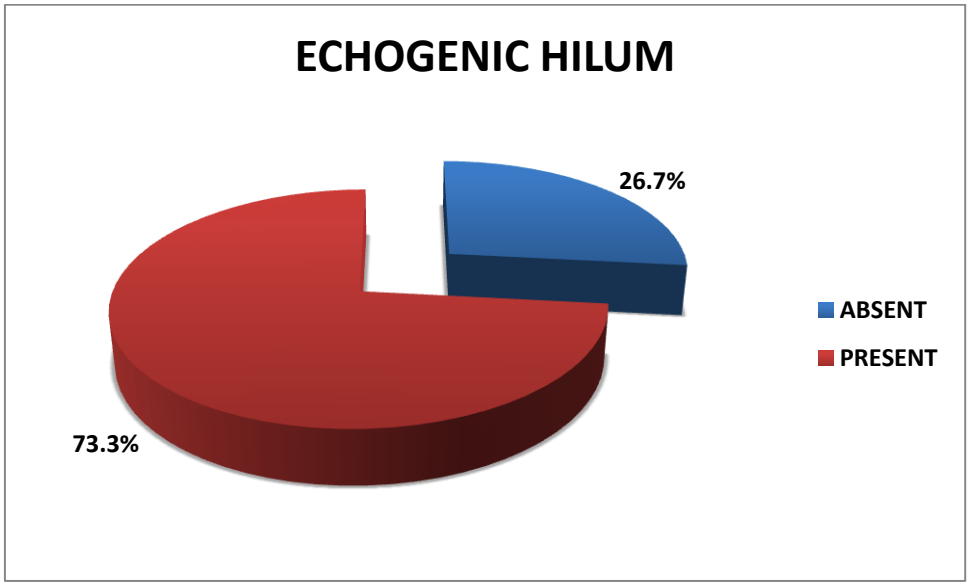


Fig 20: DISTRIBUTION OF ECHOGENIC HILUM ACCORDING TO USG

TABLE 14: DISTRIBUTION OF STRUCTURAL CHANGES ACCORDING TO USG

STRUCTURAL CHANGES	N	%
FOCAL CORTICAL NODULE	2	6.7
INTRANODAL NECROSIS	4	13.3
RETICULATIONS	3	10.0
SUBCAPSULAR HYPOECHOGENECITY	1	3.3
SOFT TISSUE EDEMA	2	6.7
RETICULATIONS	3	10.0
CALCIFICATION	3	10.0
MATTING	2	6.7

Reticulations (20%) was most common in 20% cases followed by Intranodal necrosis (13.3%) and calcifications (10%).

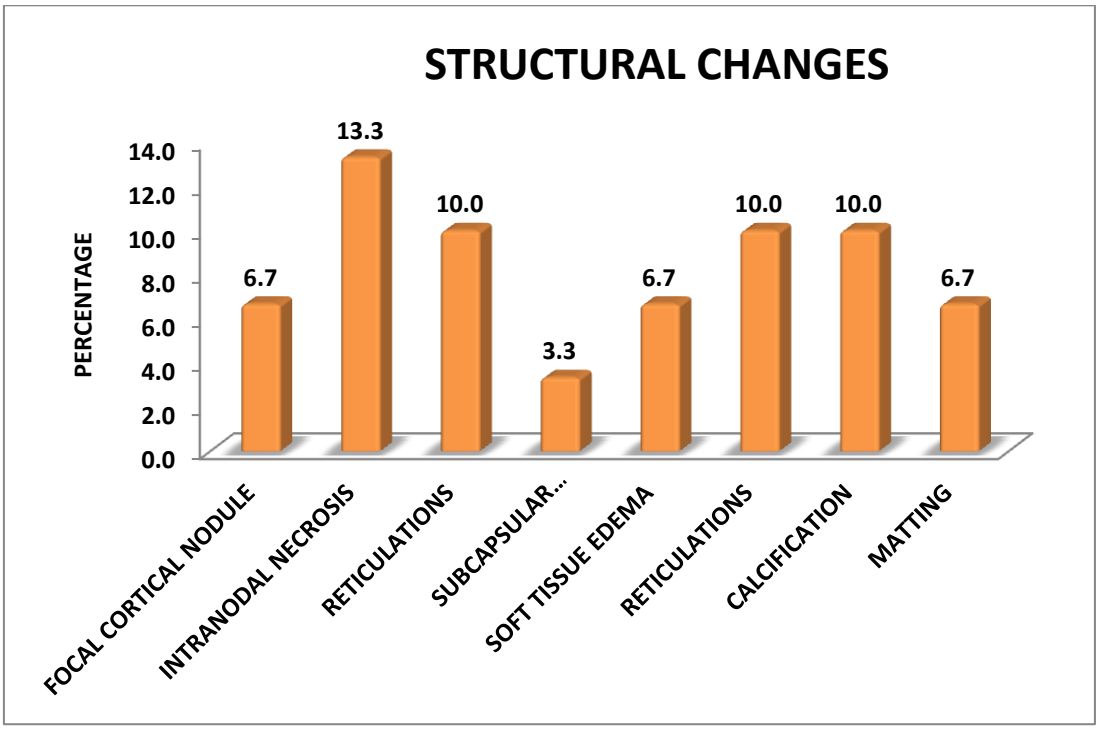


Fig 21: DISTRIBUTION OF STRUCTURAL CHANGES ACCORDING TO USG

TABLE 15: DISTRIBUTION OF FLOW ACCORDING TO USG DOPPLER

FLOW	N	%
ABSENT	3	10
MINIMAL	3	10
PRESENT	24	80
TOTAL	30	100

Flow was present in 80% cases according to USG Doppler, while it was minimal in 10% cases.

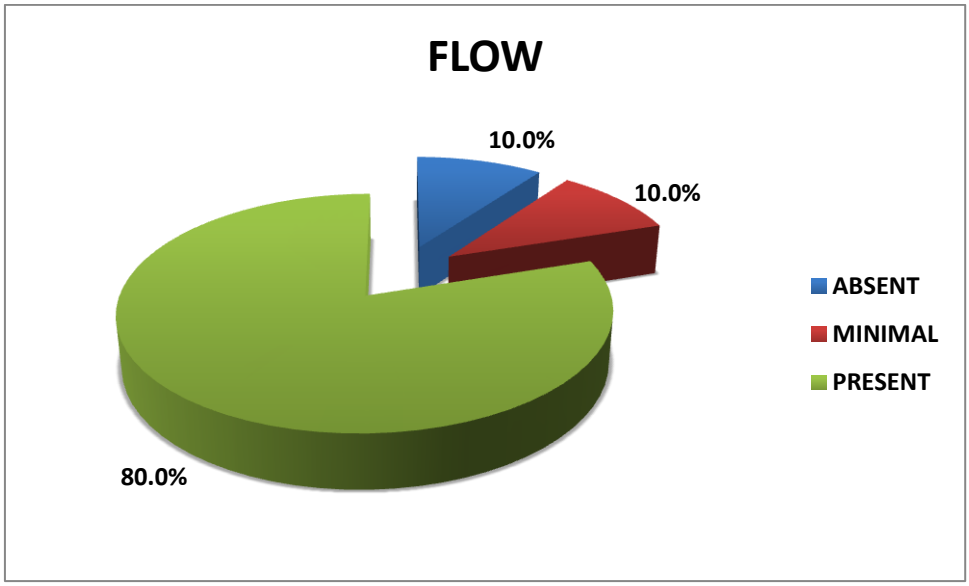


Fig 22: DISTRIBUTION OF FLOW ACCORDING TO USG DOPPLER

TABLE 16: DISTRIBUTION OF VESSEL LOCATION ACCORDING TO USG DOPPLER

VESSEL LOCATION	N	%
ABSENT	3	10
CENTRAL	18	60
ECCENTRIC AND PERIPHERAL	9	30
TOTAL	30	100

Vessel location was central in 60% cases according to USG Doppler. While 30 % cervical lymphadenopathy had eccentric and peripheral vessel location.

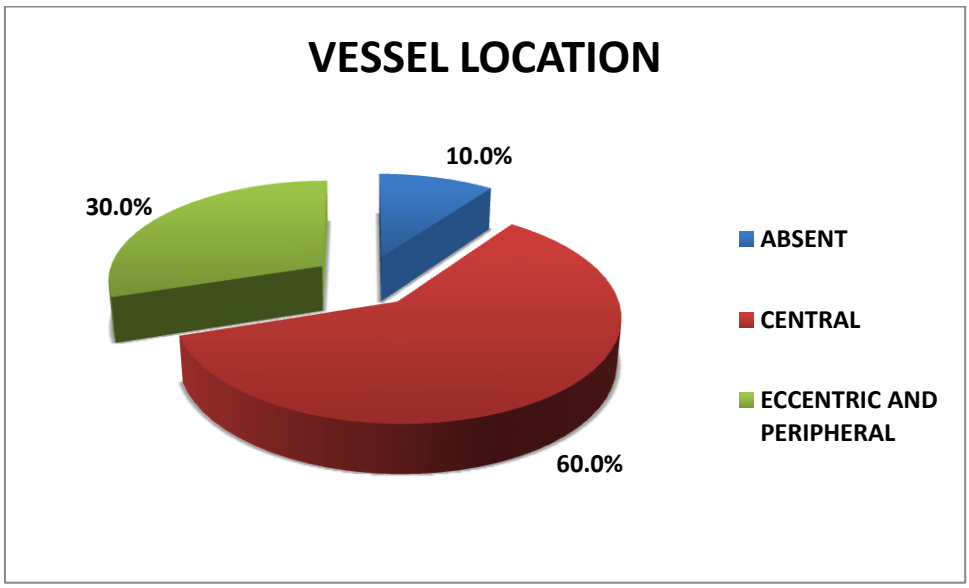


Fig 23: DISTRIBUTION OF VESSEL LOCATION ACCORDING TO USG DOPPLER

TABLE 17: DISTRIBUTION OF VASCULAR PEDICLES ACCORDING TO USG DOPPLER

VASCULAR PEDICLES	N	%
ABSENT	3	10
MULTIPLE	9	30
SINGLE	18	60
TOTAL	30	100

According to USG Doppler vascular pedicles were single in 60% cases while 30% had multiple vascular pedicles.

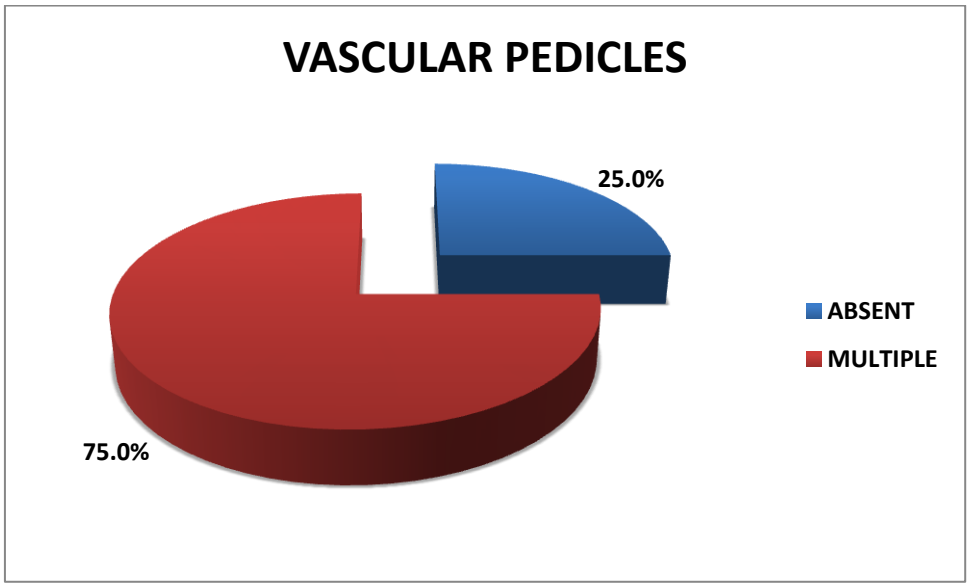


Fig 24: DISTRIBUTION OF VASCULAR PEDICLES ACCORDING TO USG DOPPLER

TABLE 18: DISTRIBUTION OF VASCULAR PATTERN ACCORDING TO USG DOPPLER

VASCULAR PATTERN	N	%
IRREGULAR	12	40
REGULAR	18	60
TOTAL	30	100

According to USG Doppler vascular pattern were regular in 60% cases while 40% had irregular vascular pedicles.

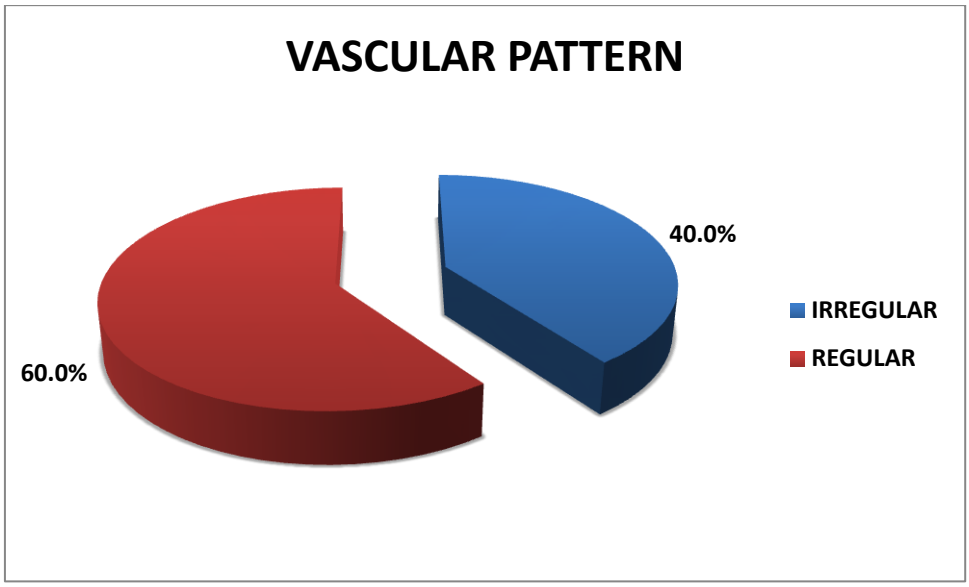


Fig 25: DISTRIBUTION OF VASCULAR PATTERN ACCORDING TO USG DOPPLER

TABLE 19: DISTRIBUTION OF LOCATION ACCORDING TO CT

LOCATION	N	%
I	14	46.7
II	26	86.7
III	28	93.3
IV	23	76.7
V	14	46.7
VI	1	3.3
VII	0	0.0

According to CT scan distribution most of cervical lymphadenopathy pathologies had location at level III (93.3%) followed by level II (86.7%) and level IV (76.7%).

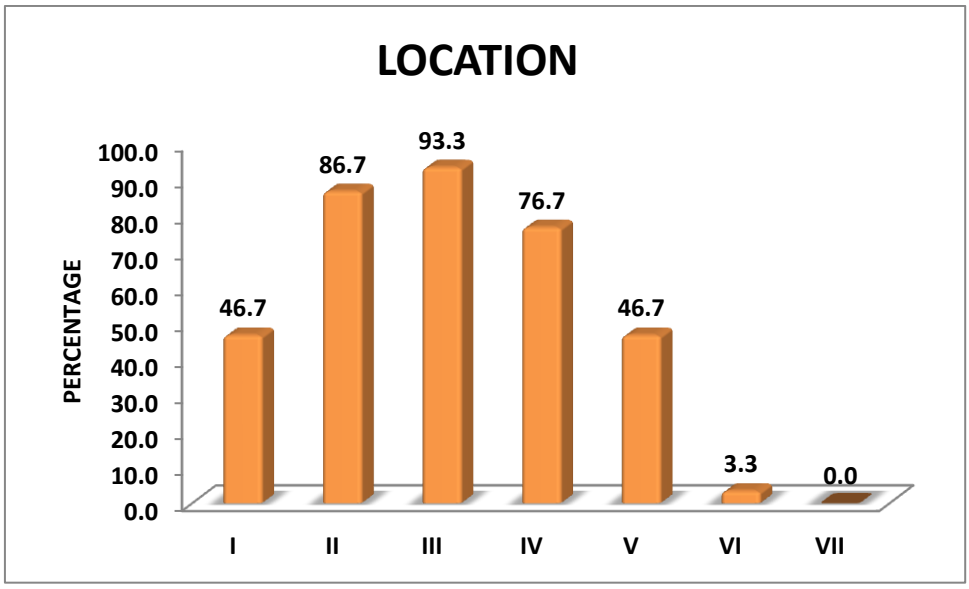


Fig 26: DISTRIBUTION OF LOCATION ACCORDING TO CT

TABLE 20: DISTRIBUTION OF SHAPE ACCORDING TO CT

SHAPE	N	%
IRREGULAR	4	13.3
OVAL	19	63.3
ROUND	7	23.3
TOTAL	30	100

Most common shape was oval (63.3%) according to CT followed by round (23.3%)

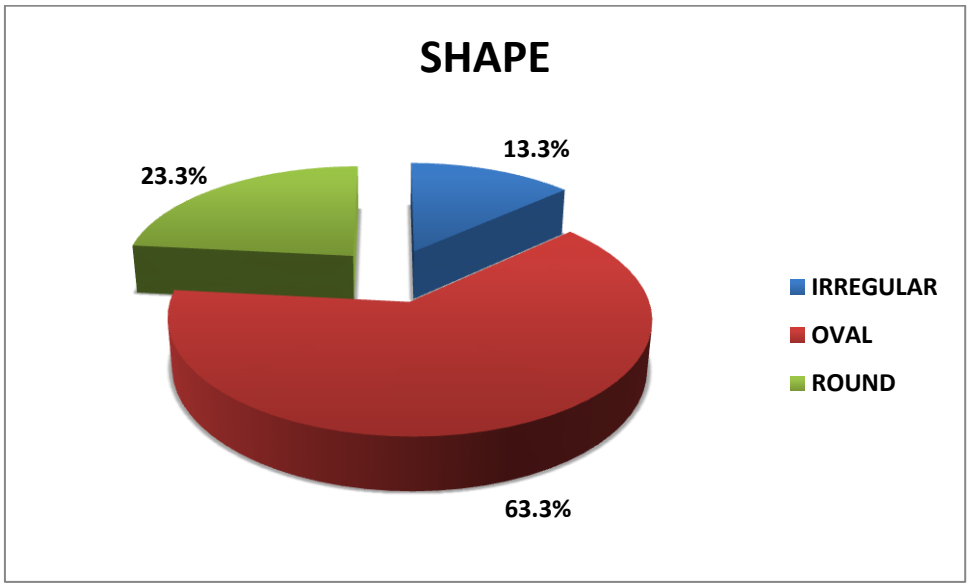


Fig 27: DISTRIBUTION OF SHAPE ACCORDING TO CT

TABLE 21: DISTRIBUTION OF DIAMETER ACCORDING TO CT

	Min	Max	Mean	SD
DIAMETER (mm) CT	12	87	22.47	14.10

According to CT mean diameter was 22.47± 14.10 mm.

TABLE 22: DISTRIBUTION OF MARGINS ACCORDING TO CT

MARGINS	N	%
IRREGULAR	10	33.3
REGULAR	20	66.7
TOTAL	30	100

According to CT margins were regular in 66.7% cases followed by 33.3% cases.

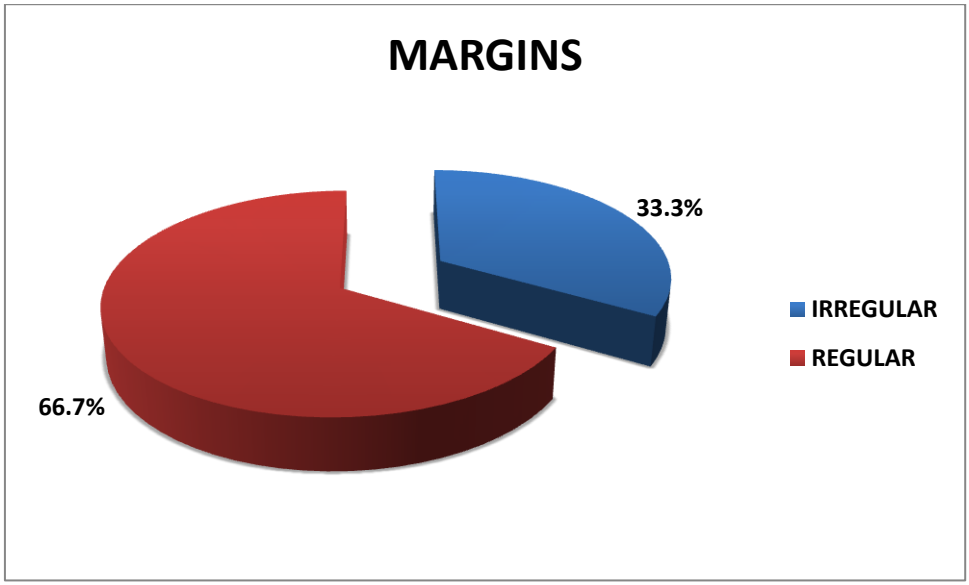


Fig 28: DISTRIBUTION OF MARGINS ACCORDING TO CT

TABLE 23: DISTRIBUTION OF ENHANCEMENT PATTERN ACCORDING TO CT

ENHANCEMENT PATTERN	N	%
HETEROGENOUS	14	46.7
HOMOGENOUS	16	53.3
TOTAL	30	100

According to CT enhancement pattern was homogenous in 53.3% cases and hetrogenous in 46.7% cases.

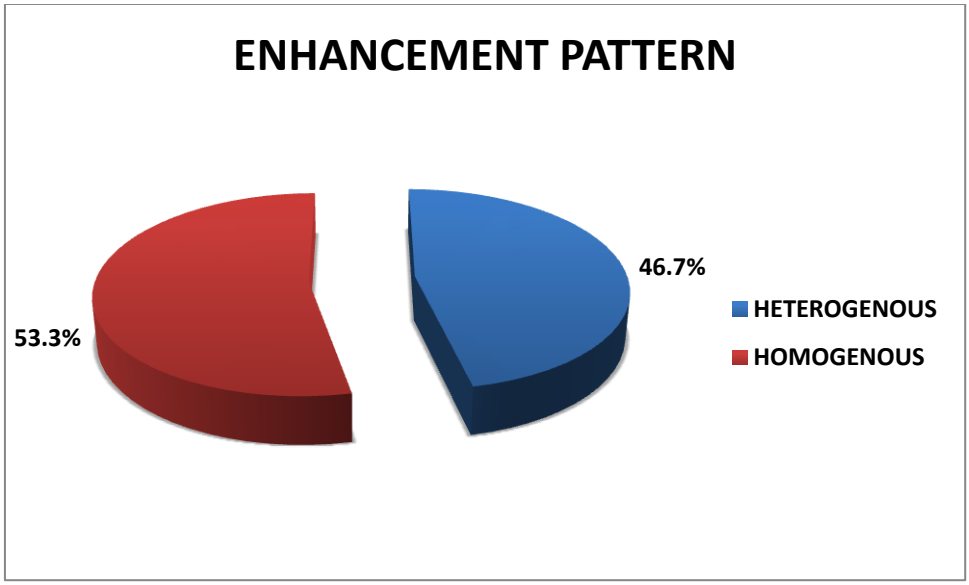


Fig 29: DISTRIBUTION OF ENHANCEMENT PATTERN ACCORDING TO CT

TABLE 24: DISTRIBUTION OF ENHANCEMENT PATTERN TYPE ACCORDING TO CT

ENHANCEMENT PATTERN TYPE	N	%
HETEROGENOUS	8	26.7
HETEROGENOUS WITH NON ENHANCING CENTRAL AREA	6	20
HOMOGENOUS	16	53.3
TOTAL	30	100

According to CT homogenous enhancement pattern was seen in 53.3% cases followed by hetrogeneous (26.7%) cases

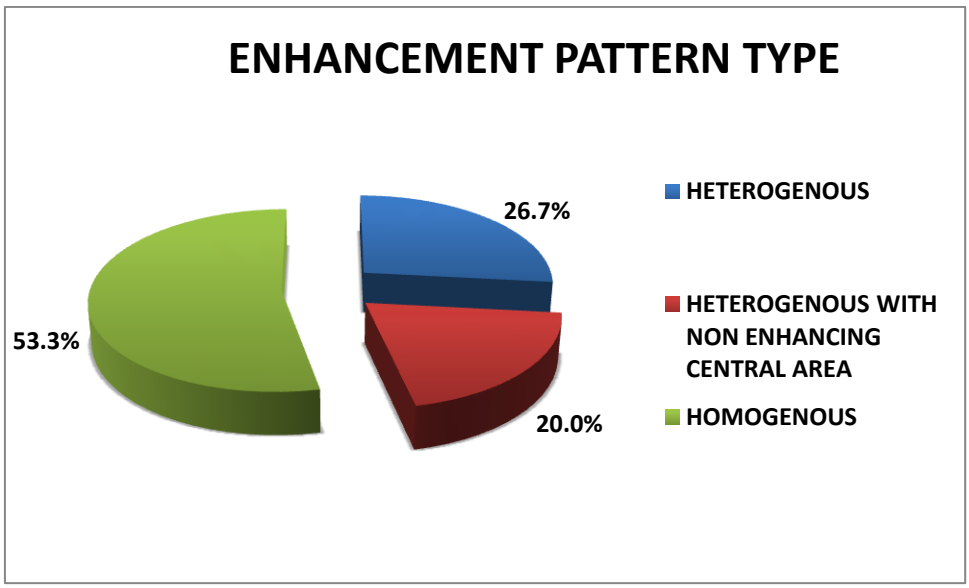


Fig 30: DISTRIBUTION OF ENHANCEMENT PATTERN TYPE ACCORDING TO CT

TABLE 25: DISTRIBUTION OF STRUCTURAL CHANGES ACCORDING TO CT

STRUCTURAL CHANGES	N	%
CONGLOMERATION	1	3.3
FOCAL CORTICAL NODULES	1	3.3
INTRANODAL NECROSIS	3	10.0
SOFT TISSUE EDEMA	2	6.7
SUBCAPSULAR HYPODENSITY	1	3.3

Intranodal necrosis was seen in most of the cases (10%) according to CT

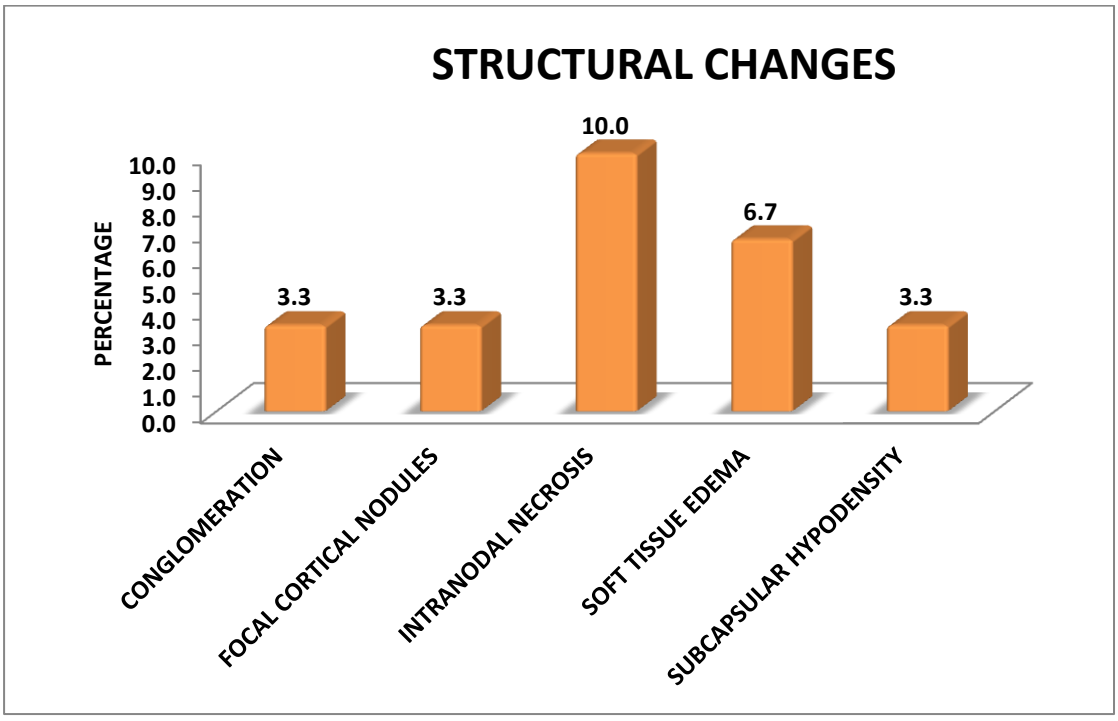


Fig 31: DISTRIBUTION OF STRUCTURAL CHANGES ACCORDING TO CT

TABLE 26: MEAN RI & PI BETWEEN NEOPLASTIC AND NON-NEOPLASTIC LESION

	Neoplastic		Non neoplastic		p value
	Mean	SD	Mean	SD	
RI	0.84	0.15	0.61	0.10	<0.001*
PI	1.59	0.12	1.36	0.09	<0.001*

Note: * significant at 5% level of significance (p<0.05)

Mean RI for neoplastic lesion was 0.84±0.15 while for non neoplastic lesion was 0.61±0.10 while mean PI was 1.59±0.12 for neoplastic and 1.36±0.09 in non neoplastic lesion.

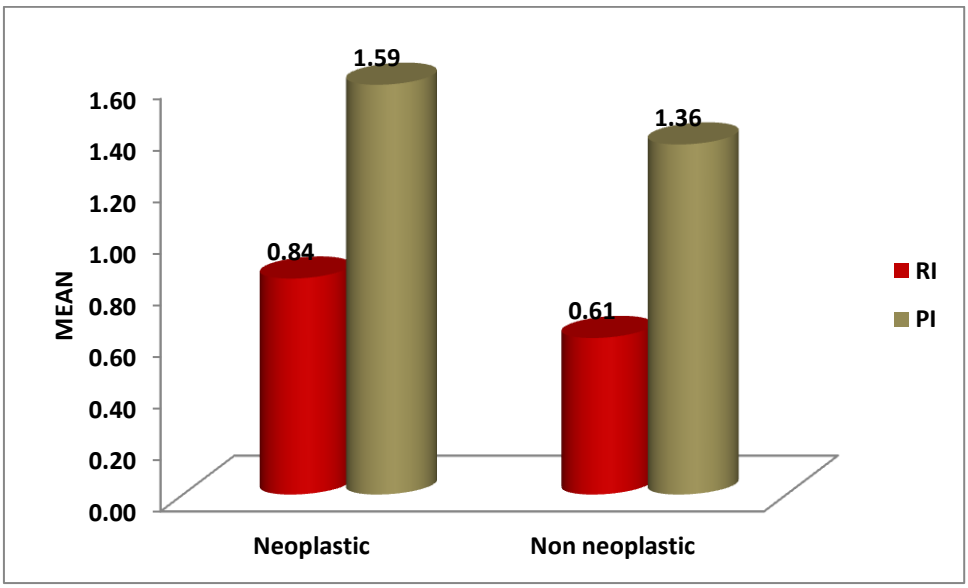


Fig 32: MEAN RI & PI BETWEEN NEOPLASTIC AND NON-NEOPLASTIC LESION

TABLE 27: DISTRIBUTION OF LESION ACCORDING TO USG

USG	N	%
NEOPLASTIC	8	26.7
NEOPLASTIC - LYMPHOMA	2	6.7
NON NEOPLASTIC	3	10
NON NEOPLASTIC - INFECTIVE	11	36.7
NON NEOPLASTIC - NON SPECIFIC	3	10
NON NEOPLASTIC - TUBERCULOSIS	3	10
TOTAL	30	100

According to USG non neoplastic infective lesions were 36.7% while neoplastic lesions were 26.7%

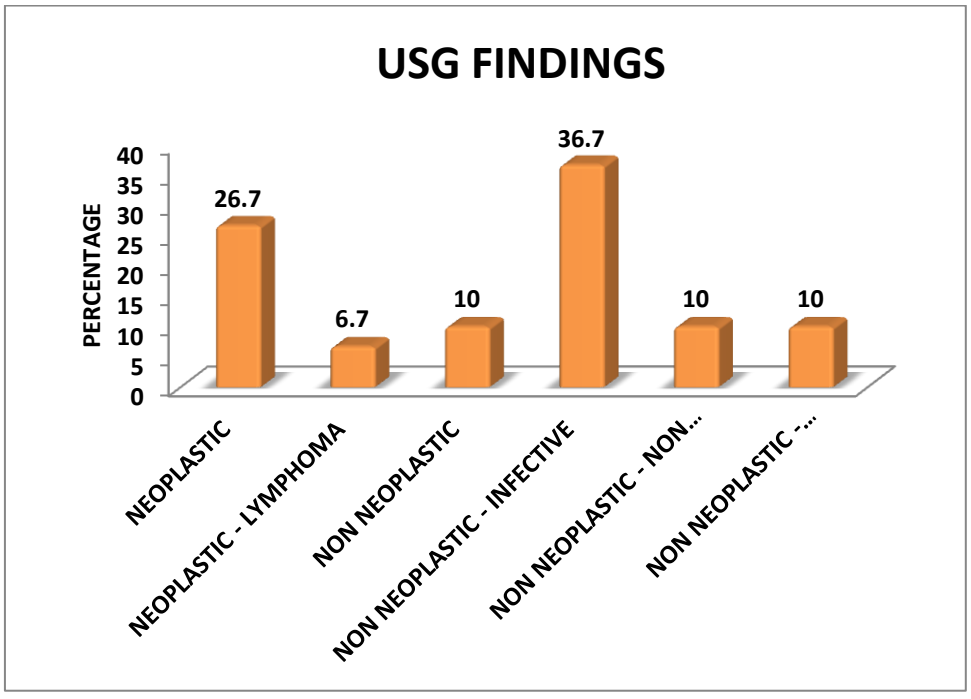


Fig 33: DISTRIBUTION OF LESIONS ACCORDING TO USG

TABLE 28: DISTRIBUTION OF LESION ACCORDING TO CT

CT	N	%
NEOPLASTIC	9	30
NON NEOPLASTIC	2	6.7
NON NEOPLASTIC – INFECTIVE	12	40
NON NEOPLASTIC - NON SPECIFIC	3	10
NON NEOPLASTIC – TUBERCULOSIS	4	13.3
TOTAL	30	100

According to CT neoplastic lesions were 30% while non neoplastic infective lesions were 40%

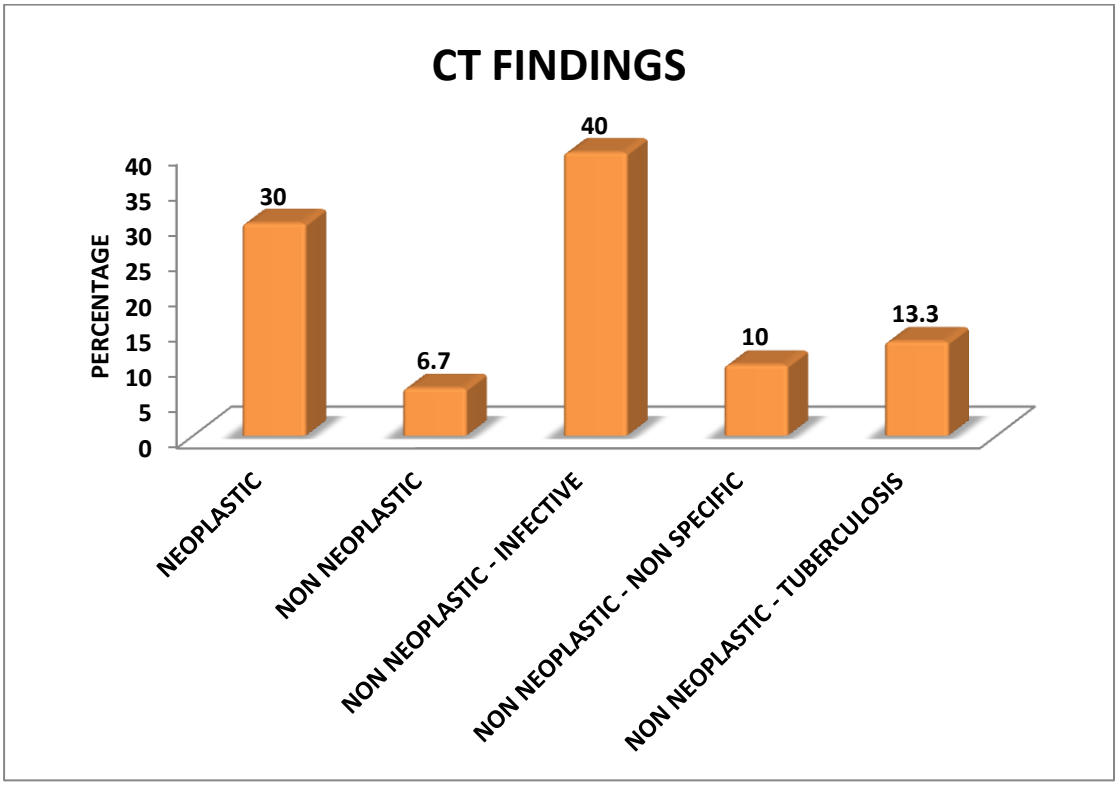


Fig 34: DISTRIBUTION OF LESIONS ACCORDING TO CT

TABLE 29: DISTRIBUTION OF LESION ACCORDING TO HPR

HPR	N	%
NEOPLASTIC	8	26.7
NEOPLASTIC - HODGKINS LYMPHOMA	1	3.3
NEOPLASTIC - NON HODGKINS LYMPHOMA	2	6.7
NON NEOPLASTIC	3	10
NON NEOPLASTIC - INFECTIVE	11	36.7
NON NEOPLASTIC - NON SPECIFIC	3	10
NON NEOPLASTIC - TUBERCULOSIS	2	6.7
TOTAL	30	100

According to HPR neoplastic lesions were 26.7% while non neoplastic infective lesions were 10%

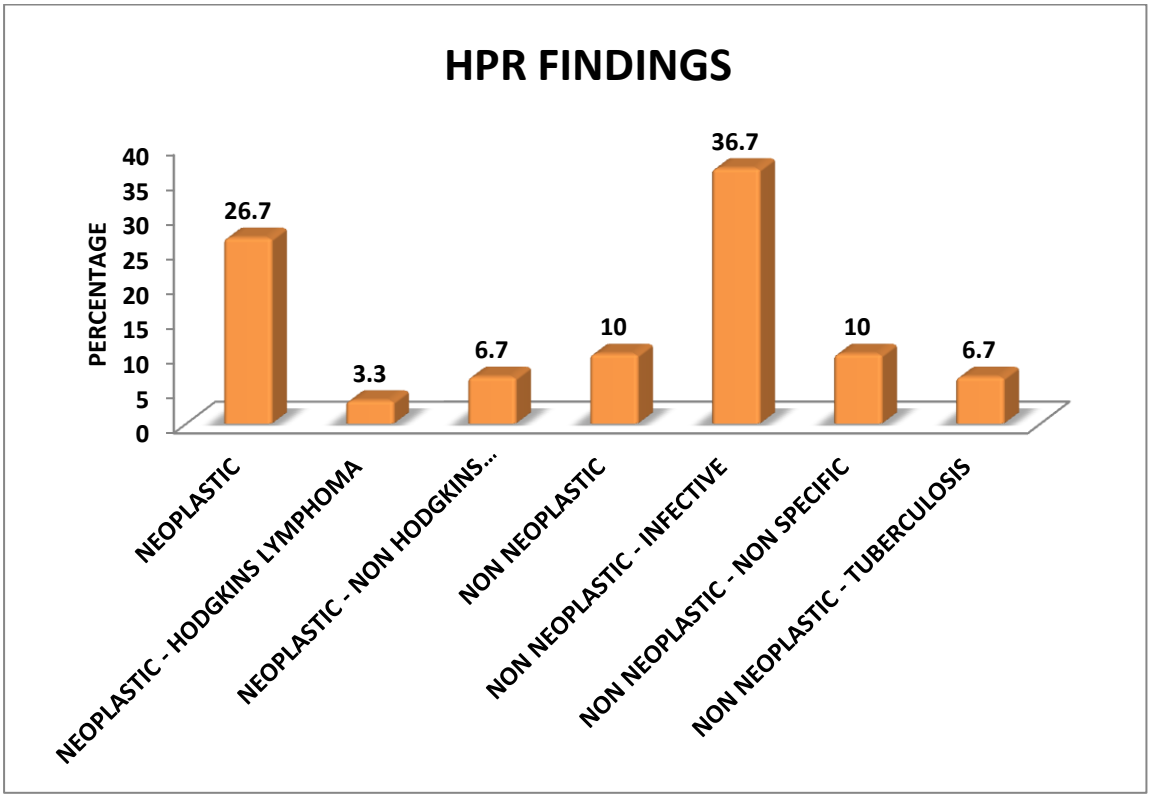


Fig 35: DISTRIBUTION OF LESIONS ACCORDING TO HPR

TABLE 30: DISTRIBUTION OF CASES BETWEEN USG & HPR

USG	HPR		Total
	Non neoplastic	Neoplastic	
Non neoplastic	18	2	20
Neoplastic	1	9	10
Total	19	11	30

On comparison of cases among USG and HPR, non neoplastic cases were 18 in both the USG and HPR, and in both USG and HPR neoplastic lesions were 9

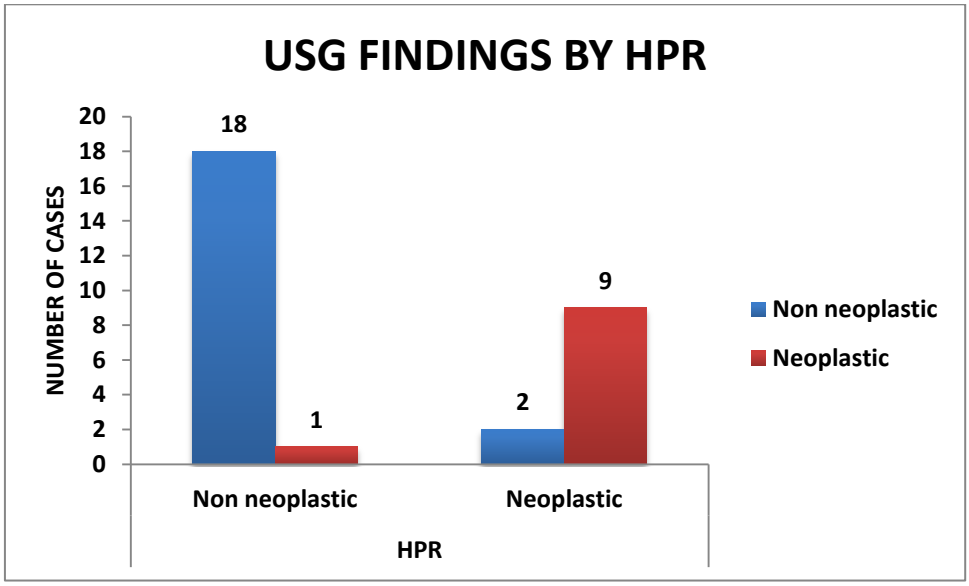


Fig 36: DISTRIBUTION OF CASES BETWEEN USG & HPR

TABLE 31: DISTRIBUTION OF CASES BETWEEN CT & HPR

CT	HPR		Total
	Non neoplastic	Neoplastic	
Non neoplastic	17	4	21
Neoplastic	2	7	9
Total	19	11	30

On comparison of cases among CT and HPR, non neoplastic cases were 17 in both the CT and HPR, and in both CT and HPR neoplastic lesions were 7

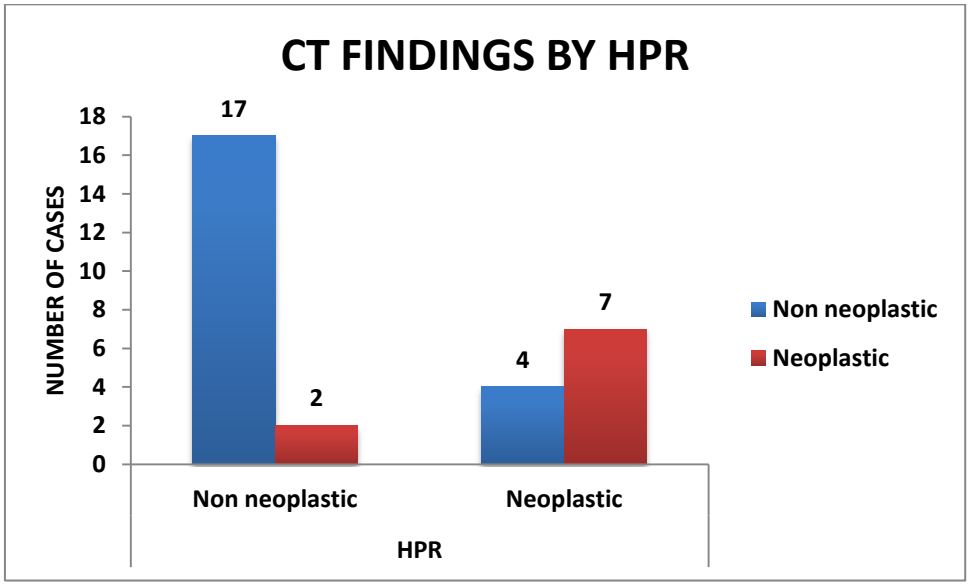


Fig 37: DISTRIBUTION OF CASES BETWEEN CT & HPR

TABLE 32: SENSITIVITY, SPECIFICITY OF USG & CT

	USG	**CT**
TP (true positive)	18	17
FN (false negative)	1	2
FP (false positive)	2	4
TN (true negative)	9	7

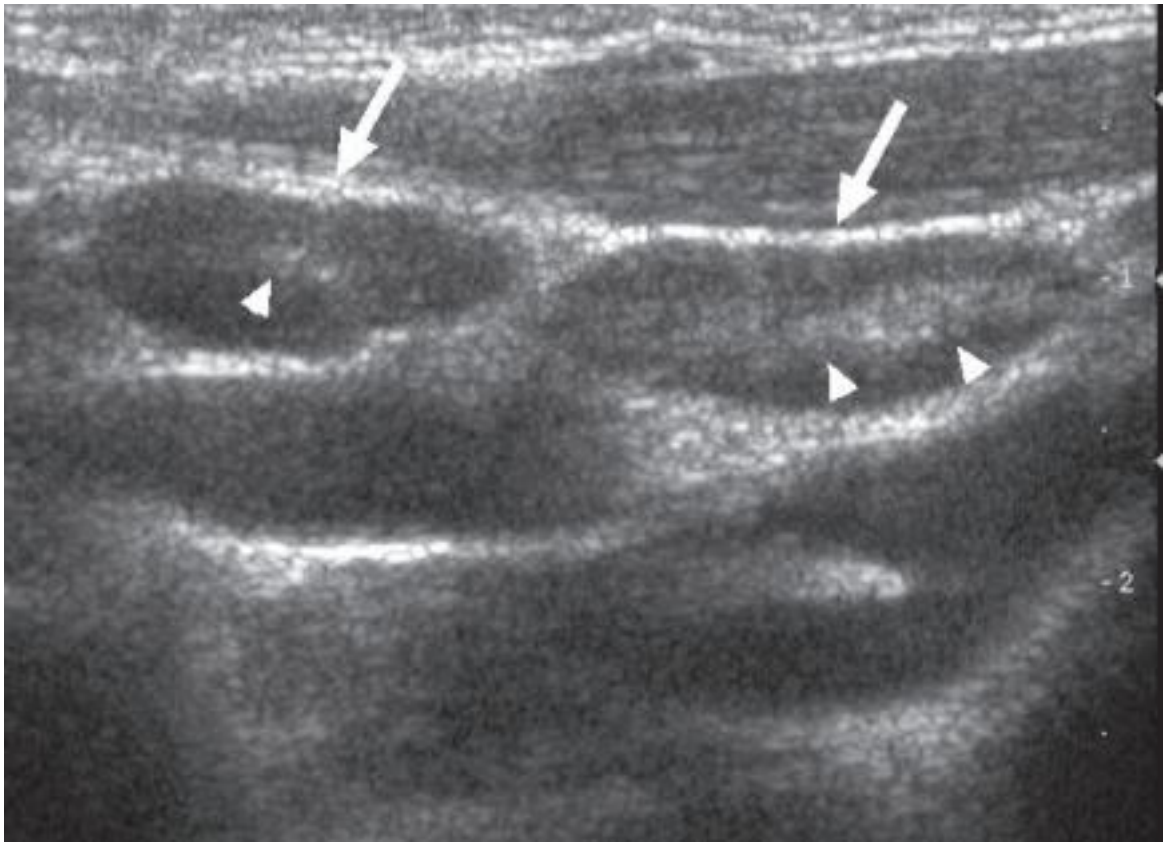
	USG	**CT**
Sensitivity	94.74%	89.47%
Specificity	81.82%	63.64%
PPV	90.00%	80.95%
NPV	90.00%	77.78%
Accuracy	90.00%	80.00%

Sensitivity of USG to assess true positive cases for pathologies of cervical lymphadenopathy was more (94.7%) with respect to sensitivity of CT (89.4%) Specificity of USG to assess true negative cases for pathologies of cervical lymphadenopathy was more (81.82%) with respect to sensitivity of CT (63.64%)

Accuracy for CT scan was 80% while accuracy for detection of pathologies in cervical lymphadenopathy by USG was 80% PPV of USG was 90% and NPV of USG was 90% while PPV of CT was 80.95% and NPV of CT was 77.78%

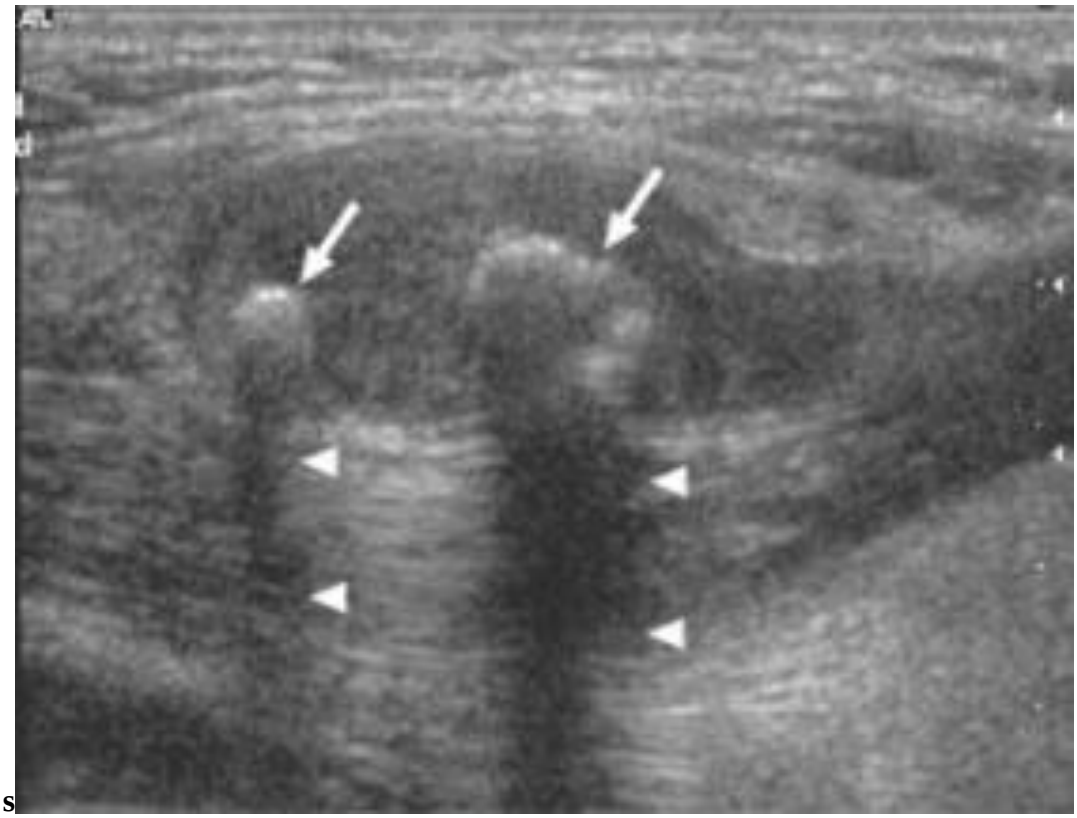
IMAGING GALLERY

Fig 38. Ultrasonography of reactive lymphadenopathy.



Ultrasonography showing multiple oval-shaped, hypoechoic lymph nodes with maintained central echogenic hilum (arrowheads).

Fig 39. Ultrasonography of tubercular lymphadenopathy



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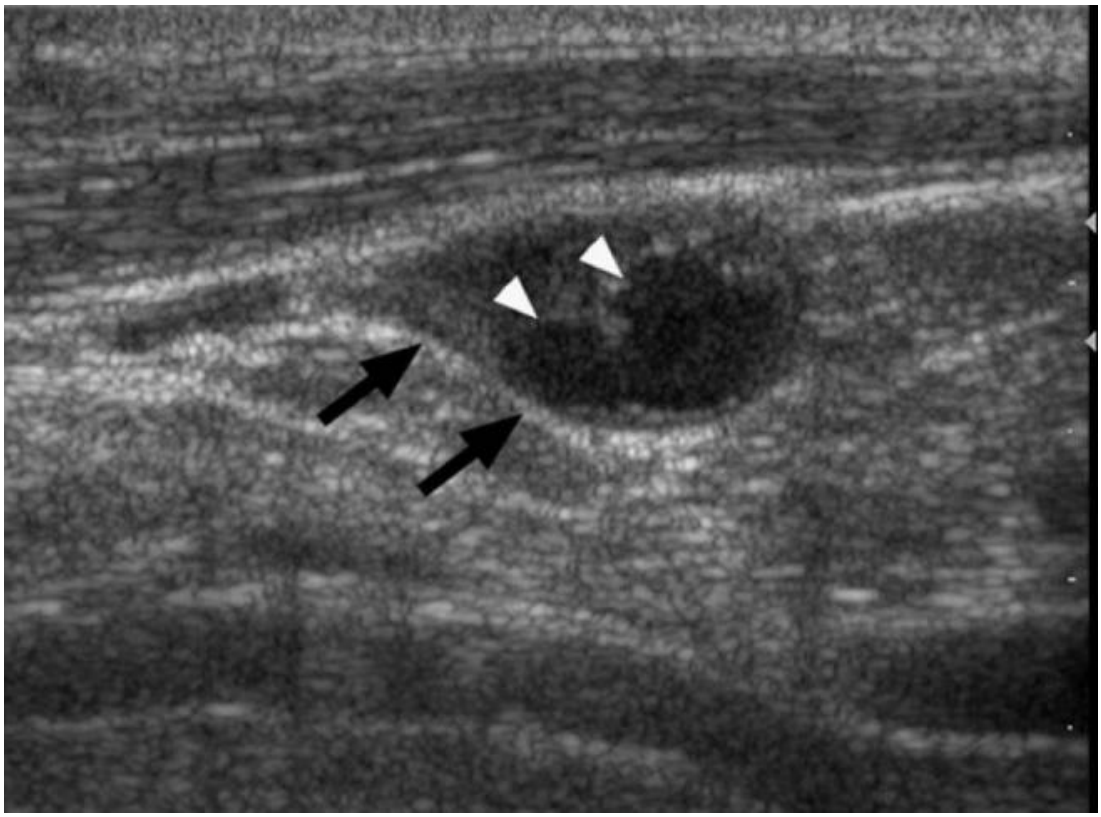
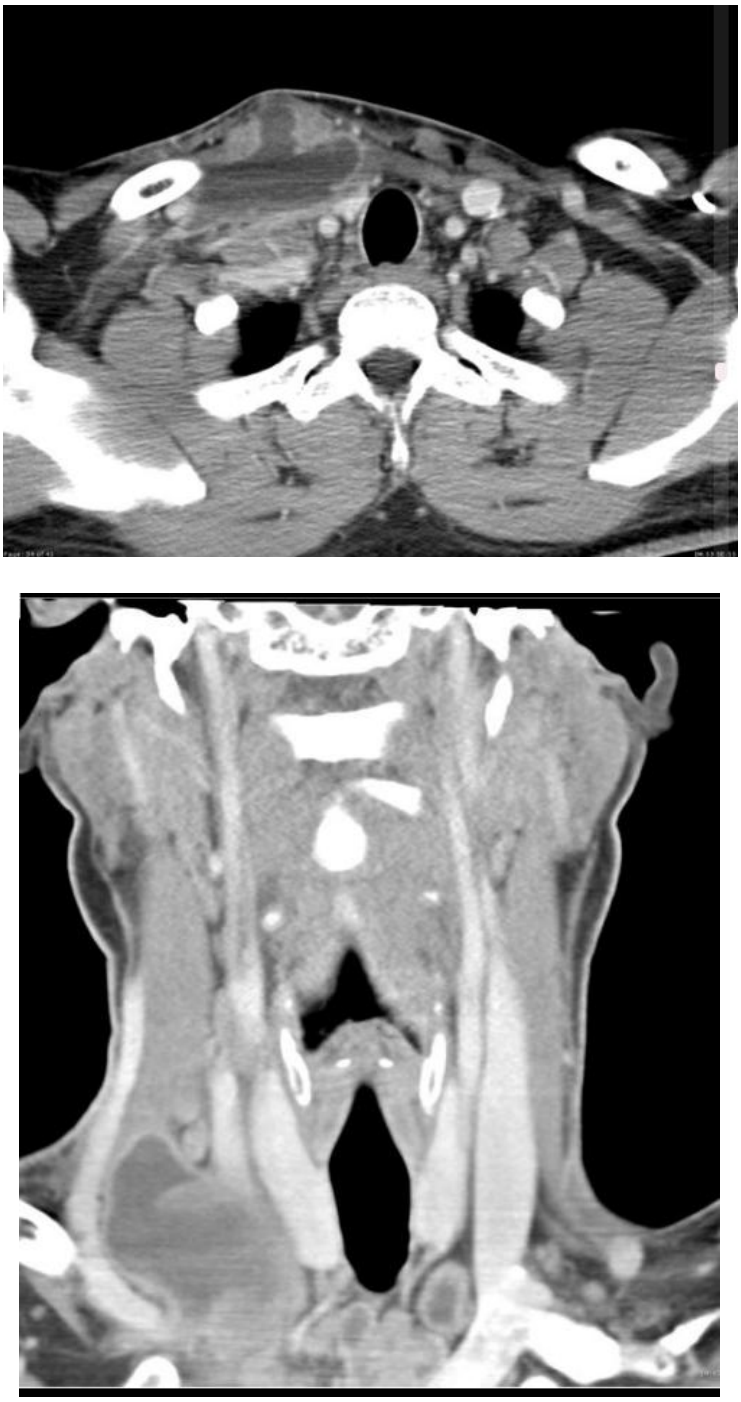
Ultrasonography showing lymph node involved with tubercular lymphadenitis. The lymph node is hypoechoic and with dense intranodal calcification (arrows) showing distal acoustic shadowing (arrowheads).

Fig 40. Ultrasonography of tuberculous lymphadenopathy with intranodal cystic necrosis.



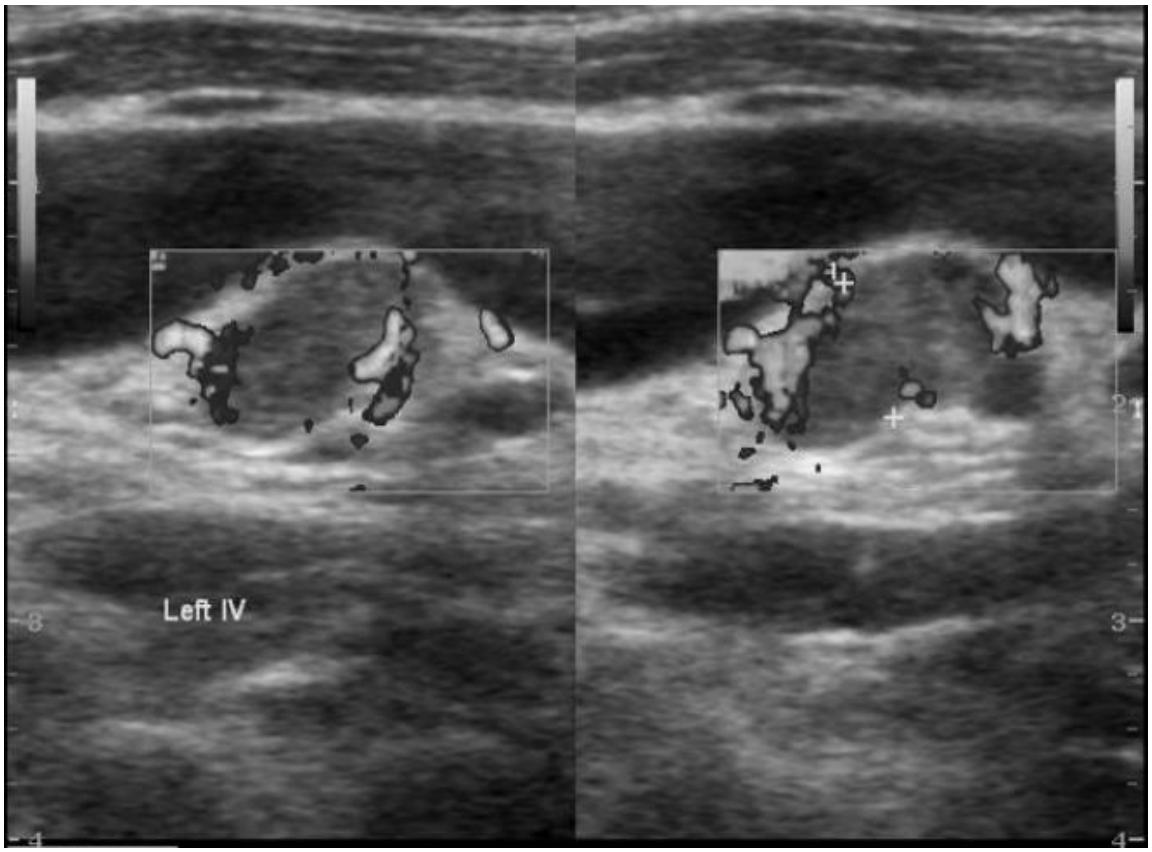
Ultrasonography of a lymph node with tubercular lymphadenitis (arrows) with intranodal cystic necrosis appearing as a hypoechoic area within the lymph node (arrowheads).

Fig 41. CECT of tubercular cervical lymphadenopathy



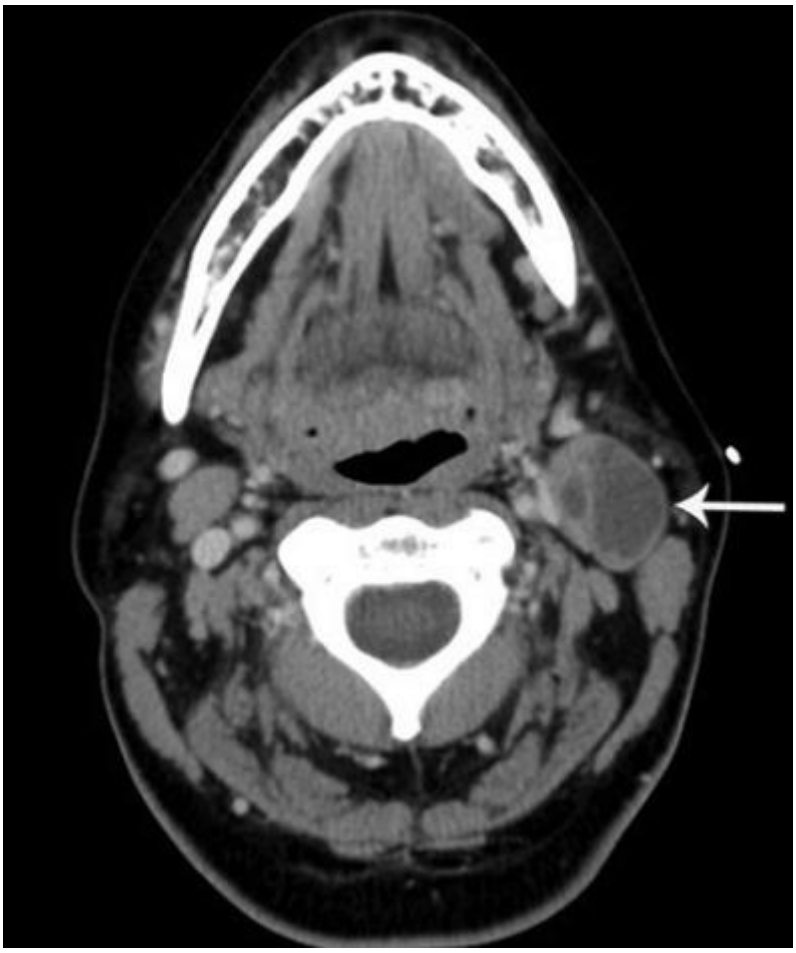
Multiple lymph nodal masses in the lower neck at level IV on right side and level VII and supraclavicular regions bilaterally having low density central non enhancing areas.

Fig 42. Ultrasonography of metastatic cervical lymphadenopathy.



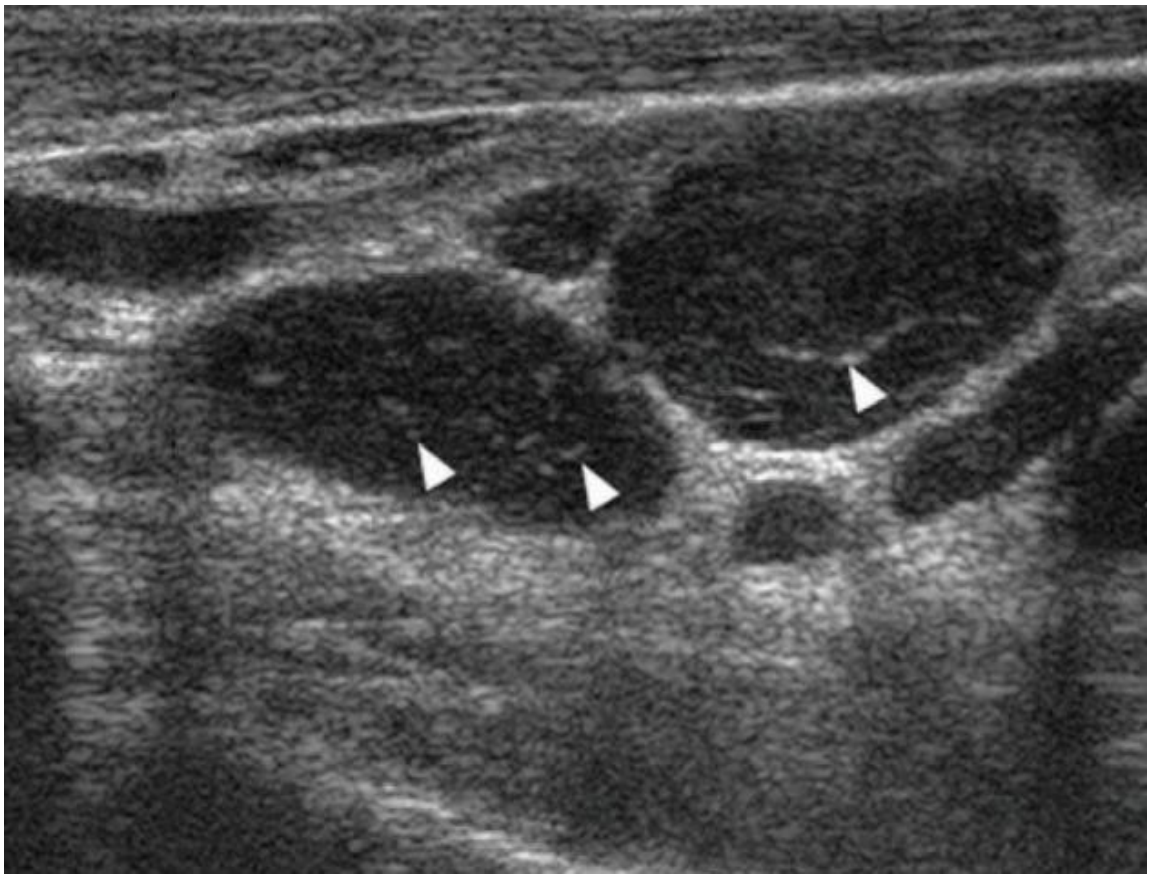
Multiple rounded and hypoechoic lymph nodes with loss of central echogenic hilum and color doppler showing peripheral capsular vascularity.

Fig 43. CT of metastatic cervical lymphadenopathy



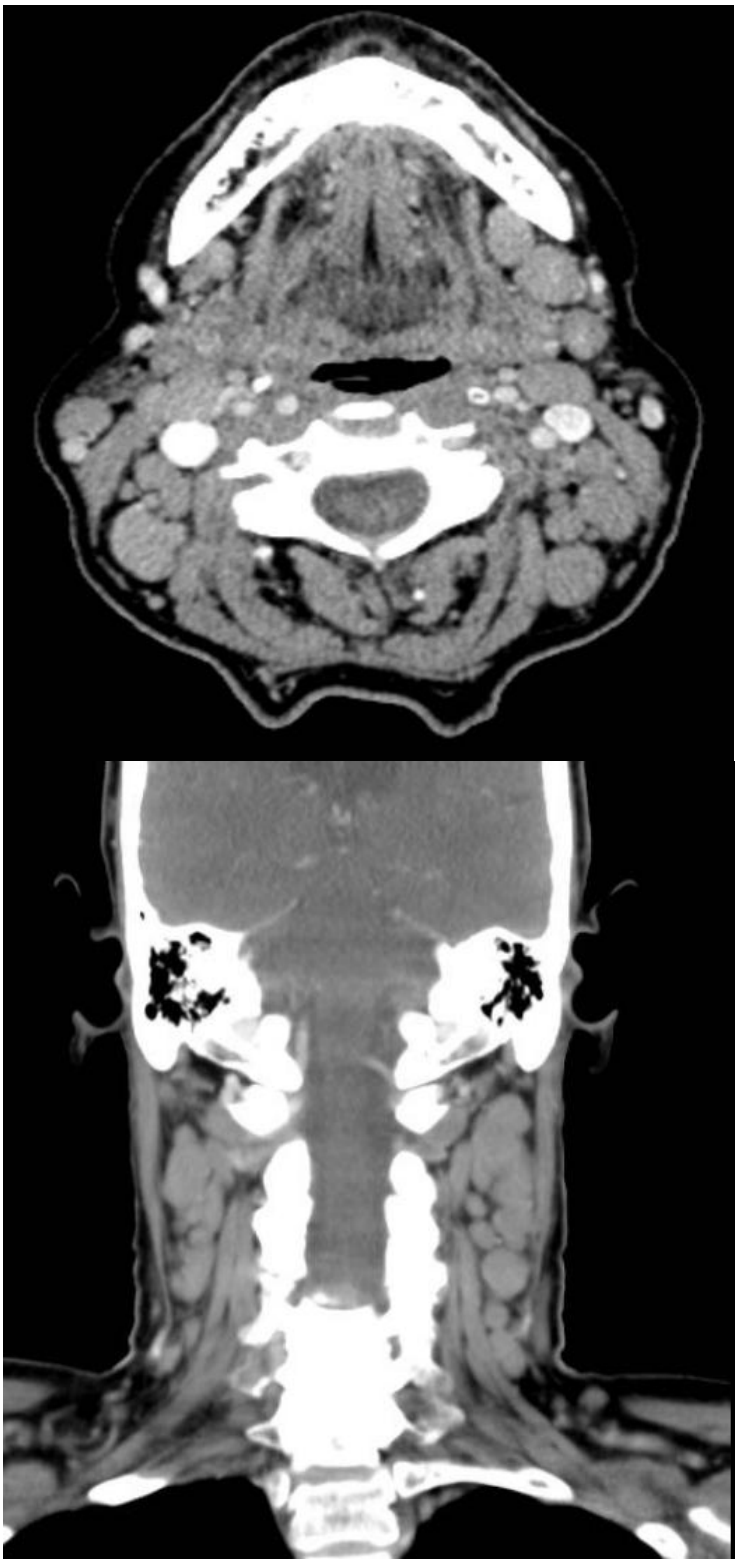
Axial contrast-enhanced CT image shows enlarged left level IIA lymph node with central non enhancing hypodense area indicating central necrotic and cystic node (*arrow*) that compresses internal jugular vein.

Fig 44. Ultrasonography of lymphomatous cervical nodes.



Ultrasonography of lymphomatous cervical nodes showing enlarged hypoechoic lymph nodes with multiple intranodal reticulations (arrowhead).

Fig 45. CT of lymphomatous cervical nodes.



CECT neck axial and coronal sections showing enhancing bilateral multiple enlarged neck nodes without necrosis.

DISCUSSION

The present study was done at our tertiary care centre on patients presenting with neck masses or with clinical suspected cases of cervical lymphadenopathy.

Ultrasound is a preferred modality of imaging over computed tomography (CT) in evaluation of cervical lymphadenopathy in differentiating benign and malignant lymph nodes. The size of the node cannot be considered as sole criteria. One of the most specific signs of metastatic involvement of the node is the presence of central nodal necrosis which has a specificity of 95-100%. It appears as a central low attenuation on CT, the nodal necrosis is. Infection and other causes sometimes can also give similar appearance on CT[80]. Ultrasonography is primary investigation modality which is easily available, radiation free, cost-effective, non-invasive and safe to differentiate reactive tubercular and malignant cervical lymphadenopathy. Ultrasound examination of the lymph nodes can be done in all planes so that exact nodal size and shape can be evaluated[81].

In present study, most of the study population were from age group 21 to 40 years (30%) and 41 to 60 years (30%). The mean age was 39.47 ±20.59 years. Most of the cases were female (66.7%) while males were 33.3%. Ratio of male: Female was 1:2 No significant association was found between age and gender of cases. 30% females of age group less than 20 years and 30% of females of age group 21 to 40 years had pathologies of cervical lymphadenopathy. This is similar to the studies of Lakshmi CR et al[82] and Kumar S et al[83].

Lakshmi CR et al[82] determining the efficacy of ultrasound in differentiating between benign and metastatic group of cervical lymph nodes observed age and gender distribution in group 1 (control group) and group 3 was nearly the same in the patients being in second decade, whereas mild male predilection in group 1 and

female predominance in group 3 were noted. The metastatic group had mean age of 57.87 with male predominance of 66.67%.

Kumar S et al[83] study on USG evaluation of Cervical Lymphadenopathy with Cytological Correlation found most common no. of cases were seen in age group (13-20).

In our study, according to USG most of the cases had cervical lymphadenopathy pathologies at level III (90%) followed by 76.7% at level II, and 70 % at level IV. This is comparable to the study of Kumar S et al[83].

Kumar S et al[83] study on USG evaluation of Cervical Lymphadenopathy with Cytological Correlation reported in USG at level I an oval lymph node with maintained Hilum and hilar vascularity was observed suggestive of reactive lymph node confirmed on FNAC.

It was observed in the present study that according to USG most of the cervical lymphadenopathy pathologies were having oval shape (70%) followed by round (16.7%). Mean diameter according to USG was 22.2±13.81 mm observed in pathologies of cervical lymphadenopathy. This is concordant to the studies of Lakshmi CR et al[82], Chikui T et al[84] and Shetty D et al[85].

Lakshmi CR et al[82] determining the efficacy of ultrasound in differentiating between benign and metastatic group of cervical lymph nodes observed mean size of lymph

nodes in group 1 was 0.82 mm, in group 2 was 2.29 mm, and in group 3 was 1.24mm with highly significant *P* value.

Chikui T et al[84] suggested that the presence of central echogenic hilum and central hilar blood flow was seen in reactive lymph nodes and enlargement of the short axis diameter is predictive of metastatic cervical lymph nodes.

Shetty D et al[85] study evaluating ultrasonography (USG), and computed tomography (CT) in assessing metastatic cervical lymph nodes also considered the enlargement of the short axis diameter as a predictor of metastasis.

It was observed in our study that according to USG most of the cervical lymphadenopathy were having regular border (63.3%) followed by irregular borders (36.7%). This is consistent with the studies of Lakshmi CR et al[82], Ahuja AT et al[86] and Kumar S et al[83].

Lakshmi CR et al[82] determining the efficacy of ultrasound in differentiating between benign and metastatic group of cervical lymph nodes reported nodal borders of metastatic cervical lymph nodes had sharp border in 100% of the cases and normal & reactive cervical lymph nodes had smooth borders in 100% of the cases with very high significant p value (*P* = 0.0000). Similar study was done and results were reported by Ahuja AT et al[86] where metastatic cervical lymph nodes had sharp nodal borders in 94% of the cases and reactive cervical lymph nodes had smooth nodal borders in 100% cases.

Kumar S et al[83] study on USG evaluation of Cervical Lymphadenopathy with Cytological Correlation reported out of 29 malignant nodes, 19 showed sharp border, out of 30 reactive 18 showed unsharp border, out of 21 tubercular 13 showed unsharp border and the association was not significant.

Sharp borders are believed to be due to the tumour infiltration and the reduced fatty deposition within the lymph nodes, which increase the acoustic impedance difference between the lymph node and the surrounding tissues. Unsharp borders are common in reactive nodes and these are due to the edema and inflammation of the surrounding soft tissue[85]. In malignancy, the infiltrating tumor cells replace normal lymphoid tissues and causes an increasing acoustic impedance difference between lymph nodes and surrounding tissues resulting in sharp borders but when malignant nodes invade into adjacent structures, they result in unsharp borders. But benign lymph nodes will have unsharp borders because of edema or active inflammation of the surrounding tissues.

In the present study, according to USG echogenecity was hetroechoic in most of the cases (50%) followed by homogenous echogenecity (40%). Echogenic hilum was absent in 26.7% cases. This is in concordance to the studies of Vassallo P et al[87], Yusha H et al[88], Lakshmi CR et al[82], Ying M et al[89] and Kumar S et al[83].

Vassallo P et al[87] reported that the echogenic hilus corresponds to the abundance of collecting sinuses and provides acoustic interfaces to reflect a portion of the ultrasonic wave making the hilus echogenic.

Yusha H et al[88] found absence of hilar echo in 97% of metastatic cervical lymph nodes whereas 73% of nonmetastatic cervical lymph nodes showed hilar echogenicity with *P* value <0.001.

Lakshmi CR et al[82] study determining the efficacy of ultrasound in differentiating between benign and metastatic group of cervical lymph nodes reported none (100%) of metastatic cervical lymph nodes revealed absence of hilar echo when compared tonormal andreactive cervical lymph nodes where hilar echo was seen in all the samples with highly significant *P* value (*P* = 0.0000).

Ying M et al[89] found similar findings echogenic hilus to be a normal sonographic feature of normal cervical lymph nodes in 96% of cases; they stated that although metastatic nodes lack this feature, hilum may be present in the early stage of involvement in which medullary sinuses have not been sufficiently disrupted to eradicate it.

Kumar S et al[83] study on USG Evaluation of Cervical Lymphadenopathy with Cytological Correlation reported Lymph node with oval shape (L/S ratio >2) echogenic hilum, homogenous echotexture and hilar vascularity were considered as significant parameters in detecting non-neoplastic (reactive) lymph nodes, which showed matting with soft tissue edema. Nodes which were round shape (L/S ratio <2), absent hilum, heterogeneous echo texture, hilar, capsular vessels, and mixed vascularity were considered as significant parameters in detecting neoplastic (malignant) lymph nodes. 83% of malignant nodes showed absent hilum, 13% of malignant nodes showed narrow hilum. 65% of tubercular nodes showed absent hilum and 23% with narrow hilum. 46% of reactive nodes showed wide hilum and was statistically significant association.

In malignancy/metastases infiltration of the malignant tissue result in early distortion of internal nodal architecture with invasion of hilum, resulting in narrowing or absence of hilum. In case of reactive nodes, pathogen reaches nodal cortex in early stages induces lymphocyte proliferation and if inflammatory stimulus still persists, causes formation of new germinal center resulting in widening of hilum. Echogenic hilumis the area in which the blood and lymphatic vessels drain into the lymph nodes[90].

In our study, reticulations (20%) was most common in 20% cases followed by Intranodal necrosis (13.3%) and calcifications (10%). Lakshmi CR et al[82] noted similar observations in their studies.

Lakshmi CR et al[82] study found presence of intranodal necrosis in 26.67% of metastatic cervical lymph nodes and there was no intranodal necrosis in reactive cervical lymph nodes. Lymph nodes with intranodal necrosis were considered to be pathologic. Intranodal necrosis can be classified into cystic necrosis and coagulation necrosis, cystic necrosis being more common than coagulation necrosis. Coagulation necrosis appears as an intranodal echogenic focus, while cystic necrosis appears as hypoechoic area within the lymph nodes.

It was observed in the present study that flow was present in 80% cases according to USG Doppler, while it was minimal in 10% cases. Vessel loacation was central in 60% cases according to USG Doppler. While 30 % cervical lymphadenopathy had eccentric and peripheral vessel location. According to USG Doppler vascular pedicles were single in 60% cases while 30% had multiple vascular pedicles. According to USG Doppler vascular pattern were regular in 60% cases while 40% had irregular vascular pedicles. These findings were consistent with the studies of Na DG et al[45] and Kumar S et al[83].

Na DG et al[45] study on usefulness of color Doppler sonography in differential diagnosis of cervical lymphadenopathy observed there is peripheral vascularity with the loss of central vascularity in tubercular and metastatic nodes. Mixed vascular pattern was seen in 85% of malignant and 76% of tubercular nodes (more commonly in malignant nodes).

Kumar S et al[83] study on USG evaluation of Cervical Lymphadenopathy with Cytological Correlation showed tubercular 7 and malignant 3 lymph nodes only

capsular vascularity and was statistically not significant. Out of the 100 lymph nodes malignant were 80%, reactive 10%, and tubercular 62% showed mixed vascularity and the association showed statically significant.

It was observed in our study that according to CT scan distribution most of cervical lymphadenopathy pathologies had location at level III (93.3%) followed by level II (86.7%) and level IV (76.7%). Similar observations were noted in the studies of Sumi M et al[91] and Mittal D et al[92].

Sumi M et al[91] study found that when the long-axis diameter criterion alone CT did not perform well. However, when the short-axis diameter was used as a size criterion, even with the size criterion alone, CT performed as well as, if not better than, when the internal architecture alone was used. The performance of CT using short-axis diameter assessment approximated that of CT using overall impression. Therefore, these findings suggest that the contribution of size determination to the dia gnostic performance was relatively greater in CT than in sonography.

Mittal D et al[92] study assessing the CECT findings in enlarged malignant cervical lymph nodes reported level II was commonest to be involved. For location IV and VI, the proportion of lymphoma groups was significantly higher as compared to other groups ($p<0.05$). 63.6% (42/66) of metastatic nodes were unilateral. Out of 27 cases 15 cases of lymphomatous nodes were bilateral.

Different anatomic levels in the neck may affect the performance of diagnostic imaging for metastatic lymph nodes. Several studies of sonography and CT have confirmed that enlarged nodes require different size criteria for different levels for predicting whether nodes are metastatic[93,94].

Diagnosis of metastatic nodes using CT also depends on assessment of changes in the internal architecture along with size determination. In this context, Curtin HD et al[93] studied the effect of size criteria and internal architectural changes of the node on diagnostic accuracy for metastatic nodes showed that the addition of information on internal architecture of the node resulted in a considerable improvement of the diagnostic accuracy of CT using long-axis length (maximum axial diameter).

The most common shape in the present study was oval (63.3%) according to CT followed by round (23.3%). This is similar to the studies of Lakshmi CR et al[82] and Mittal D et al[92].

Lakshmi CR et al[82] determining the efficacy of ultrasound in differentiating between benign and metastatic group of cervical lymph nodes reported 86.6% of metastatic cervical lymph nodes were round in shape (short axis/long axis ratio > 0.60) when compared to normal and reactive nodes which were oval (short axis/long axis ratio < 0.60) with significant *P* value ($P = 0.0015$).

Mittal D et al[92] study assessing the CECT findings in enlarged malignant cervical lymph nodes observed 90.9% (60/66) of metastatic and 66.7% (18/27) of lymphomatous lymph nodes were round.

In our study, according to CT mean diameter was 22.47± 14.10 mm and margins were regular in 66.7% cases followed by 33.3% cases. This is comparable to the study of Mittal D et al[92].

Mittal D et al[92] study assessing the CECT findings in enlarged malignant cervical lymph nodes observed short axis >10 mm was seen in 72.7% (48/66) metastatic lymph nodes and 88.9% (24/27) of lymphomatous nodes. The authors

observed blurring of margins, suspicious of extra nodal extension was seen in 31.8% (21/66) of metastatic lymph nodes, and 22.2% (6/27) lymphomatous nodes.

It was observed in the present study that according to CT enhancement pattern was homogenous in 53.3% cases and hetrogenous in 46.7% cases. Homogenous enhancement pattern was seen in 53.3% cases followed by hetrogeneous (26.7%) cases. This is concordant to the study of Mittal D et al[92].

Mittal D et al[92] study observed homogeneous enhancement in 31.8% (21/66) metastatic lymph nodes and peripheral enhancement was seen in 27.3% (18/66) of metastatic lymph nodes. 44.4% (12/27) of lymphomatous lymph nodes were non enhancing while they have homogeneous and peripheral enhancement in 44.4% (12/27) and 11.1% (3/27) cases respectively. On enhancement, the incidence of non enhancing pattern (N) was significantly higher in lymphoma groups as compared to metastatic groups (p=0.007).

It was observed in our study that Intranodal necrosis was seen in most of the cases (10%) according to CT followed by soft tissue edema (6.7%). This is consistent with the study of Mittal D et al[92].

Mittal D et al[92] study observed calcification in 9.1 % (6/66) of metastatic lymph nodes and 22.2% (6/27) of lymphomatous nodes (3 were untreated non-Hodgkin's lymphoma and 3 were Hodgkin's lymphoma). Necrosis was present in 81.8% (54/66) of metastatic lymph nodes, 22.2% (6/27) of lymphomatous nodes. Incidence of necrosis was found to be significantly higher among metastatic groups as compared to other groups (p=0.021). Matting was found in 50% (33/66) cases of metastatic lymph nodes, 22.2% (2/27) of lymphomatous nodes.

In the present study, mean RI for neoplastic lesion was 0.84±0.15 while for non neoplastic lesion was 0.61±0.10 while mean PI was 1.59±0.12 for neoplastic and

1.36±0.09 in non neoplastic lesion. This is in concordance to the study of Mittal D et al[92].

Mittal D et al[92] study reported hilum was absent in 86.4% (57/66) of metastatic lymph nodes, and 100% (27/27) lymphomatous nodes. Majority of metastatic lymph nodes were with central low density (CLD) 45.5% (30/66) followed by large confluent low density (LCLD) 31.8% (21/66), homogeneous soft tissue density (HSTD) 18.2% (12/66) and multilocular central low density (MCLD) 4.5% (3/66). Among internal architecture findings, homogeneous soft tissue density (HSTD) was more common in lymphoma groups as compared to the malignant groups (p=0.021).

In our study, according to USG non neoplastic infective lesions were 36.7% while neoplastic lesions were 26.7%. Kumar S et al[83] noted similar observations in their study.

Kumar S et al[83] study on USG Evaluation of Cervical Lymphadenopathy with Cytological Correlation reported out of 45 nonneoplastic nodes (reactive and tubercular), only 40 nodes were identified as non-neoplastic (reactive/tubercular) on ultrasound before FNAC/histopathology. Out of 35 possible neoplastic (malignant nodes) detected on ultrasound, only 29 lymph nodes turned out to be neoplastic on FNAC/histopathology.

It was observed in the present study that according to CT neoplastic lesions were 30% while non neoplastic infective lesions were 40%. This finding was consistent with the studies of Som PM[54] and Haberal I et al[95].

Som PM[54] reported the lower limits of submandibular lymph nodes and other regional neck lymph nodes to be accepted as metastasis are 15 mm and 10 mm, respectively. Haberal I et al[95] observed presence of more than one lymph node

specially conglomerated, the presence of central necrosis, Capsular invasion, extranodal involvement, and irregular contours are other criteria of metastasis in CT investigation.

It was observed in our study that according to HPR neoplastic lesions were 26.7% while non neoplastic infective lesions were 10%. On comparison of cases among USG and HPR, non neoplastic cases were 18 in both the USG and HPR, and in both USG and HPR neoplastic lesions were 9. On comparison of cases among CT and HPR, non neoplastic cases were 17 in both the CT and HPR, and in both CT and HPR neoplastic lesions were 7.

Sensitivity of USG to assess true positive cases for pathologies of cervical lymphadenopathy was more (94.7%) with respect to sensitivity of CT (89.4%). Specificity of USG to assess true negative cases for pathologies of cervical lymphadenopathy was more (81.82%) with respect to sensitivity of CT (63.64%). Accuracy for CT scan was 80% while accuracy for detection of pathologies in cervical lymphadenopathy by USG was 80%. PPV of USG was 90% and NPV of USG was 90% while PPV of CT was 80.95% and NPV of CT was 77.78%. Similar observations were noted in the studies of Lakshmi CR et al[82], Shetty D et al[85], Geetha NT et al[96], Woolgar JA et al[97], Haberal I et al[95], Bergman SA et al[98], Kumar S et al[83], Ghafoori M et al[99] and Suh CH et al[100].

Lakshmi CR et al[82] reported ultrasound in differentiating metastatic and nonmetastatic cervical lymph nodes, which include normal and reactive nodes, on ultrasonography criteria such as nodal borders and echogenic hilum had high sensitivity and specificity of 100%.

Shetty D et al[85] study evaluating the accuracy of preoperative clinical methods such as palpation, ultrasonography (USG), and computed tomography (CT) in assessing metastatic cervical lymph nodes reported among 156 levels that were evaluated in 26 patients, USG had 40 levels that were positive out of which 24 were true positive, and 16 were false positive when compared to histological examination. USG also had 106 levels negative out of which 96 were true negative, and 20 were false negative. Among 156 levels, which were evaluated in 26 patients, CT had 21 levels, which were positive out of which 14 were true positive, and 7 were false positive when compared to histological examination. CT also had 135 levels negative out of which 105 were true negative, and 30 were false negative. The sensitivity and specificity of USG was 54.5% and 85.71% whereas for CT was 31.81% and 93.75 % respectively.

Geetha NT et al[96], Woolgar JA et al[97], Haberal I et al[95] and Bergman SA et al[98] reported the accuracy, specificity, and positive predictive value is more when compared to palpation on USG and accuracy for CT ranges from 68% to 92.30%.

Kumar S et al[83] study on USG evaluation of Cervical Lymphadenopathy with Cytological Correlation reported Sensitivity and specificity of ultrasound in differentiating neoplastic from non-neoplastic cervical lymphadenopathy was 90% and 74%, respectively. A high sensitivity of 91.3%, specificity of 75.93%, positive predictive value of 91.11%, and also a negative predictive value of 76.36% in differentiating neoplastic from non-neoplastic lymphadenopathy was found. USG sensitivity, specificity, PPV and NPV are 90%, 74%, 77% & 92% for differentiating neoplastic from non-neoplastic cervical lymphadenopathy.

Ghafoori M et al[99] prospective diagnostic study determining sonographic features for differentiating metastasis from benign nodes using gray scale and Doppler Sonography in evaluation of Cervical Lymphadenopathy reported the cut-off level for

length or maximal diameter of lymph nodes was 33.5 mm and this level for width or minimal diameter of lymph nodes was 18.5 mm. Using these levels, the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of metastatic lymph nodes length were 59%, 68%, 84% and 36%, respectively and these measures for width of metastatic lymph nodes were 63%, 75%, 88% and 41%. The sensitivity, specificity and accuracy for oval shaped metastatic lymph nodes were 63%, 68% and 64%.

Suh CH et al[100] in a meta-analysis on Performance of CT in the Preoperative Diagnosis of Cervical Lymph Node Metastasis observed concerning the lateral cervical lymph nodes, CT demonstrated a summary sensitivity of 70% and a specificity of 89% and US demonstrated a summary sensitivity of 71% and a specificity of 85%. The summary estimates of sensitivity and specificity did not differ between CT and US. Regarding central cervical lymph nodes, CT demonstrated a summary sensitivity of 57% and a specificity of 85%, and US demonstrated a summary sensitivity of 38% and a specificity of 91%. Although the summary sensitivity of CT was higher than that of US, there was no significant difference (P=0.88). The summary specificity (P=0.368) did not differ between CT and US.

SUMMARY

The present study was done at our tertiary care centre on patients presenting with neck masses or with clinical suspected cases of cervical lymphadenopathy. The following observations were noted:

1. Most of the study population were from age group 21 to 40 years (30%) and 41 to 60 years (30%). The mean age was 39.47 ±20.59 years.
2. Most of the cases were female (66.7%) while males were 33.3%. Ratio of male: Female was 1:2
3. No significant association was found between age and gender of cases.
4. 30% females of age group less than 20 years and 30% of females of age group 21 to 40 years had pathologies of cervical lymphadenopathy.
5. According to USG most of the cases had cervical lymphadenopathy pathologies at level III (90%) followed by 76.7% at level II, and 70 % at level IV.
6. According to USG most of the cervical lymphadenopathy pathologies were having oval shape (70%) followed by round (16.7%).
7. Mean diameter according to USG was 22.2±13.81 mm observed in pathologies of cervical lymphadenopathy.
8. According to USG most of the cervical lymphadenopathy were having regular border (63.3%) followed by irregular borders (36.7%)
9. According to USG echogenecity was hetroechoic in most of the cases (50%) followed by homogenous echogenecity (40%)
10. According to USG, echogenic hilum was absent in 26.7% cases.

11. Reticulations (20%) was most common in 20% cases followed by Intranodal necrosis (13.3%) and calcifications (10%).
12. Flow was present in 80% cases according to USG Doppler, while it was minimal in 10% cases.
13. Vessel loacation was central in 60% cases according to USG Doppler. While 30 % cervical lymphadenopathy had eccentric and peripheral vessel location.
14. According to USG Doppler vascular pedicles were single in 60% cases while 30% had multiple vascular pedicles.
15. According to USG Doppler vascular pattern were regular in 60% cases while 40% had irregular vascular pedicles.
16. According to CT scan distribution most of cervical lymphadenopathy pathologies had location at level III (93.3%) followed by level II (86.7%) and level IV (76.7%).
17. Most common shape was oval (63.3%) according to CT followed by round (23.3%)
18. According to CT mean diameter was 22.47± 14.10 mm.
19. According to CT margins were regular in 66.7% cases followed by 33.3% cases.
20. According to CT enhancement pattern was homogenous in 53.3% cases and hetrogenous in 46.7% cases.
21. According to CT homogenous enhancement pattern was seen in 53.3% cases followed by hetrogeneous (26.7%) cases
22. Intranodal necrosis was seen in most of the cases (10%) according to CT followed by soft tissue edema (6.7%).

23. Mean RI for neoplastic lesion was 0.84±0.15 while for non neoplastic lesion was 0.61±0.10 while mean PI was 1.59±0.12 for neoplastic and 1.36±0.09 in non neoplastic lesion.
24. According to USG non neoplastic infective lesions were 36.7% while neoplastic lesions were 26.7%
25. According to CT neoplastic lesions were 30% while non neoplastic infective lesions were 40%.
26. According to HPR neoplastic lesions were 26.7% while non neoplastic infective lesions were 10%
27. On comparison of cases among USG and HPR, non neoplastic cases were 18 in both the USG and HPR, and in both USG and HPR neoplastic lesions were 9
28. On comparison of cases among CT and HPR, non neoplastic cases were 17 in both the CT and HPR, and in both CT and HPR neoplastic lesions were 7
29. Sensitivity of USG to assess true positive cases for pathologies of cervical lymphadenopathy was more (94.7%) with respect to sensitivity of CT (89.4%)
30. Specificity of USG to assess true negative cases for pathologies of cervical lymphadenopathy was more (81.82%) with respect to sensitivity of CT (63.64%)

- Accuracy for USG was more (90%) than CT scan (80%) for detection of pathologies in cervical lymphadenopathy.

31. PPV of USG was 90% and NPV of USG was 90% while PPV of CT was 80.95% and NPV of CT was 77.78%.

CONCLUSION

High resolution grey scale sonographic with color Doppler examination proved to be a valuable primary investigation to identify lymph nodes and helps to differentiate neoplastic (malignant/ metastatic) from non-neoplastic (reactive and tubercular) lymph nodes. Ultrasound evaluation is very sensitive in evaluation of intranodal architecture & vascularity and differentiating between cystic/necrotic foci and solid swellings. Easy availability, lack of a requirement for radiation and the low cost are the major advantages of sonographic examination.

The diagnostic performances of US was better than CT, though US and CT combined are superior to US alone for evaluation of cervical lymphadenopathy in patients by a level-by-level analysis. CT may be used as a complementary method in addition to US for evaluation of cervical lymphadenopathy and for differentiation of pathologies of lymph nodes.

REFRENCES

1. Bamji M, Stone R, Kaul A et al. Palpable lymph nodes in healthy newborns and infants. Pediatrics. 1986, 78:573–575
2. King D, Ramachandra J, Yeomanson D. "Lymphadenopathy in children: refer or reassure?"Archives of disease in childhood. Education and practice. 2014, 99:101–110.
3. Larsson LO, Bentzon MW, Berg K et al. Palpable lymph nodes of the neck in Swedish schoolchildren. Acta Paediatrica. 1994, 83,1092-1094.
4. Park YW. Evaluation of neck masses in children. Am. Family Physician. 1995, 51 (8): 1904- 1912
5. Stell and Maran‟s head and neck surgery 2nd chapter (Assessment) page 20-21. 4th edition.
6. Hill AR, Premkumar S, Brustein S et al. Disseminated tuberculosis in the acquired immunodeficiency syndrome era. Am Rev Respir Dis. 1991, 144:1164.
7. Cummings Otolaryngology Head & Neck Surgery, Fifth Edition vol 2 section 6, differential diagnosis of neck masses chapter 116.
8. Dudea SM, Botar-Jid C, Dumitriu D et al. “Differentiating benign from malignant superficial lymph nodes with sonoelastography.,” Med. Ultrason. 2013, vol. 15, no. 2, pp. 132–139.
9. Bhatia KSS, Cho CCM, Yuen YH et al. “Real-time qualitative ultrasound elastography of cervical lymph nodes in routine clinical practice: interobserver agreement and correlation with malignancy.,” Ultrasound Med. Biol. 2010, vol. 36, no. 12, pp. 1990–7.

10. Van den Brekel MW. US-guided fine-needle aspiration cytology of neck nodes in patients with N0 disease. Radiology. 1996, 201(2):580-581.
11. Van den Brekel MW, Reitsma LC, Quak JJ et al. Sonographically guided aspiration cytology of neck nodes for selection of treatment and follow-up in patients with N0 head and neck cancer. AJNR AmJ Neuroradiol. 1999, 20(9):1727-1731.
12. Ahuja A, Ying M. Sonography of neck lymph nodes. Part II: abnormal lymph nodes. Clin Radiol. 2003, 58(5):359-366.
13. Ahuja AT, Ying M, Ho SY et al. Ultrasound of malignant cervical lymph nodes. Cancer Imaging. 2008, 8:48-56.
14. Ying M, Ahuja A, Brook F. Accuracy of sonographic vascular features in differentiating different causes of cervical lymphadenopathy. Ultrasound Med Biol. 2004, 30(4):441-447.
15. Webb AJ. Early microscopy: history of fine needle aspiration (FNA) with particular reference to goitres. Cytopatology. 2001, 12:1-7.
16. Frable WJ. Needle aspiration biopsy: past, present and future. Hum Pathol. 1989, 20:504-517.
17. Ansari NA, Derias NW. Fine needle aspiration cytology. J Clin Pathol. 1997, 50:541-543.
18. Stewart FW. The diagnosis of tumour by aspiration. Am J Pathol. 1933, 9: 801-812.
19. Martin HE, Ellis EB. Biopsy by needle puncture and aspiration. Ann Surg. 1930, 92:169-181.
20. Singh IB and Pal GP. Human Embryology, 7th Edition. 2001, 265-266.

21. Sadler TW. Langman‟s Medical Embryology. Williams and Wilkins: Baltimore. 1995, 228-30
22. Moore and Persaud. The Developing Human – Clinical Oriented Embryology, 7th Edition. 2003, 375-379 .
23. AJCC Cancer Staging Manual Summery of Changes from Sixth to seventh edition. www.cancerstaging.com.
24. Rouvière H. Lymphatic system of the head and neck. Tobias M, Translator. Ann Arbor, MI: Edwards Brothers, 1938.
25. .Pandey A, Kureel SN, Pandey J et al. Chronic cervical Lymphadenopathy in children: Role of ultrasonography. Journal of Indian Association of Paediatric Surgeons. 2012, 17(2): p 58-62.
26. Lankeshwar S, Ramchandra U, Prabhu NB. A study of assessment of prevalence of infection and tubercular cervical Lymphadenopathy in Rural school of Naga Mangal a Taluka Dist Mandya , Karnataka State. International Journal of recent trends in science and technology. 2013, 9(1): 2013 pg.
27. Sambandan T, christefi MR. Cervical Lymphadenopathy - A review .JIADS. 2011, 2(1),p 31-33
28. Bharadwaj JR. Boyd‟s Textbook of Pathology, 10 th edition Lippincott Williams & Wilkins.
29. Pamra ST and Mathur GP. A cooperative study of tuberculous cervical Lymphadenopathy. Indian Journal of Medical Research. 1974, 6(2):11-14.
30. Orell SR, Sterrett GF, Whitaker D. Fine needle aspiration cytology, Elsevier Churchill Livingstone, 2005.

31. Andry G, Dor P. Diagnosis and surgical treatment of metastatic cervical adenopathies. Acta Chir Belg. 1983, 83(2):124-9.
32. Hakej PC, Salomonwitz E, Turk R et al. Lymph Nodes Of neck; evaluation with US.Radiology.1986, 158:739-4
33. Ying M, Ahuja A. Sonography of neck lymph nodes. I. Normal lymph nodes. Clin Radiol. 2003, 58:351 –358.
34. van den Brekel MW, Castelijns JA, Stel HV et al. Modern imaging techniques and ultrasound-guided aspiration cytology for the assessment of neck node metastases: a prospective comparative study. Eur Arch Otorhinolaryngol. 1993, 250:11 –17
35. Ahuja A, Ying M. Sonography of neck lymph nodes. II. Abnormal lymph nodes. Clin Radiol. 2003, 58:359 –366.
36. Ahuja AT, Ying M, Yuen HY et al. `Pseudocystic' appearance of non-Hodgkin's lymphomatous nodes: an infrequent finding with high-resolution transducers. Clin Radiol. 2001, 56:111 –115
37. Ahuja A, Ying M. Sonographic evaluation of cervical lymphadenopathy: is power Doppler sonography routinely indicated? Ultrasound Med Biol. 2003, 29:353 –359.
38. Ahuja A, Ying M, Yuen YH et al. Power Doppler sonography to differentiate tuberculous cervical lymphadenopathy from nasopharyngeal carcinoma. AJNR. 2001, 22:735 –740.
39. Ying M, Ahuja AT, Yuen HY. Grey-scale and power Doppler sonography of unusual cervical lymphadenopathy. Ultrasound Med Biol. 2004, 30:449 –454.

40. Ying M, Ahuja A, Brook F et al. “Sonographic appearance and distribution of normal cervical lymph nodes in a Chinese population.,” J. Ultrasound Med. 1996, vol. 15, no. 6, pp. 431–6.
41. Som PM, Brandwein M, Lidov M et al. “The varied presentations of papillary thyroid carcinoma cervical nodal disease: CT and MR findings.,” AJNR. Am. J. Neuroradiol. 1994, vol. 15, no. 6, pp. 1123–8.
42. Ahuja AT, Chow L, Chick W et al. Metastatic cervical nodes in papillary carcinoma of the thyroid: ultrasound and histological correlation. Clin Radiol. 1995, 50:229–331
43. Maurer J, Willam C, Schroeder R et al. Evaluation of metastases and reactive lymph nodes in Doppler sonography using an ultrasound contrast enhancer. Invest Radiol. 1997, 32:441–446.
44. Ariji Y, Kimura Y, Hayashi N et al. Power Doppler sonography of cervical lymph nodes in patients with head and neck cancer. AJNR Am J Neuroradiol. Power Doppler sonography of cervical lymph nodes in patients with head and neck cancer. AJNR Am J Neuroradiol. 1998, 19:303–307.”
45. Na DG, Lim HK, Byun HS et al. Differential diagnosis of cervical lymphadenopathy: usefulness of color Doppler sonography. AJR Am J Roentgenol. 1997, 168:1311–1316.
46. Papakonstantinou O, Bakantaki A, Paspalaki P et al. High-resolution and color Doppler ultrasonography of cervical lymphadenopathy in children. Acta Radiol. 2001, 42:470–476.
47. Reede DL, Whelan MA, Bergeron RT. Computed tomography of the infrahyoid neck, parts I and II. Radiology. 1982, 145:389–402.

48. Mancuso AA, Maceri D, Rice D et al. CT of cervical lymph node cancer. AJR. 1981, 135:381–5.
49. Silverman PM, Korobkin M, Moor AV. Computed tomography of cystic neck masses. J Comput Assist Tomogr. 1983, 7:498–502.
50. Mancuso AA, Hanafee W. 2nd edn. Baltimore, MD: Williams & Wilkins. Computed Tomography and Magnetic Resonance Imaging of the Head and Neck, 1985.
51. Rouviere H, Arbor AMI. Edwards. Lymphatic System of the Head and Neck. 1983.
52. Svojanen JN, MvKherji SK, Supuy DE et al. Spiral CT in evaluation of head and neck lesions. Radiology. 1992, 183:281–3.
53. Van den Brekel MWM, Castelings JA, Snow G. Detection of lymph node metastases in the neck: radiologic criteria. Radiology. 1994, 192:617–8.
54. Som PM. Detection of metastasis in cervical lymph node: CT and MR criteria and differential diagnosis. AJR. 1992, 158:961–9.
55. Spiro RH. The management of neck nodes in head and neck cancer: a surgeon's view. Bull NY Acad Med. 1985, 61:629–37.
56. Beahrs OH, Henson DE, Hutter RVP et al. 3rd edn. Philadelphia, PA: Lippincott. Manual for Staging Cancer. 1988.
57. Robbins KT. Alexandria, VA: American Academy of Otolaryngology—Head and Neck Surgery Foundation. Pocket Guide to Neck Dissection and TNM Staging of Head and Neck Cancer, 1991.
58. Lindberg RD. Distribution of cervical lymph node metastases from squamous cell carcinoma of the upper respiratory and digestive tracts. Cancer. 1972, 29:1446–9.

59. Van den Brekel MWM. Utrecht: University of Amsterdam. Assessment of Lymph Node Metastases in the Neck: A Radiological and Histopathological Study, 1992.
60. Fleming ID, Cooper JS, Henson DE et al. 5th edn. Philadelphia, PA: Lippincott–Raven. American Joint Committee on Cancer Staging Manual. 1997.
61. Feinmesse R, Freeman JL, Nojek AM et al. Metastatic neck disease: a clinical/radiographic/pathologic correlative study. Arch Otolaryngol Head Neck Surg. 1987, 113:1307–10.
62. Close LG, Merkel M, Vuitch MF et al. Computed tomographic evaluation of regional lymph node involvement in cancer of the oral cavity and oropharynx. Head Neck. 1989, 11:309–17.
63. Stevens MH, Harnsberger R, Mancuso AA et al. Computed tomography of cervical lymph nodes: staging and management of head and neck cancer. Arch Otolaryngol Head Neck Surg. 1985, 111:735–9.
64. Som PM, Curtin HD, Mancuso AA. An imaging-based classification for the cervical nodes designed as an adjunct to recent clinically based nodal classifications. Arch Otolaryngol Head Neck Surg. 1999, 125:388–96.
65. Som PM, Curtin HD, Mancuso AA. Imaging-based nodal classification for evaluation of neck metastatic adenopathy. AJR. 2000, 174:837–44.
66. Mancuso AA, Hamsberger HR, Muraki AS et al. Computed tomography of cervical and retropharyngeal lymph nodes: normal anatomy, variants of normal, and applications in staging head and neck carcinoma, parts I and II. Radiology. 1983, 148:709–23.

67. Robbins KT, Medina JE, Wolfe GT et al. Standardizing neck dissection terminology. Arch Otolaryngol Head Neck Surg. 1991, 117:601–5.
68. Husband JES, Reznek RH. 2nd edn. Oxford: ICIS Medical Media Ltd. Imaging in Oncology: Tumors of the Pharynx, Tongue, and Mouth, 2004.
69. Som PM, Brandwein MS. 4th edn. St. Louis, MO: Mosby. Lymph Nodes in Head and Neck Imaging, 2003.
70. Rouviere H. Anatomy of the Human Lymphatic System. Ann AMI: Edward Brothers, 1938.
71. Shah JP, Strong E, Spiro RH et al. Surgical grand rounds: neck dissection: current status and future possibilities. Clin Bull. 1981, 11:25–33.
72. O'Brien CJ, Smith JW, Soong SJ et al. Neck dissections with and without radiotherapy—prognostic factors, patterns of recurrence and survival. Am J Surg. 1986, 152:456–63.
73. Johnson JT, Barnes EL, Myers EN. The extracapsular spread of tumors in cervical nodal metastasis. Arch Otolaryngol Head Neck Surg. 1981, 107:725–8.
74. Leemans CR, Tiwari R, Nauta JJ et al. Regional lymph node involvement and its significance in the development of distant metastasis in head and neck carcinoma. Cancer. 1993, 71:452–6.
75. Teo PML, Leung SF, Yu P et al. A comparison of Ho's, International Union Against Cancer, and American Joint Committee stage classifications for nasopharyngeal carcinoma. Cancer. 1991, 167:434–9.
76. Medina JE, Houck JR, O'Malley BB et al. Management of cervical lymph nodes in SCC of head and neck. editors. Head and Neck Cancer. Philadelphia, PA: Lippincott-Raven. 1999, pp. 353–77.

77. Yousem DM, Hatabu H, Hurst RW et al. Carotid artery invasion by head and neck masses: prediction by MR imaging. Radiology. 1995,195:715–20.
78. Pratap V, Jain SK, Choudhary AK et al. Efficacy Evaluation of Ultrasonography and Computerized Tomography in Palpable Neck Masses. Journal of Evolution of Medical and Dental Sciences. 2013, Vol 2, Issue 41, Page: 7891-7898.
79. Thakkar DK, Khaladkar S, Jantre M et al. Evaluation of neck lesions with MDCT – A case series. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS). 2015, Volume 14, Issue 8 Ver. III , PP 66-80.
80. Kaji AV, Mohuchy T, Swartz JD. Imaging of cervical lymphadenopathy. Semin Ultrasound CT MR 1997;18:220-49.
81. Vassallo P, Wernecke K, Nikolus roos. Differentiation of benign from malignant superfi cial lymphadenopathy: The role of high resolution US. Radiology 1992;83:215-220.
82. Lakshmi CR, Rao S, Ravikiran A et al. Evaluation of Reliability of Ultrasonographic Parameters in Differentiating Benign and Metastatic Cervical Group of Lymph Nodes. ISRN Otolaryngology, 2014, Volume 2014, Article ID 238740, 7 pages.
83. Kumar S, Pande S, Shrivastava G. Ultrasonographic Evaluation of Cervical Lymphadenopathy with Cytological Correlation. Int J Sci Stud 2017;4(11):180-185.
84. Chikui T, Yonetsu K, Nakamura T. Multivariate feature analysis of sonographic findings of metastatic cervical lymph nodes: Contribution of blood flow features revealed by power Doppler sonography for predicting metastasis. AJNR Am J Neuroradiol. 2000;21:561–7.

85. Shetty, D, Jayade BV, Joshi SK et al. Accuracy of palpation, ultrasonography, and computed tomography in the evaluation of metastatic cervical lymph nodes in head and neck cancer. Indian journal of dentistry. 2015;6(3):121–124.
86. Ahuja AT, Ying M. “Sonographic evaluation of cervical lymph nodes,” American Journal of Roentgenology, vol. 184, no. 5, pp. 1691–1699, 2005002E
87. Vassallo P, Edel G, Roos N et al. “Invitro high-resolution ultrasonography of benign and malignant lymph nodes: a sonographic-pathologic correlation,” Investigative Radiology, 1993;28(8): 698–705,.
88. Evans RM, Ahuja A, Metreweli C. “The linear echogenic hilus in cervical lymphadenopathy—a sign of benignity or malignancy?” Clinical Radiology1993;47(4): 262–264.
89. Yusha H et al. “Power Doppler ultrasonographic differentiation of benign and metastatic cervical lymph node,” Journal of Ultrasound in Medicine, 1999; 12: 948–951.
90. M. Ying, Ahuja A, Brook F. “Gray scale and power doppler sonography of normal cervical lymph nodes comparison Between chinese and white Subjects,” Journal of Ultrasound in Medicine, 2002;21(1): 59–65.
91. Sumi M, Ohki M, Nakamura T. Comparison of Sonography and CT for Differentiating Benign from Malignant Cervical Lymph Nodes in Patients with Squamous Cell Carcinoma of the Head and Neck. American Journal of Roentgenology. 2001;176: 1019-1024.

92. Mittal D, Dhawan S. Role Of Contrast Enhanced Computed Tomography In Cervical Lymphadenopathy In Head and Neck Malignancy. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS). 2019; 18(6):23-30.
93. Curtin HD, Ishwaran H, Mancuso AA et al. Comparison of CT and MR imaging in staging of neck metastases. Radiology 1998; 207:123-130.
94. van den Brekel MWM, Castelijns JA, Snow GB. The size of lymph nodes in the neck on sonograms as a radiologic criterion for metastasis: how reliable is it? AJNR 1998; 19:695-700
95. Haberal I, Celik H, Gocmen H et al. H, Yurok M, Ozeri C. Which is important in the evaluation of metastatic lymph nodes in head and neck cancer: Palpation, ultrasonography, or computed tomography? Otolaryngol Head Neck Surg. 2004;130:197–201.
96. Geetha NT, Hallur N, Goudar G et al. Cervical lymph node metastasis in oral squamous carcinoma preoperative assessment and histopathology after neck dissection. J Maxillofac Oral Surg. 2010;9:42–7.
97. Woolgar JA, Beirne JC, Vaughan ED et al. Correlation of histopathologic findings with clinical and radiologic assessments of cervical lymph-node metastases in oral cancer. Int J Oral Maxillofac Surg. 1995;24:30–7.
98. Bergman SA, Ord RA, Rothman M. Accuracy of clinical examination versus computed tomography in detecting occult lymph node involvement in patients with oral epidermoid carcinoma. J Oral Maxillofac Surg. 1994;52:1236–9.
99. Ghafoori M, Azizian A, Pourrajabi Z et al. Sonographic Evaluation of Cervical Lymphadenopathy; Comparison of Metastatic and Reactive Lymph Nodes in Patients With Head and Neck Squamous Cell Carcinoma Using Gray Scale and Doppler Techniques. Iran J Radiol. 2015;12(3):e11044.

100. Suh CH, Baek JH, Choi YJ et al. Performance of CT in the Preoperative Diagnosis of Cervical Lymph Node Metastasis in Patients with Papillary Thyroid Cancer: A Systematic Review and Meta-Analysis. AJNR Am J Neuroradiol. 2017. A4967, 1-8.

ANNEXURE-2

CASE SHEET PROFORMA

- NAME:
- AGE:
- SEX:
- CHIEF COMPLAINTS/HISTORY:

RELEVANT EXAMINATION FINDINGS:

- Palpation of lymph nodes for

  Location

  Number

  Mobility

  Presence of any local changes like redness, discharge or sinus formation.

- **RADIOLOGICAL FINDINGS :**

B scan criteria

Criterion

Size

Shape ovoid/ round/ irregular

Extent

Number

Hilum

Echogenicity

Margins

Structural changes

- focal cortical nodules
- intranodal necrosis
- reticulation
- calcification
- matting.

Extracapsular spread

Invasion of vascular/ surrounding structutes.

Soft tissue edema

Doppler criteria

Flow

Vessel location

Vascular pedicles

Vascular pattern

Doppler Indices - RI & PI

CT SCAN CRITERIA

Size

Shape

Margins

Extent

Structural changes

- focal cortical nodules

- intranodal necrosis
- reticulation
- calcification
- matting
-

Extracapsular spread

Invasion of vascular/ surrounding structures.

Soft tissue edema

Enhancement pattern

KEY TO MASTER CHART

sl.no	-	Serial number
USG	–	Ultrasonography
CT	–	Computed tomography
RI	-	Resistive index
PI	-	Pulsatility index

MASTERCHART

								USG	
Sl .no	**age (yrs)**	**Sex**	**Location**	**Size (mm)**	**Shape & number**	**Border**	**Echogenecity**	**echogenic hilum**	**Structural changes**
1	7	Female	level II & III	30x17	oval and regular	well defined and regular	hypoechoic	Central	-
2	65	male	I(right)	20x20	round	irregular and blurred	hypoechoic	Lost	punctate calcification
3	6	female	II & III	20X10	oval	well defined	heteroechoic with a focal hypoechoic area within	Present	--
4	65	female	I - V	40X36	irregular to round	irregular	heteroechoic with subcapsular hypoechoic area.		intranodular necrosis, reticulations, calcification, matting
5	32	male	I-IV	14x8	oval to round	regular	heterogenous	Central	-
6	10	female	I & II	12x10	oval	well defined	homogenously hypoechoic	Present	reticulations
7	40	female	V(right)	85x85	round to ill defined	ill defined with eccentric cortical thickening	heteroechoic with hypoechoic central region	Lost	intranodal necrosis
8	19	female	II & III	19x14	oval	well defined	heteroechoic with hypoechoic central area	Present	intranodular necrosis, reticulations, calcification, matting
9	30	female	III & IV	16X12	oval	well defined	hypoechoic	Present	-
10	70	female	III & IV	24x22	oval to round	ill defined	heteroechoic	Eccentric	focal cortical nodule
11	50	female	III, IV & V	23X15	round	irregular	heteroechoic	Lost	--
12	35	female	I-V	12x8	irregular	ill defined	heterogenous	Lost	-
13	46	male	I - IV	23x11	irregular	ill defined	heteroechoic	Lost	Subcapsular hypoechogenecity, soft tissue edema
14	35	female	II - IV	18x18	oval	regular	homogenous	Present	--
15	38	female	II - V	12X10	oval	regular	homogenous	Present	--
16	45	female	II, III	12x10	oval	regular	homogenous	Present	
17	75	female	II - IV	18x15	round	irregular	heterogenous	present	--
18	48	male	I - III	14x8	ovoid	regular	heterogenous	Present	Intranodal necrosis and soft tissue edema
19	7	female	III - V	26X12	ovoid	regular	homogenous	Present	
20	57	male	III - V	22x8	ovoid	regular	homogenous		--
21	35	male	I - V	30x15	irregular	irregular	heterogenous	Absent	--
22	60	male	II - V	26x18	round to irregular	irregular	heterogenous	Present	--
23	55	female	I - IV	16x20	ovoid	regular	homogenous	present	--
24	42	female	II - IV	20x10	ovoid	regular	homogenous	Present	--
25	75	male	I - IV	12x10	ovoid	regular	homogenous	Present	--
26	30	male	I - III	18x12	ovoid	regular	homogenous	Present	--
27	15	female	I - IV	17x12	ovoid to round	regular	heterogenous	Present	--
28	50	female	II - V	36x26	regular	irregular	heterogenous	Present	Focal cortical nodule
29	14	male	I - IV	15x10	regular	regular	homogenous	Present	--
30	28	female	I - V	16X10	regular	regular	homogenous	Present	--

Doppler					
Flow	**Vessel location**	**Vascular pedicles**	**Vascular pattern**	**RI**	**PI**
Present	central a& hilar	single	regular	0.65	1.31
present	peripherally displaced	multiple	chaotic and mixed	0.9	1.55
present	central	single	regular	0.61	1.37
present	peripheral and eccentric with absent hilar flow	multiple	irregular	0.74	1.46
present	central	multiple	regular	0.76	1.5
present	central	single	regular	0.66	1.25
present	mixed flow, predominantly peripheral	single	irregular	0.86	1.54
absent	-	single	irregular	0.44	1.36
present	central	single	regular	0.48	1.4
absent	-	multiple	irregular and chaotic	0.84	1.68
absent	-	multiple	chaotic and mixed	0.94	1.7
present	peripheral and eccentric	multiple	mixed and irregular	0.86	1.58
present	eccentric and peripheral	multiple	chaotic and mixed	0.94	1.68
present	central	single	regular	0.66	1.34
present	central	single	regular	0.64	1.28
present	central	single	regular	0.64	1.28
present	central	single	regular	0.56	1.3
minimal	peripheral and eccentric	multiple	mixed	0.84	1.52
present	central	single	regular	0.68	1.44
present	central	single	regular	0.44	1.28
present	central	single	regular	0.54	1.4
minimal	peripheral	multiple	chaotic and mixed	0.98	1.74
present	peripheral	multiple	mixed	0.94	1.7
present	central	single	regular	0.56	1.34
present	central	single	regular	0.48	1.3
present	central	single	regular	0.46	1.28
present	central	single	regular	0.54	1.38
present	central	single	irregular	0.78	1.6
minimal	peripheral and eccentric	multiple	regular	0.68	1.44
present	central	single	regular	0.64	1.3
present	central	single	regular	0.66	1.28

	CT					
Sl .no	**Location**	**size**	**Shape**	**margins**	**enhancement pattern**	**structural changes**
1	level II & III	30x17	Oval	regular	homogenous	
2	I& II(right)	18x19	Round	irregular with eccentric cortical buldge	heterogenous	
3	II & III	20x10	Oval	regular	homogenous with a non enhancing focal area within	
4	I - V	43X35	Oval	irregular	homogenous with non enhancing central area	conglomeration
5	I - V	14x10	round to irregular	ill defined	heterogenous with non enhancing central area	-
6	I - III	14x12	Oval	well defined	homogenous	-
7	V (right)	87x84	oval to round	well defined	peripheral enhancement with non enhancing central region	intranodal necrosis
8	II, III & IV	22x18 mm	Oval	regular	peripheral enhancement with non enhancing central area	intranodal necrosis
9	II, III & IV	20x12	Oval	regular	homogenous	-
10	II, III & IV	24x24	Round	irregular to blurred margins	heterogenous enhancement with few non enhancing areas	-
11	III, IV & V	20X15	Oval	regular	heterogenous enhancement	
12	I-VI	12x10	Round	irregular	heterogenous	
13	I - IV	24x10	Irregular	irregular	heterogenous	subcapsular hypodensity and soft tissue edema
14	II - IV	20x20	Oval	regular	homogenous	
15	II - V	14x10	Oval	regular	homogenous	
16	III, III	12x10	Oval	regular	homogenous	
17	II - V	18x12	Irregular	irregular	heterogenous	
18	I - IV	14x10	oval to round	regular	heterogenous with non enhancingnecrotic foci within	Intranodal necrosis and soft tissue edema
19	III - V	20x10	Ovoid	regular	homogenous	
20	III - V	22x8	Ovoid	regular	homogenous	--
21	I-V	30x15	Regular	regular	heterogenous	--
22	II - V	25x20	Irregular	irregular	heterogenous	--
23	I-IV	16x20	Ovoid	regular	homogenous	--
24	II - IV	20x10	Round	irregular	heterogenous	--
25	I - IV	12x10	Ovoid	regular	homogenous	--
26	I- III	18x13	Ovoid	regular	homogenous	--
27	I - IV	17x12	Ovoid	regular	homogenous	--
28	II - V	36x24	Irregular	irregular	heterogenous	Focal cortical nodules
29	I - V	16X10	Regular	regular	homogenous	--
30	I - V	16x12	Regular	regular	homogenous	--

SL.NO	**USG**	**CT**	**HPR**
1	Non neoplastic (infective)	Non reactice (infective)	Non neoplastic
2	Neoplastic	Neoplastic	Neoplastic
3	Non neoplastic - Infective	Non neoplastic - infective	Non neoplastic - infective
4	Non neoplastic - tuberculosis	Non neoplastic - tuberculosis	Non neoplastic - tuberculosis
5	Non neoplastic	Neoplastic	Non neoplastic
6	Non neoplastic	Non neoplastic	Non neoplastic
7	Neoplastic	Non neoplastic - tuberculosis	Neoplastic
8	Non neoplastic - tuberculosis	Non neoplastic - tuberculosis	Neoplastic
9	Non neoplastic - infective	Non neoplastic - infective	Non neoplastic - infective
10	Neoplastic	Neoplastic	Neoplastic
11	Neoplastic - lymphoma	Non neoplastic	Neoplastic - Non hodgkins lymphoma
12	Neoplastic - lymphoma	Neoplastic	Neoplastic - hodgkins lymphoma
13	Neoplastic	Neoplastic	Neoplastic
14	Non neoplastic - non specific/ reactive	Non neoplastic - non specific/ reactive	Non neoplastic - non specific/ reactive
15	Non neoplastic - infective	Non neoplastic - infective	Non neoplastic - infective
16	Non neoplastic -Infective	Non neoplastic - infective	Non neoplastic - infective
17	Neoplastic	Neoplastic	Neoplastic
18	Non neoplastic - tuberculosis	Non neoplastic - tuberculosis	Non neoplastic - tuberculosis
19	Non neoplastic - Non specific	Non neoplastic - Non specific	Non neoplastic - Non specific
20	Non neoplastic - infective	Non neoplastic - infective	Non neoplastic - infective
21	Neoplastic	Non neoplastic - infective	Neoplastic - non hodgkins lymphoma
22	Neoplastic	Neoplastic	Neoplastic
23	Non neoplastic - infective	Non neoplastic - Infective	Non neoplastic - infective
24	Non neoplastic - infective	Neoplastic	Non neoplastic - infective
25	Non neoplastic - infective	Non neoplastic - infective	Non neoplastic - infective
26	Non neoplastic - non specific	Non neoplastic - non specific	Non neoplastic - non specific
27	Neoplastic	Non neoplastic - infective	Non neoplastic - infective
28	Non neoplastic	Neoplastic	Neoplastic
29	Non neoplastic - infective	Non neoplastic - infective	Non neoplastic - infective
30	Non neoplastic - infective	Non neoplastic - infective	Non neoplastic - infective