"EVALUATION OF CERVICAL LYMPHADENOPATHY BY ULTRASOUND IN COMPARISION WITH FNAC"

By

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In partial fulfillment of the requirements for the degree of

DOCTOR OF MEDICINE

IN

RADIODIAGNOSIS

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Dr. SINDHOORI KOMMA

LIST OF ABBREVIATIONS

AJCC	American Joint Committee of Cancer
CT	Computed tomography
CDS	Color doppler sonography
FNAC	Fine needle aspiration cytology
L/S ratio	Long axis / Short axis
M	Malignant lymphadenopathy
MHz	Megahertz
MRI	Magnetic resonance imaging
R	Reactive lymphadenopathy
SCM	Sternocleidomastoid muscle
SHL	Sinus histiocytosis with lymphadenopathy
T	Tubercular lymphadenopathy
TB	Tuberculosis
USG (US)	Ultrasonography

ABSTRACT

AIMS AND OBJECTIVES:

1. To study and differentiate neoplastic (malignant) and nonneoplastic (reactive and tubercular) cervical lymph nodes by High resolution ultrasonography
2. To correlate the diagnostic accuracy of ultrasound with FNAC in differentiating neoplastic (malignant) and nonneoplastic (reactive and tubercular) cervical lymphadenopathy

MATERIAL AND METHODS:

Data was collected from a total of 83 cases referred for ultrasound of neck to the Department of Radiodiagnosis, Sri R.L. Jalappa Hospital and Research Center over a period of 16 months from December 2011 to April 2013, with 5-10 MH linear transducer using SEIMENS G 40 /G 50/ Acuson Ax 300 ultrasound equipment. Lymph nodes were assessed using grey scale and colour Doppler parameters like : nodal level and site, nodal size, nodal shape, nodal L/S ratio, nodal border, nodal hilum, nodal echotexture, nodal necrosis, nodal matting and nodal angioarchitecture [hilar vessels, focal absence of perfusion, capsular vessels (peripheral),displacement and mixed flow] .A provisional diagnosis was suggested after the ultrasound examination and these findings were correlated with Fine Needle Aspiration Cytology / Histopathological findings.

RESULTS :

Our study out of 41 non neoplastic nodes (reactive and tubercular) only 37 nodes were identified as nonneoplastic (reactive / tubercular) on ultrasound prior to FNAC. Out of 49 possible neoplastic (malignant nodes) detected on ultrasound only 38 lymph nodes turned out to be neoplastic on FNAC/ histopathology. Lymph node with oval shape (L/S ratio > 2) ,echogenic hilum, homogenous echotexture and hilar

vascularity were considered as significant parameters in detecting nonneoplastic lymphnodes (tubercular lymphnodes). Nodes which were round. Lymph nodes ,which showed matting with soft tissue edema were considered as significant parameters in detecting nonneoplastic lymphnodes (tubercular lymphnodes). Nodes which were Round shape (L/S ratio < 2), absent hilum, heterogenous echotexture, capsular vessels, mixed vessels, displacement of vessels and focal absence of perfusion were considered as neoplastic (malignant) lymph nodes. Correlation of sonographic findings with

Fine Needle Aspiration Cytology / Histopathological findings. Sensitivity and Specificity of ultrasound in differentiating neoplastic from non neoplastic cervical lymphadenopathy was found to be 90% and 74% respectively.

CONCLUSION:

This study concludes that:

1) High resolution ultrasonographic examination proved as a valuable primary investigation to identify lymph nodes and differentiate nonneoplastic and neoplastic lymphadenopathy.

2) Combination of ultrasonographic features and vascular pattern of the lymph nodes have a high sensitivity, specificity in differentiating neoplastic and non neoplastic lymphadenopathy.

Key words: - Ultrasonography, Doppler, Cervical lymphadenopathy.

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INTRODUCTION

The highest number of lymph nodes in the human body containing nearly 300 of the body's total of 800 lymph nodes is found in cervical region. These nodes are surrounded by varying amounts of fibroadipose tissue.

Cervical lymphadenopathy is one of the most common cause of mass in head and neck region there are various causes of CL common among them are reactive, tuberculosis, metastasis and lymphoma .

The differentiation helps in both planning treatment and prognosis. Imaging modalities for the evaluation of cervical lymphadenopathy are ultrasound, CT, MRI and USG guided FNAC. Recent advances include PET, PET CT and ultrasound elastography.[1]Biopsy and other pathological tests are invasive and time consuming.

Ultrasound is preferred because it is easily available, cost effective, radiation free and safe investigation over CT and MRI .

Ultrasound has been shown to have higher sensitivity than palpation for detecting enlarged lymph nodes in patients who have suspected regional lymph node enlargement. ultrasound can evaluate the internal architecture of lymph nodes due to improve spatial and contrast resolution which helps in indentifying etiology of lymphadenopathy.

Ultrasonographic criteria for distinguishing neoplastic and nonneoplastic lymph nodes have been studied under site, shape,size, echogenicity, hilus, matting, nodal border, long/short axis ratio, intra nodal necrosis and angioarchitecture.[2]

Ultrasonographic features that help to identify abnormal nodes as well as giving clues to neoplastic nodes are heterogeneous echogenecity, absent hilus, invasion, and intranodal necrosis. The shape is the best method to attempt the differentiation between neoplastic and nonneoplastic lymph nodes. The Long/short diameter ratio of lymph node provides excellent criteria for differentiation between neoplastic and nonneoplastic cervical lymphadenopathy.[3]

By using colour / power Doppler Sonography can further characterize lymphnodes as non neoplastic (reactively, tubercular) and neoplastic. The non neoplastic(reactive) nodes show increased central hilar vascularity, with radial symmetry whereas, neoplastic(malignant) nodes show displaced or absent hilar vascularity and increased peripheral vascularity.[2]

This study has been conducted to evaluate the efficacy of ultrasonography and doppler to differentiate nonneoplastic(reactive and tubercular) from neoplastic (malignant) cervical lymphadenopathy and findings are correlated with other diagnostic procedures like fine needle aspiration cytology(FNAC)/ histopathology.

AIMS AND OBJECTIVES

- To study and differentiate neoplastic(malignant) and nonneoplastic cervical (reactive and tubercular)lymph nodes by High Resolution Ultrasonography.

- To correlate the diagnostic accuracy of ultrasound with Fine Needle Aspiration Cytology in differentiating neoplastic (malignant) and nonneoplastic cervical (reactive and tubercular) lymphadenopathy

REVIEW OF LITERATURE

ULTRASOUND AND DOPPLER PHYSICS

ULTRASONOGRAPHY –BASIC PHYSICS [4]

Ultrasound pulses are usually produced by scanners of frequency from 2-10 Mhz (1MHz is 1000000 cycles per sec). The duration of the pulse is nearly about one microsecond (ie a millionth of a second) and these ultrasound pulses are repeated 1000 times per second. Some tissues reflect waves directly and some others scatter the waves before they return to the transducer as echoes depend upon the tissue, different tissue alter the waves in different ways. The waves that pass through the different tissues travel at different speed, (1540 cms per sec through soft tissues.)

The reflected ultrasound pulses which are detected by the transducer are amplified in the scanner. The echoes that come from deep within the body are more attenuated when compare to superficial parts. So the echoes that come from deep within the body require more amplification. Ultra sound scanners have controls on overall sensitivity, the threshold of the instrument and even for change of amplification of the echoes from the different depths. When working with any scanner needs to achieve a balanced image that contains echoes of approximately equal strength from all depths of tissues. When these echoes return to transducer, so it is possible to reconstruct a two dimensional map of all the tissues that is there in the beams. This information which is stored in a computer will be displayed on video monitor. Strong echoes have high intensity and appear as bright dots on the screen. Transducer is both transmitter and receiver of ultra sound. The ultrasound waves are generated by Piezo- Electric crystals in transducer which can turn electric signals into

mechanical waves. The same transducer also receive the reflected ultrasound and change it back into electric signal.

DOPPLER PHYSICS INTRODUCTION:

Johann Christian Doppler had described the Doppler effect in1842. Sautomura stated that ultrasound can derive information of the velocity of blood flow by using the Doppler effect. The first continuous wave Doppler system was developed at the University of Washington was termed ***"DOPOTONE".***

THE DOPPLER EFFECT:

When energy is reflected from a moving boundary, the frequency of the reflected energy varies is in relation to the velocity of the moving boundary. There will be change in frequency which is known as the **"DOPPLER FREQUENCY SHIFT'**

The Doppler Frequency shift is calculated by the equation

$$\Delta F = (FR - FT) \quad \text{----------or} \quad V = \frac{2FT.V.Cos\Phi}{C} \quad \text{----------} \quad \frac{\Delta F.C}{2\,FT\,Cos\Phi}$$

FT = Frequency of Transmitting source in cycles/second

V = Velocity of blood flow

CosΦ = Cosine of angle of insonation

C = Velocity of sound in tissue (1540 m/s)

FR = is the reflected frequency

ΔF = (Frequency Shift) = Difference in frequency between the emitted and returning sound.

(The denominator contains the number 2 which denotes for the time taken for the

incident USG beam to pass through the tissues from the transducer and the reflected beam to return to the transducer).

These principle determine the velocity of blood flow in the vessels. The frequency of sound reflected off moving blood cells is slightly altered from the sound emitted from the source (the transducer) in proportion to the velocity of the blood.

INSTRUMENTATION (DOPPLER MODES):

- Continuous wave Doppler (CW)
- Pulsed wave Doppler (PW)
- Color flow mapping (CF)
- Duplex sonography
- Power Mode Doppler

ANATOMY OF CERVICAL LYMPH NODES

EMBRYOLOGY-

The lymphatics arises from the embryogenic mesenchyme. This system is closely related to and develops with the other systems for the return of fluid from the tissue space. There are two theories are proposed for the origin of the system. In 1902, Sabin proposed a budding and sprouting of endothelial cells from veins into lymph sacs. Pair of these develops in the neck and are called as jugular lymph sacs. A pair of them appears near the iliac veins (at the junction of iliac and posterior cardinal vein). Two of them appear near the posterior abdominal wall, one in retroperitoneal near the root of mesentry and one cysterna chyli dorsal to retroperitoneal sac.[5]

In 1909, Huntington and McClure has suggested the development of lymph sacs from mesenchyme, followed by venous endothelial sprouting in the lymph sacs. This centripetal theory development was supported by studies in avian species (Schneider et al. 1999).[6] Cells lining the spaces are at first undifferentiated mesenchymal cells, but later they become altered to form the endothelium of the lymphatic vessels. The definitive lymph space, which represent the beginning of the definitive lymphatic system appear in the human embryo of 10 to 11wks. These sacs become closely associated with the lymphatics of the arm bed. The caudal part is formed by the union of the spaces of the thoracic duct on each side. It may also be formed by budding of the existing sacs along the lateral channels. They become the secondary lymphatic veins. In later development transverse anastomosis results in most of the lymphatics ultimately reaching the left jugular sac.

THE LYMPH NODES:

Lymphnodes have a highly cellular cortex (reticular fibres with lymphoidfollicles) and a medulla which consists of a network of minute lymphatic channels(sinuses) through which lymph from the afferent lymphatics is filtered, collected at the hilum by the efferent lymphatic. Cortex is deficit at the hilum. The cortex will be at the surface so that the afferent vessels drain directly into it. These lymphnodes are numerous in the neck, the axilla, the mediastinum, in the mesentry, the posterior abdominal wall, the pelvis and the upper end of lower limbs. [7]

THE STRUCTURE OF LYMPH NODE:

Lymphnode consists of the capsule, the trabeculae, and the reticular tissue with cells enmeshed in it.

CAPSULE AND TRABECULAE:

The capsule consists of collagen fibres, elastin fibres and a few fibroblasts. The capsule covers the node completely and it extends into contents making it into small compartments. These extensions are called as the trabeculae and they are similar in structure with that of capsule. These trabeculae form the supporting structure of the node.[7] The afferent lymphatics drain into the area known as subcapsular lymphatic plexus. The reticulum itself consists of reticular fibres and reticular cells.

RETICULAR FIBRES:

These are extremely fine collagen fibres produced by primitive reticular cells. They are numerous in number and form a thick meshwork at the cortex, around the blood vessels and around the lymph follicles.

CELLS OF LYMPHNODES:

The lymphatic nodule (cortex proper) is made up of B-lymphocytes. The cells in the paler germinal centre of nodules are mainly lymphoblasts. They represent the B-lymphocytes stimulated by antigens. The lymphocytes divide repeatedly and give rise to more B-lymphocytes, aggregation of which form the dark staining rims around germinal centre. They mature into plasma cells that are seen mainly into medullary cords from which antibodies formed reach efferent vessel and into blood stream. T-lymphocytes are present in medullary cords and also form the lymphoid tissue intervening between nodules.

In association with framework of reticular fibres are numerous fibroblasts (previously called reticular cells). Numerous macrophages are present in lymph sinuses and around germinal centre which phagocytise antigens and present to lymphocytes.[8]

AFFERENT VESSELS:

They enter at different parts of the periphery and after branching and forming a dense plexus in the substance of the capsule open into subcapsular lymphatic sinuses. This space is in continuity with the lymph sinuses of the cortex. As the vessels enters the node it looses all its coverings except the endothelial covering.

EFFERENT VESSEL:

They commence from lymph sinus from medulla which emerges finally at the hilum. The stream of lymph as it passes through the sinus slows down. This enables the arrest of morphological elements carried in the lymph stream. Many lymphocytes pass with efferent lymph stream to join the general blood stream.

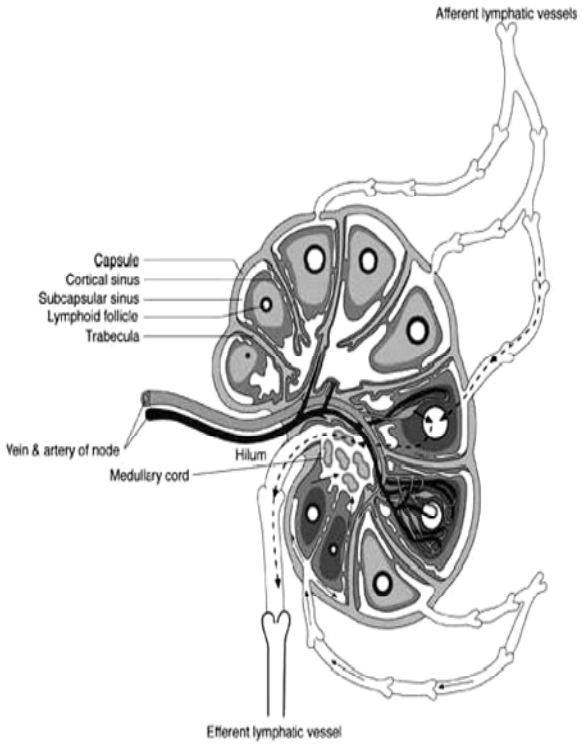

Fig 1 : Structure of lymph node[3]

VASCULAR SUPPLY OF NECK [9]

The common carotid, internal carotid, and external carotid arteries provide the major source of blood to the head and neck .Additional arteries arise from branches of the subclavian artery, particularly the vertebral artery.

On the right, the common carotid arises from the brachiocephalic artery. On the left, the common carotid artery arises from the arch of the aorta in the superior mediastinum. Following a similar course on both sides, the common carotid artery ascends, to the level of the upper border of the thyroid cartilage of the larynx (C3–4 junction), it divides into external and internal carotid arteries

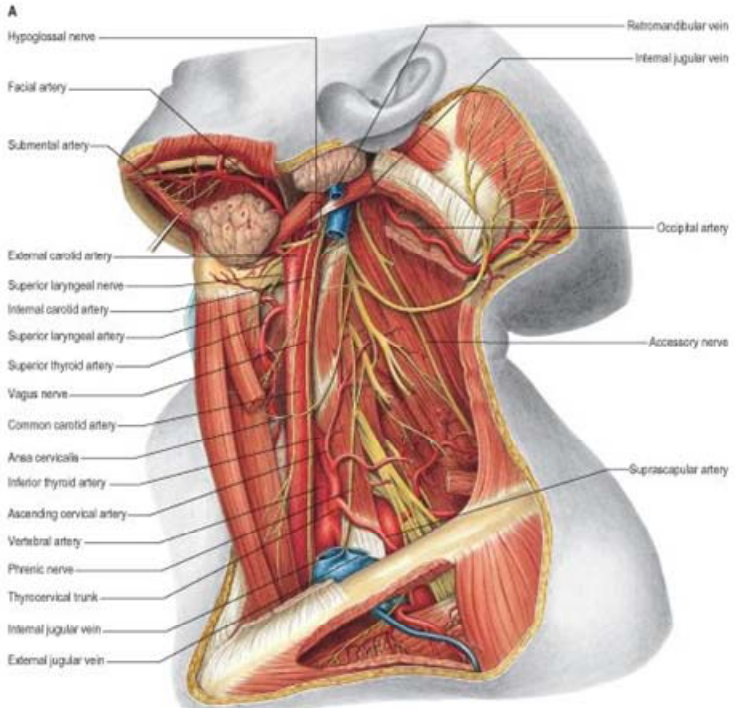

Fig 2 : Vessels and nerves of the neck, left lateral view [9]

The external carotid artery- The external carotid artery has eight branches distributed to the head and neck. The superior thyroid, lingual and facial arteries arise from its anterior surface, the occipital and posterior auricular arteries arise from its posterior surface and the ascending pharyngeal artery arises from its medial surface. The maxillary and superficial temporal arteries are its terminal branches within the parotid gland.

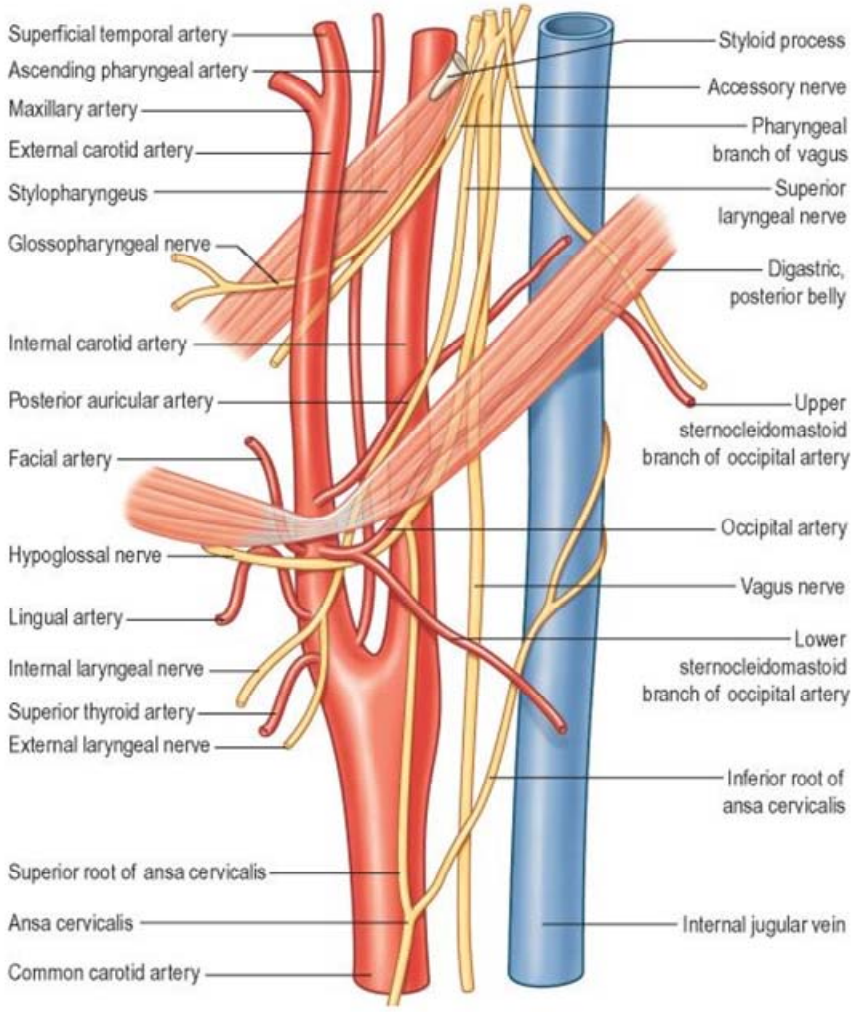

Fig 3 : Branches of the external carotid artery[9]

The internal carotid artery -From its origin at the carotid bifurcation (where it usually has a carotid sinus), it ascends in front of the transverse processes of the upper three cervical vertebrae to the inferior aperture of the carotid canal in the petrous part of the temporal bone where it enters the cranial cavity and through the cavernous sinus in the carotid groove it terminates into the anterior and middle cerebral arteries. It may be divided conveniently into cervical, petrous, cavernous and cerebral parts.

Veins of neck :

Veins are superficial or deep to the deep fascia but are not entirely separate systems. Superficial veins are tributaries, some with specific names, given below, of the anterior, external and posterior jugular veins .They drain all but the subcutaneous structures, mostly into the internal jugular vein and also into the subclavian vein.

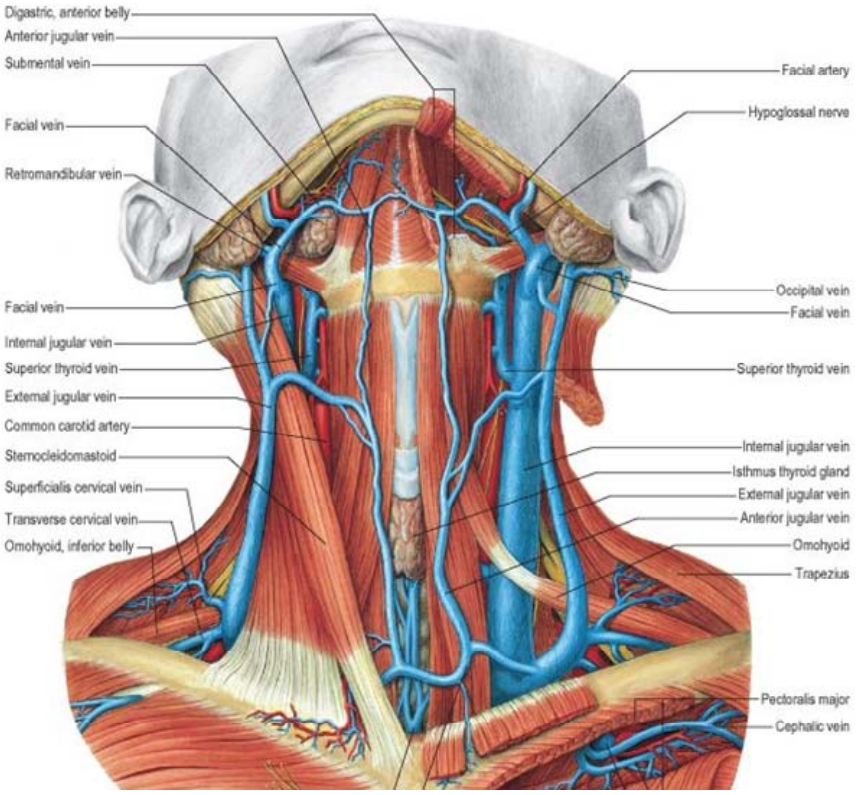

Fig 4 : Veins of neck in frontal view [9]

External jugular vein:

The external jugular vein mainly drains the scalp and face, although it also drains some deeper parts. The vein is formed by the union of the posterior division of the retromandibular vein with the posterior auricular vein. The external jugular receives the posterior external jugular and, near its end, transverse cervical, suprascapular and anterior jugular veins.

Posterior external jugular vein:

The posterior external jugular vein begins in the occipital scalp, and drains the skin and the superficial muscles which lie posterosuperior in the neck. It usually joins the middle part of the external jugular vein.

Anterior jugular vein:

The anterior jugular vein arises near the hyoid bone from the confluence of the superficial submandibular veins, it joins either the end of the external jugular vein or may enter the subclavian vein directly. It receives the laryngeal veins and sometimes a small thyroid vein. There are usually two anterior jugular veins, united just above the manubrium by a large transverse jugular arch, receiving the inferior thyroid tributaries.

Internal jugular vein:

The internal jugular vein collects blood from the skull, brain, superficial parts of face and much of the neck. The internal jugular vein descends in the carotid sheath, and unites with the subclavian vein, to form the brachiocephalic vein. The inferior petrosal sinus, facial, lingual, pharyngeal, superior and middle thyroid veins, and occasionally the occipital vein, are all tributaries of the internal jugular vein. The internal jugular vein may communicate with the external jugular vein. The thoracic duct opens near the union of the left subclavian and internal jugular veins.

DISTRIBUTION OF LYMPH NODES OF NECK

There are approximately 800 lymph nodes in body. Among them about 300 nodes lie in the neck. Inflammation of lymphnodes of the neck particularly by tuberculosis.[10]

CLASSIFICATION:

A) CIRCULAR CHAIN OF NODES

B) VERTICAL CHAIN OF DEEP CERVICAL NODES

CIRCULAR CHAIN OF NODES:

This consists of the following node groups.

a) **Occipital nodes:** One or two nodes situated midway between the mastoid process and the external occipital protuberance. They drain the back of the scalp.

b) **Posterior auricular nodes:** Situated on the mastoid process behind the pinna.They drain the temporal region of the scalp, back of the pinna and external auditory meatus.

c) **Pre-auricular nodes:** Situated immediately in front of the tragus. The node lies superficial to the parotid fascia and drains the outer surface of the pinna and side of the scalp.

d) **Parotid nodes:** These nodes are situated both in the substance of the parotid salivary gland deep to it, i.e. between it and the side wall of the pharynx.

The deeper nodes drain: i) Nasopharynx ii) Back of the nose.

The more superficial receive lymph from: i) Eyelids ii) Front of the scalp iii) External auditory meatus and iv) Tympanic cavity

e) **Facial nodes:** Consists of superficial and deep groups.

Superficial group: consists of

(i) **Infra-orbital:** Just below the orbit.

(ii) **Buccinator:** On the muscle of this name lateral to the angle of the mouth.

(iii) **Supramandibular:** On mandible, in front of the masseter aroud the facial artery.

These nodes receive lymph from conjunctiva and eyelids, nose and cheek.

Deep group: These lie around the maxillary vessels and in relation to the external pterygoid muscle. They drain (i) The temporal fossa (ii) Infra temporal fossa (iii)Back of the nose (iv) Pharynx.

f) **Submandibular nodes:** An important group lying in the submandibular triangle in close relation to the submandibular salivary gland. The lymph nodes are under the deep fascia in actual contact with the salivary glands. These submandibular nodes drain (i) The side of the nose (ii) Inner angle of the eye (iii) The cheek (iv) Angle of the mouth (v) Whole of the upper lip (vi) Outer part of the lower lip (vii) The gums (viii) Some lymph from the side of the tongue.

g) **Submental nodes:** These lie in the submental triangle. They drain central part of the lower lip and floor of the mouth. They receive some lymph from the apex of the tongue.

h) **Superficial cervical nodes:** These lie on the outer surface of the sternomastoid around the external jugular vein. They drain the parotid region and lower part of the ear.

i) **Anterior cervical nodes:** These lie near the midline of the neck in front of the larynx and the trachea. They consist of superficial and deep set of nodes.

1) **Superficial set:** Lie in relation to the anterior jugular vein and drain the skin of the neck. They are unimportant.

2) **Deep set:** Consists of the infra hyoid nodes: These lie on the thyrohyoid membrane and drain the front of the larynx.

The prelaryngeal nodes: These lie on the cricothyroid ligament and drain the larynx. Their afferents pass through a small foramen in the middle of the cricothyroid ligament. These nodes assist in the drainage of the thyroid.

The pretracheal nodes: These lie in relation to the inferior thyroid veins in front of the trachea and drain the thyroid and the trachea.

EFFERENTS OF CIRCULAR CHAIN:

The deep cervical chain receives ultimately all the lymph from the nodes enumerated above as it receives the efferents directly from all these node groups the facial and submental. The efferents from these two groups pass first to the submandibular nodes.

VERTICAL CHAIN OF DEEP CERVICAL NODES:

This consists of a number of large nodes lying in relation to the carotid sheath. A few members of this group occupy an outlying position behind the pharynx and are called the retropharyngeal nodes. They drain the back of nose and pharynx and the auditory tube.

The vertical chain of deep cervical nodes lies alongside the pharynx, trachea and oesophagus, and extends from the base of the skull to the root of the neck. They are arbitrarily divided into superior deep cervical and inferior deep cervical groups till the point of bifurcation of the common carotid (or alternatively by the omohyoid).The nodes of both groups are in close relationship with the internal jugularvein. Some of the nodes of the inferior group are present beyond the posterior border of the

sternomastoid into the posterior triangle of the neck. There are a few small nodes of this group which lie in the groove between the trachea and oesophagus alongside the recurrent laryngeal nerve. They are called paratracheal nodes and assist in the drainage of the thyroid. Two of the deep cervical group is named.

i) Jugulodigastric- main node of the tonsil

ii) Jugulo-omohyoid node- a node situated on the common carotid just above the point where the anterior belly of omohyoid crosses this vessel. It plays a very important part in the lymph drainage of the tongue.[11]

EFFERENTS OF VERTICAL CHAIN:

The lymph from the deep cervical (i.e. all the lymph from the half of the head and neck) is collected into one trunk-the jugular lymph trunk- which leaves the inferior deep cervical nodes. On the right side this trunk enters the junction of the subclavian vein and internal jugular vein; on the left side this trunk enters the thoracic duct.

AFFERENTS OF VERTICAL CHAIN:

The deep cervical nodes receive the lymph from the entire head and neck, either directly or indirectly from the nodes of circular chain.[11]

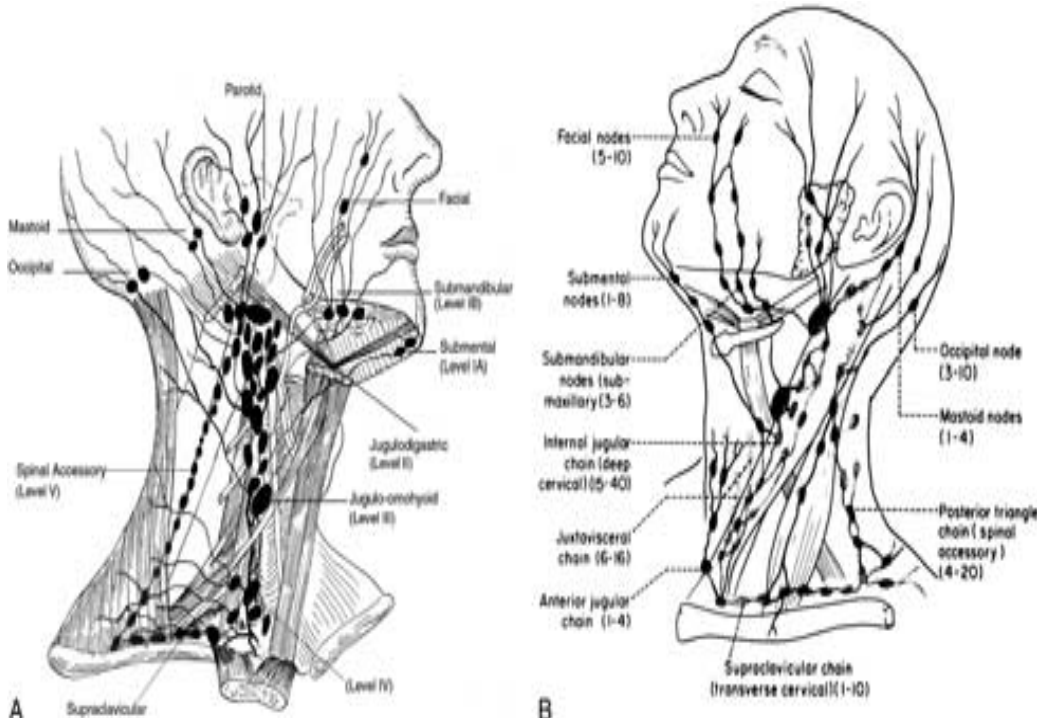

Fig 5 : Distribution Of Lymph Nodes In Neck[11]

PHYSIOLOGY OF LYMPHNODE:

Lymphnode must be looked upon as an important structure in the defence mechanism of the body. The one that filters the agents travelling by lymph paths. When the infection of the part lying proximal to a gland occurs, latter becomes inflamed as a result of localization of these bacteria or their toxins carried in the lymph. Cells in lymphnodes attack, phagocytise and destroy the invading organisms. The barrier is raised against the passage of dangerous organisms. In case of infections, it appears that no materials can pass from tissue to blood stream via its lymph without filtering through the lymphnode. Bacteria pass from tissue to blood slowly by lymph stream and that the toxins and viruses of large molecular weight (cover 20,000 molecular weight) are not carried into the blood if the lymph vessels have been blocked. These observations, in part explain the success which followed the

immobilization of the infected part in a plaster cast. Immobilization is expected to reduce the area of infected part and confines it to the process of resolution. The other function is the production of immunoglobulins by the lymphocytes.[12]

Nodal terminology

In 1981, Shah et al[13]suggested the anatomically based nodal terminology to be replaced with a simpler level-based system. Since then, a number of clinically and radiologically based classifications have been proposed. The aim of this classifications was more functional than anatomical helps the surgeon in selecting the most appropriate type of nodal dissection based on the nodal groups involved

American Joint Committee on Cancer (AJCC) classification of cervical lymph nodes is commonly used, especially by surgeons and oncologists. It is one of the widely used classifications.[14]

Level I	Contains the submental and submandibular triangles bounded by the posterior belly of the digastric muscle, the hyoid bone inferiorly, and the body of the mandible superiorly
Level II	Contains the upper jugular lymph nodes and extends from the level of the skull base superiorly to the hyoid bone inferiorly.
Level III	Contains the middle jugular lymph nodes from the hyoid bone superiorly to the cricothyroid membrane inferiorly
Level IV	Contains the lower jugular lymph nodes from the cricothyroid membrane superiorly to the clavicle inferiorly
Level V	Contains the lymph nodes in the posterior triangle bounded by the anterior border of the sternocleidomastoid muscle anteriorly and the clavicle inferiorly.

	Level V may be further subdivided into upper, middle, and lower levels corresponding to the superior and inferior planes that define levels II, III, and IV.
Level VI	Contains the lymph nodes of the anterior compartment from the hyoid bone superiorly to the suprasternal notch inferiorly. They lie between the medial borders of the carotid sheaths.
Level VII	Contains the lymph nodes inferior to the suprasternal notch in the upper mediastinum.

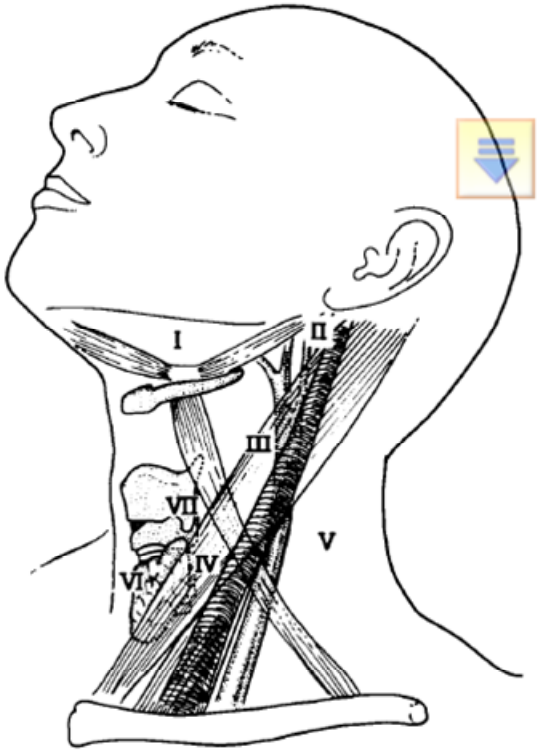

Fig 6 :Drawing of the head and neck region as seen from the left side showing the AJCC nodal levels.[14]

But some important lymph nodes, such as parotid and retropharyngeal nodes, are not included in this classification.

Another Classification of cervical lymph nodes was established by

Hajek et al[15]for ultrasound examinations. The cervical lymph nodes are classified into eight regions according to their location in the neck.

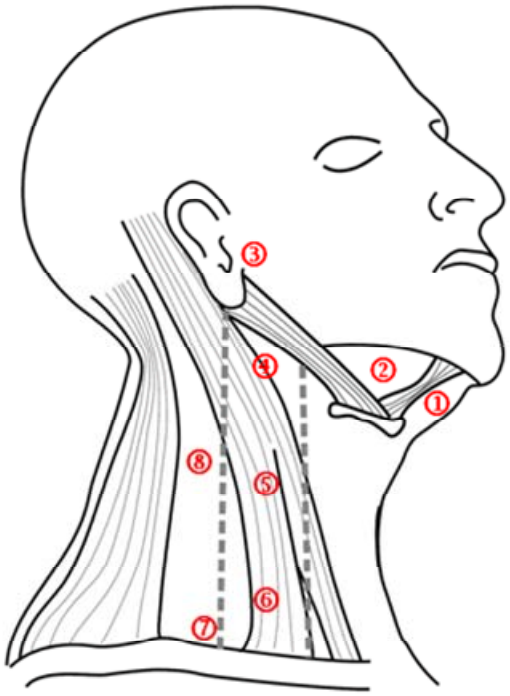

Fig 7: Drawing of the head and neck region showing Hajek et al nodal levels.[15]

HAZEK et al[15]

Classification :

1. Sub – mental.
2. Sub- mandibular.
3. Parotid.
4. Upper Cervical : between the level of hyoid bone and along the internal jugular chain

5. Middle Cervical: between the level of hyoid bone and cricoid cartilage and along the internal jugular chain
6. Lower Cervical: below the level of crocoid cartilage, and along the internal jugular chain.
7. Supraclavicular Fossa.
8. Posterior Triangle (also known as accessory chain).

The Imaging-Based System:[16]

Imaging was chosen to be the basis of the modification for three reasons:

1) Most patients with head and neck cancers have an initial computed tomography (CT) or magnetic resonance (MR) imaging study to assess both the primary tumour and the extent of nodal disease. It is estimated that over 80% of cancer patients obtain such imaging.
2) Imaging can identify clinically silent nodes in head and neck cancer etc
3) Imaging has the potential to best reveal precise anatomic landmarks that lend themselves to a consistent definition of nodal groups or levels

IMAGING BASED CLASSIFICATION

Level I The submental and submandibular nodes. They lie above the hyoid bone, below the mylohyoid muscle and anterior to the back of the submandibular gland.

Level IA The submental nodes. They lie between the medial margins of the anterior bellies of the digastric muscles.

Level IB The submandibular nodes. On each side, they lie lateral to the level IA nodes and anterior to the back of each submandibular gland.

Level II The upper internal jugular nodes. They extend from the skull base to the level of the bottom of the body of the hyoid bone. They are posterior to the back of the submandibular gland and anterior to the back of the sternocleidomastoid muscle.

Level IIA A level II node that lies anterior, medial, lateral, or posterior to the internal jugular vein. If posterior to the vein, the node is inseparable from the vein.

Level IIB A level II node that lies posterior to the internal jugular vein and has a fat plane separating it from the vein.

Level III The midjugular nodes. They extend from the level of the bottom of the body of the hyoid bone to the level of the bottom of the

cricoid arch. They lie anterior to the back of the sternocleidomastoid muscle.

Level IV The low jugular nodes. They extend from the level of the bottom of the cricoid arch to the level of the clavicle. They lie anterior to

a line connecting the back of the sternocleidomastoid muscle and the posterior-lateral margin of the anterior scalene muscle. They are also lateral to the carotid arteries.

Level V The nodes in the posterior triangle. They lie posterior to the back of the sternocleidomastoid muscle from the skull base to thelevel of the bottom of the cricoid arch and posterior to a line connecting the back of the sternocleidomastoid muscle and the posterior-lateral margin of the anterior scalene muscle from the level of the bottom of the cricoid arch to the level of the clavicle.They also lie anterior to the anterior edge of the trapezius muscle.

Level VA Upper level V nodes. They extend from the skull base to the level of the bottom of the cricoid arch.

Level VB Lower level V nodes. They extend from the level of the bottom of the cricoid arch to the level of the clavicle as seen on each axial scan.

Level VI The upper visceral nodes. They lie between the carotid arteries from the level of the bottom of the body of the hyoid bone to the level of the top of the manubrium.

Level VII The superior mediastinal nodes. They lie between the carotid arteries below the level of the top of the manubrium and above the level of the innominate vein.

Supraclavicular Nodes

They lie at or caudal to the level of the clavicle and lateral to the carotid artery on each side of the neck as seen on each axial scan.

Retropharyngeal Nodes

Within 2 cm of the skull base they lie medial to the internal carotid arteries

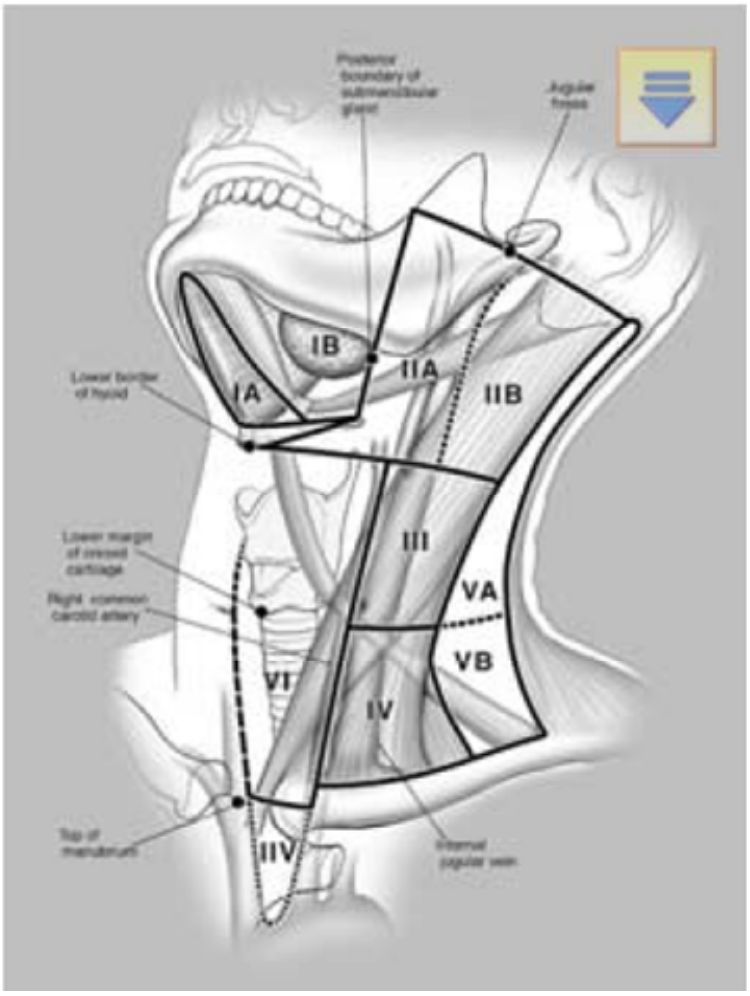

Fig 8 : Diagram of the head and neck viewed from the left anterior oblique projection. The anatomic landmarks used in the imaging-based nodal classification are shown[16]

ETIOLOGICAL CLASSIFICATION OF CERVICAL LYMPHADENOPATHY

Normal and Reactive Lymph Nodes [3]

Normal and reactive lymph nodes are usually found in submandibular, parotid, upper cervical, and posterior triangle regions. On gray-scale sonography, normal and reactive nodes tend to be hypoechoic compared with adjacent muscles and oval (short axis–to–long axis ratio [S/L] < 0.5) and to have an echogenic hilus.On color Doppler, power Doppler, and 3D sonography, normal cervical nodes show hilar vascularity or appear avascular, and reactive nodes predominantly show hilar vascularity.

EITOLOGICAL CLASSIFICATION OF CERVICAL LYMPHADENOPATHY:

Granulomatous disease

- Mycobacterium Tuberculosis
- Atypical Mycobacteria
- Mycobacterium leprae
- Sarcoidosis
- Langerhan's cell histiocytosis

Neoplasms

- Lymphoproliferative Disorders.
- Kaposi sarcoma
- Metastases(squamous cell carcinoma , papillary thyroid carcinoma ,Renal Cell Carcinoma,Breast,Melanoma and Lung,Carcinoid)
- Leukemia

Infection

- Viral Lymphadenitides- Infectious Mononucleosis,Cytomegalovirus,Herpes Simplex Virus,Varicella,Vaccinia,Measles, Rubella(German Measles) ,Human Immunodeficiency Virus
- Bacterial Lymphadenitides
- Routine Bacterial Lymphadenitis,Lemierre's Syndrome,Cat-Scratch Lymphadenitis
- Bacillary Angiomatosis,Syphilitic Lymphadenitis
- Lyme lymphadenitis
- Fungal Lymphadenitides- Cryptococcosis,Histoplasmosi,Coccidioidomycosis , Pneumocystosis.
- Protozoal Lymphadenitis

Miscellaneous

- Castleman's disease
- Kikuchi's disease
- Kimura's disease
- Sinus histiocytosis with massive lymphadenopathy
- Post radiation changes.
- Connective tissue disorder
- Atypical Lymphoid Hyperplasia
- Lymphadenopathies Associated with Clinica Syndromes
- Dermatopathic Lymphadenopathy
- Angiofollicular Lymph Node Hyperplasia
- Angioimmunoblastic Lymphadenopathy

- Kawasaki's Syndrome
- Post transplantation Lymphoproliferative Disorders
- Tumor-Reactive Lymphadenopathy
- Vascular Lymphadenopathies
- Foreign Body Lymphadenopathies
- Lymph Node Inclusions
- Proliferative Histiocytic Disorders
- Spindle Cell Neoplasms of Lymph Nodes
- Vascular Neoplasms of Lymph Nodes
- Drugs such as Phenytion

Tuberculosis(TB)[17] –

It is important cause of cervical lymph node enlargement in developing countries like India.

Pathogenesis : Tuberculosis lymphadenitis is a local manifestation of the systemic disease. Primary infection occurs due to initial exposure to tubercle bacilli ,it lodge in terminal alveoli of lungs causing Ghon focus. The Ghon focus and related hilar lymphadenopathy form the primary complex. The infection may spread from primary focus to regional lymph nodes via the lymphatic system to other nodes or may pass through the nodes to reach blood stream, from where it can spread to virtually all organ of the body. Hilar, mediastinal and paratracheal lymphnodes are the first site of spread of infection from the lung parenchyma. supraclavicular lymphnode involvement may reflect the lymphatic drainage routes for the lung parenchyma.

Cervical tuberculous lymphadenitis may represent a spread from the primary focus of infection in the tonsils, adenoids, sinonasal or osteomyelitis of the ethmoid bone.

Sarcoidosis[18]

It is a common cause of non-necrotic, homogenous, diffuse cervical lymph node enlargement and is more common in women. Although the lung is the organ most often involved, cervical lymph nodes enlargement and the salivary gland involvement may also be observed.

Langerhan's Cell Histiocytosis[19]

It is currently accepted term for group of diseases formerly called Histiocytosis-X, Eosinophilic granuloma, Hand Schuller Christian disease is a disorder primarily affecting younger patients, characterized by the proliferation of specific histiocytes called the Langerhan's cell. The inguinal and cervical nodes are the two most often affected and nodes are tender on palpation. On imaging diffuse nodal enlargement is noted.

Metastatic cervical lymphadenopathy [20, 21]

The presence or absence of metastatic cervical lymphadenopathy in head and neck carcinomas is important. The presence of a unilateral metastatic node reduces the 5-year survival rate by 50%, whereas bilateral metastatic nodes reduce the 5-year survival rate to 25%. Metastatic cervical lymph nodes from head and neck carcinomas are usually site specific about location of the primary tumour. Moreover, metastatic nodes in an unexpected site indicate that the primary tumour is biologically more aggressive. The evaluation of metastasis helps in treatment and management.

Lymphoma[22]

The malignant lymphomas are a heterogeneous group of solid lymphoreticular neoplasms. Hodgkin's disease is a subgroup of lymphomas that it accounts for 25% of all malignant lymphomas. The other Iymphomas are grouped together as nonhodgkin's lymphomas. One of the most common initial presentations of Hodgkin's disease is painless lymphnode enlargement in the head and neck region. When neck nodes are involved in either Hodgkin's or nonhodgkin's lymphoma, the disease spreads into multiple nodes. Whether the nodal involvement is unilateral or bilateral, the deep lymphatic chains are almost always involved, particularly the internal jugular chain. The middle and lower jugular nodes are often diseased when lymphomas present in the nodal pattern. Extranodal presentation of Hodgkin's disease is rare, even with nodal involvement. Conversely, nonhodgkin's lymphoma frequently involves extra- nodal structures in the head and neck region .The extranodal sites most frequently involved are Waldeyer's ring, the paranasal sinuses, and the nasal cavity. The size of the involved lymphnode can be quite variable, with larger ones more than 10 cm in diameter and smaller ones less than 5 mm. Frequently, multiple nodes of varying sizes are involved. Sometimes they are elliptical in shape, although a rounded appearance is most common. It is of interest to note that nodal necrosis was uncommon. Lymphomatous nodes are also round and hypoechoic and may have a micronodular or a pseudocystic appearance and show profuse central and peripheral vascularity on Doppler sonograms

Rosai-Dorfman disease[23]

Sinus histiocytosis with massive lymphadenopathy (SHML) was described in 1969 by Rosai and Dorfman It is a rare, benign lymphoproliferative condition presenting with painless cervical lymphadenopathy, fever, leukocytosis with neutrophilia, increased hemosedimentation rate and polyclonal hypergammaglobulinemia.This condition generally affects children and young adults. The disease is found worldwide. Its etiology remains uncertain. Possible causes include altered immune responses and infections by agents such as varicella-zooster and other herpetic viruses, Epstein-Barr and cytomegalovirus, Brucella and Klebisiela. It is a self-limited and seldom life-threatening disease, rendering therapy unnecessary in most cases.

Kimura disease[24]

Kimura disease is a rare chronic inflammatory disorder mimicking malignancy. The disease was initially called eosinophilic hyperplastic lymphogranuloma. This disease became more widely known as Kimura disease after Kimura et al. The disease occurs mainly in people of Asian descent, and more than 80% of the patients are men in their second and third decades. The most common presenting feature is swelling in the salivary region and adjacent lymphadenopathy. Nodes are present in the submental and submandibular regions, within the parotid gland, and in the upper cervical chain. On gray scale sonograms, they are hypoechoic and round, with normal hilar architecture and homogeneous internal echoes. On power Doppler sonograms, the nodes show prominent intranodal vessels with a hilar pattern and low intranodal resistance. The soft tissue and parotid lesions also show low-resistance vascularity within.

Kikuchis Disease[25]

Kikuchi disease is a benign disease that is common in Japan, affecting younger women Kikuchi's disease is also called "histiocytic necrotizing lymphadenitis whereas most clinicians are unaware of the existence of this rare disease, which can easily be mistaken for malignant lymphoma. Sonographically, the nodes are hypoechoic, homogeneous, or heterogeneous, but are surrounded by hyperechoic rims. They also show a benign vascular pattern on power Doppler sonograms.

Castleman's disease[26]: It is also known as angio-follicular lymph node hyperplasia or giant lymph node hyperplasia. It was first described as a solitary mediastinal mass by Castleman in 1954. The disease is most often manifested by hypervascular lymph node enlargement in the mediastinum, hilum and cervical regions, can also involve the adnominal lymph nodes. On imaging lymph nodes are classically hypervascular.

Table 1-Common sites of metastatic, lymphomatous and tuberculous nodes in the neck :

	Commonly involved nodal groups
Metastases from oropharynx, hypopharynx, larynx carcinomas	Internal jugular chain
Metastases from oral cavity carcinomas	Submandibular Upper cervical
Metastases from nasopharyngeal carcinoma	Upper cervical Posterior triangle
Metastases from papillary carcinoma of the thyroid	Internal jugular chain
Metastases from non-head and neck carcinoma	Supraclavicular fossa Posterior triangle
Lymphoma	Submandibular Upper cervical Posterior triangle
Tuberculosis	Supraclavicular fossa Posterior triangle

HISTORY

Told was the first man who gave the name "lymph node". In 1955 at Noming Anatomica at Paris the term lymph node was adopted.

Hazek PC et al [15] (1986) said that ultrasound is highly effective in detection, localization and delineation of enlarged lymph nodes of the neck. Infiltration of nearby structures specifically the carotid arteries including muscles of neck was demonstrated.

Grasl MC et al[27] (1989) said that lymph nodes with a rupture of the capsule, with central necrosis or larger than 3cm, are proved to be metastatic in all cases..Either round or oval nodes with a size of larger than 2 cm were found to be metastatic, this criteria has an accuracy of 89%.

Naito K[28] (1990) evaluated 108 cervical lymph node of 37 patients. Submandibular, submental, middle and inferior external jugular lymph nodes larger than 8mm and superior internal jugular nodes larger than 9mm were regarded as metastatic and high sensitivity of 92% was demonstrated. All of 31 lymph nodes with irregular margins were metastatic. In 20 benign nodes eccentric hyperechoic area which was considered to be hilus of the lymph node was observed. All of 48 lymph nodes with inhomogeneous internal echoes or with central hyperechoic area and peripheral hypoechoic zone were proven metastatic.

Hessling KH et al[29] (1991) stated about the importance of ultrasound as a follow up method in preoperative radiotherapy. If there is reduction in the area of the reference lymph nodes by at least 25% of the initial value with 'minor remission' in oncological teams was considered as a positive reaction to radiotherapy.

Vassallo P et al[30]**(1992)** with 7.5 MHz probes evaluated nodes according to longitudinal /transverse diameter ratio (L/T), the central hilus, cortical widening and

size of a lymphnode. Lymph node shape was assessed by measuring the largest and smallest diameter on the same scan and by calculating L/T ratio. The nodes were divided into 2 classes: L/T >2 and L/T <2. Central hilus was divided into 3 hilar classes: wide, narrow and absent. Peripheral cortex was also separated into 3 cortical classes: narrow, concentrically wide or eccentrically wide. 85% of benign nodes showed L/T > 2 and 15% exhibited an L/T < 2. Nodes with a narrow hilus showed concomitant cortical widening in only 54% of benign nodes but in 90% of malignant nodes. Thus presence of hilar narrowing with cortical widening was regarded with suspicion for malignancy. Wide hilus was seen usually in benign nodes (58%) than in malignant nodes (8%).

Luigi et al[31](1992 Sep) stated that the ultrasonography helps in the evaluation of the lymph nodes in the neck region due to high frequency probes which permits visualization of more subtle anatomic and pathologic details. He also concluded that high frequency probes play an important role in assessing the status of cervical nodes and also to differentiate benign nodes from metastastic nodes.

Steincamp HJ and colleagues[32] (1995 March) stated that the largest diameter /smallest diameter ratio of lymph nodes provides an excellent criterion for differentiation between benign and malignant enlargement in cervical lymphadenopathy. A study showed 95% of enlarged cervical nodes shown on ultrasound to have LA/ SA diameter ratio of > 2 were correctly diagnosed as benign. Nodes presenting with a more circular shape and LA/ SA diameter ratio of <2 were diagnosed correctly as metastasis with 95% accuracy.

Na et al[33](1997) analyzed the morphologic features of lymph nodes shown on ultrasound according to shape and morphology of echogenic nodal hilum. Lymph node shape was assessed by measuring the largest and smallest diameter on the same

scan and by calculating ratio of longitudinal to transverse diameter (L/T). L/T ratio was sonographically different between malignant and benign nodes (P<0.02). Malignant nodes appeared to have a lower L/T (<2.0;85%) and deformed echogenic hilum (94%). L/T less than 2 had a sensitivity of 85% and specificity of 61%.

Takashima et al[34](1997) did a study on assessment of non palpable neck nodes using US and US guided aspiration biopsy. Nodes with Calcification, A cystic portion, Loss of central echogenic hilus, A minimal axial diameter of 10mm or more and A minimal: maximal diameter ratio of 0.4, were recommended for biopsy. The accuracy of US guided FNAC for detecting malignancy was 88% with 96%sensitivity and 94% specificity. This study concluded that the ratio of minimal / maximal axial diameter to be the most accurate criterion. A ratio of more than 0.55 yielded the highest accuracy of 80% (92% sensitivity and 63% specificity).

Toriyabe Y[35](1997 Feb) stated that ultrasound has higher sensitivity than palpation in the detection of metastatic cervical lymph nodes. Ultrasound can evaluate the size, the S/L ratio, margins and internal structure of superficial lymph nodes, which helps to differentiate benign and malignant nodes.

Arjun Vikram kaji[36]and colleagues (1997) told that CT, MR and USG all have higher sensitivity than palpation alone, when evaluated with appropriate criteria including such factors as lymph node size, shape (the ratio of longitudinal to transverse diameter) location, number, the presence or absence of necrosis extra nodal spread and location. They also concluded nodes that longitudinal to transverse diameter ratio less than 2 associated with central nodal necrosis were thought to be the most specific sign of metastasis.

Francesco Gio Vagnanio et al[37] (1997) states that ultrasound has always been considered a powerful tool for lymph nodes characterization, as it evaluates important parameters such as number, shape, dimensions, margins and internal structure. He also proposed that certain ultrasound parameters of possible malignancy like round shape of lymph nodes, absence of echogenic hilum, and presence of central tubular structures repressing small arteries encased by neoplastic tissue.

Issing PR et al[38](1999) said that ultrasound is the imaging system with the highest sensitivity for the evaluation of pathological lymph nodes, lymph node metastases showed higher Doppler signals than the reactive ones. Most of the metastases were perfused in the periphery or had a diffuse spread of blood flow.

Michael Ying et al[39](1998) stated Sonographic criteria for distinguishing normal and abnormal lymph nodes include size, shape, and S/L ratio and echogenic hilus. It is site specific . He stated in his study echogenic hilus is more accurate to assess submandibular nodes. The nodal shape is more reliable with the submental and upper cervical lymph nodes are assessed.

Takeyuchi Y et al[2] (1999) investigated 36 metastatic lymph nodes in head and neck with squamous cell carcinoma and 24 non metastatic nodes in benign disease with a10MHz transducer. The short axis diameter and shape of metastatic nodes were larger and rounder than those of non metastatic ones.

Moritz et al[40](2000) in their evaluation of enlarged cervical lymph nodes in head and neck tumors using contrast enhanced color Doppler sonography, examined all patients using conventional B-mode sonography in the first step. 57 of 94 enlarged lymphnodes hyperechogenic hilum was found in 28% of benign nodes and 19% of metastatic nodes. In contrast, 20 of 37 lymph nodes with metastases were poorly defined whereas 17showed sharp borders. The L/T ratio was < 2 in 40% inflammatory

nodes and >2 in 30% of metastases. Sensitivity and specificity of B-mode sonography were 68% and 88% for metastases and 88% and 68% for non metastatic lymphadenitis respectively. These parameters alone resulted in a correct diagnosis in approximately 79% of the cases.

Koischwitz D et al[41](2000) showed the various presentations of lymph nodes in the neck. Reactive nodes had a longitudinal to oval shape with a smooth borders. Roundness Index (L/T ratio) of > 2 indicates inflammatory disease (84%) where as Roundness Index <1.5 favours metastatic involvement (71%). Lymph nodes with chronic inflammation were hypoechoic with smooth borders and longitudinal shape. Characteristic sonographic findings of metastatic nodes were enlargement with a round to spherical shape, hypoechogenic, or inhomogenously echogenic with loss of hilar vascularity.

Yusa H et al[42](2000) used ultrasonography to predict the response of lymph node metastases to preoperative chemotherapy. Ultrasonograms were catagorised among poor, good and complete response lymph nodes. Before radio chemotherapy, hypoechoic internal echo and intranodal blood perfusion demonstrated many complete response nodes. In contrast poor response nodes showed peripheral blood perfusion and avascular pattern. Complete response nodes showed a significant reduction in their maximum and minimum diameters after radio chemotherapy.

Mikanii Y et al[43](2000) told that size to be the best criteria for distinguishing metastatic lymph nodes from non metastatic lymph nodes in all cervical regions (78% accuracy).Diagnostic methods involving a combination of several criteria are more accurate than methods involving only a single criteria.

Kenji Yuasa et al[44](2000 Jan) stated in their study that ultrasound is a non invasive and less expensive diagnostic procedure than MR imaging or CT. ultrasound helps to monitor cervical lymph nodes in cancer patients during follow up .

Ahuja A et al[45](2000) made the use of a high resolution transducer (> 7.5MHz) to assess the nodes for their shape, size, internal architecture, echogenicity, nodal border, posterior enhancement and ancillary features i.e. soft tissue edema and matting. Primary malignant and metastatic nodes tend to be round whereas normal nodes are usually oval; 61-99% of lymph nodes had a short/ long axis (S/L) ratio > 0.5. It was of little value in differentiating various causes of cervical adenopathy. Most tuberculous and metastatic nodes were hypoechoic (72-100%) where as hyperechoic nodes were from papillary carcinoma of thyroid (77%).Heterogenous nodes are seen in tuberculosis (65%) and papillary carcinoma (47%). Presence of liquefaction necrosis was highly suggestive of tuberculosis, it was also seen in metastatic nodes (94%) from Squamous cell carcinoma of oral cavity. Metastatic nodes from carcinoma of larynx,pharynx and oesophagus is usually seen coagulation necrosis (8%). Most of the metastatic nodes had a sharp border (77-100%) due to replacement of normal lymphoid tissue by infiltrating tumor cells.Ancillary features were more commonly seen in tuberculosis.

Micheal Ying et al[46] (2001) stated that ultasound criteria assessed by S/L ratio is useful criterion for distinguishing reactive or normal nodes from pathologic nodes. They also stated fewer lymph nodes were detected in older than in younger subjects and the incidence of echogenic hilum within the lymph nodes is higher in older than younger subjects.

Ying M and Ahuja A[47] (2003) stated that before examination of pathologic nodes a clear understanding of anatomy of cervical nodes, scanning techniques and Sonographic appearances of normal cervical nodes is essential. They concluded that grayscale and power Doppler Sonography play an important role in assessment of cervical lymphadenopathy.

Ying M and Ahuja A[48](2003) stated in their study that metastatic lymph nodes in the neck are site specific and this specificity helps to identify metastasis and assists in tumour staging. They considered in their study: distribution of lymph nodes, size, shape,nodal border, echogenic hilus, calcification, intranodal necrosis, vascular pattern and ancillary features like matting and surrounding tissue edema in differentiation of benign and malignant cervical lymphadenopathy.

Jank S et[49]**(2003)** made use of ultrasonography to detect occult lymph node involvement in patients with squamous cell carcinoma in the maxillofacial region. For all levels ultrasound yielded a sensitivity of 71% and a specificity of 87% while CT showed sensitivity of 32% and a specificity of 96%.

Haberal I et al[50](2004) compared the various pre treatment evaluation methods i.e. palpation, CT and US and yielded results that are significantly different from histopathology results, suggesting that no pretreatment study can accurately assess the requirement to histopathologically stage the neck. US findings are more correlated with the pathological findings than palpation but CT gives the most effective and reliable results when it is combined with US in neck staging.

Mazaher H[51] (2004) and colleagues in their study of triplex ultrasonography assessment of cervical lymph nodes observed that majority of lymph nodes with a ratio of L/S more than 2 were benign and <2 were malignant.. They also concluded

that vascular pattern was peripheral type in the majority of the malignant lymph nodes and hilar type in all of reactive lymph nodes.

Ahuja A et all[3] (2005) concluded that sonographic features like shape, absent hilus, intranodal necrosis, reticulation, calcification, matting, soft tissue edema and peripheral vascularity helps in identification of abnormal lymph nodes.

Zehra et al[52] (1998) stated that detecting and differentiating the benign and malignant nature of cervical lymph node enlargement is critical in planning the therapy of malignancy suspected patients. He concluded that depiction of lymph node shape altering to flat oval to broad oval or round and loss of central echogenic hilus indicated the presence of metastasis.

Ahuja AT et all[53](2008) concluded that ultrasonography is a useful examination in the evaluation of malignant cervical lymph nodes. It helps in identifying the abnormal nodes, confirms the nature (with guided FNAC) and helps in assessing the response to treatment.

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COLOR DOPPLER

Sonography has been shown to have a higher sensitivity than palpation for detecting enlarged lymph nodes in patient with regional lymph node metastases.

Giovagnorio F et al[54](1997) made use of power Doppler sonography to differentiate benign from malignant nodes. Three main vascular patterns were identified:

Type I (single vascular pole)

Type II (hypertrophied vascular pole)

Type III (mainly peripheral vascularity)

The first one was related to chronic inflammation (sensitivity 85% specificity 90%); the second and third were related to a lesser extent to acute inflammation and neoplasm respectively.

Chang et al[55] (1994) did a study to evaluate the efficacy of color Doppler sonography to detect difference in blood flow patterns between benign and malignant cervical lymph nodes. Color flow patterns were seen in 6 of the 16 benign lymph nodes and in 29 of 32 malignant nodes. Sensitivity and specificity of color flow pattern alone, in diagnosis of malignant lymph nodes, were 91% and 63% respectively

Na DG et al [33](1997) further made use of CDS to study patterns of hilar vascularity, central nodal vascularity and peripheral vascularity in differentiating benign from malignant cervical lymphadenopathy.

94% of benign reactive nodes showed a normal pattern of nodal vascularity, radially symmetric central nodal vascularity and no demonstrable peripheral vascularity.

Loss of hilar vascularity was observed in 94% of malignant nodes and 94% of tuberculous nodes. Abnormal patterns of central vascularity (deformed radial pattern oraberrant multifocal) were observed in 91% of malignant nodes and 76% of tuberculousnodes. Peripheral vascularity was observed in 82% of tuberculous nodes and 86% of malignant nodes.

Mixed vascularity pattern with central and peripheral nodal vascularity was common in tuberculous nodes (76%) and malignant nodes (82%). Peripheral vascularitywith loss of central nodal vascularity was seen in 24% tuberculous nodes and 6%metastatic nodes.

Tschammler et al[56](1998) made use of color Doppler for assessment of intranodal angioarchitecture for differentiating benign from malignant lymphadenopathy.

Angioarchitecture in reactive lymph nodes was classified as

a. Hilar vessels

b. Longitudinal vessels

c. Peripheral branches that originated from longitudinal vessels

d. Short vessels segments

Malignant lymph node alterations showed typical distortions of this angioarchitecture, which were classified by using following four criteria.

1. Displacement
2. Aberrant vessels (mixed vessels)
3. Focal absence of perfusion and
4. Capsular vessels.

The presence of one of these four colour Doppler criteria of malignancy led to classification ‘malignant lymph node’. 96% of malignant nodes (66 of 69 nodes) showed at least one criteria of malignancy in assessment of intra nodal architecture. In

48 reactive lymphnodes, 12 showed no perfusion, 25 showed normal angioarchitecture and 11wereclassified false positive. If exactly one criteria of malignancy was found positive predictive value was only 6-7% but if all four criteria of malignancy were present in anode positive predictive value increased to 94%.

Steinkamp HJ et al [57](1998) in their prospective study evaluated four parameters in order to quantify nodal perfusion and to detect perfusion patterns.

a) Sites of perfusion.
b) Perfusion intensity (perfusion scale 0-III)
c) Nodal area being perfused.
d) Relative perfusion intensity.

Sites of perfusion were subdivided into 3 groups: Central, peripheral and hilar perfusion. The intensity of perfusion was subjectively quantified in a semi quantitative scale from 0 (no perfusion). 178 of 208 nodes showed perfusion. Relatively enlarged lymph nodes showed characteristically intense hilar perfusion (91.8%) whereas nodal metastases had mainly peripherally located flow (84.1%) of intensity grades I –III.Lymph nodes invaded by malignant lymphoma were highly perfused, showing color signals in center and nodal periphery (78.7%).

6 of the malignant nodes also showed central flow signals (7.3%), 2 nodes showed isolated hilar flow whereas 4 nodes showed both peripheral and hilar perfusion.

Barbera Apgar[58](1998 July) stated in his study that color Doppler Sonography is the only accurate method of displaying the angioarchitecture of lymph nodes. A distorted angioarchitecture has been described occurring more frequently in malignant lymphnodes. He concluded that use of color Doppler ultrasonography in the assessment of intranodal angioarchitecture is a reliable and reproducible method of differentiating between reactive and malignant lymphadenopathy.

Sato N et al[59](1998) did a study to difference reactively enlarged nodes from metastatic nodes by means of color Doppler flow imaging in patients with oral squamous cell carcinoma.. Of the 12 with central flow signals, 11 (92%) were reactively enlarged and one was metastatic. Therefore the presence of central flow signals on color Doppler imaging appeared to be a significant parameter associated with reactively enlarged benign nodes.

Ariyi Y et al[60](1998) showed a combination of 2 criteria (parenchymal color signal and transverse/ longitudinal ratio of more than 0.65) improved diagnostic accuracy to 92% sensitivity and 100% specificity.

Koischwitz et al [41](2000) the classification of lymph node perfusion is very subjective and not applicable as a single method for differentiation of various lymphadenopathies. In reactive lymph nodes a central hilar increased perfusion was found whereas in acute lymphadenitis a subjective recognizable, massive increased perfusion was seen with preserved vascular architecture. A missing or weak perfusion correlated with chronic inflammation but also with metastases. In metastatic squamous cell carcinoma, different patterns of perfusion were found including peripheral increased perfusion, focal absence of central vessels, displacement of vessels or a chaotic irregular pattern of perfusion.

Chikui T et al [61](2000) did a multivariate feature analysis of sonographic findings of metastatic cervical lymph nodes. Multivariate analysis suggested the presence or absence of hilar echoes, increase in short axis length and presence of normal hilar flow was the only sonographic features that were predictive of reactive nodes.

Moritz JD et al[40](2000) determined the accuracy of contrast enhanced color Doppler sonography in evaluating enlarged cervical lymph nodes in head and neck tumors.B-mode sonography gave correct diagnosis in approximately 79% of nodes. With contrast enhanced color Doppler sonography 86% of nodes showed vessels with this technique exclusively. Using contrast enhanced CDS characteristic configuration were identified: hilar vessels with branching indicated lymphadenitis (sensitivity-98%specificity –100%) and predominantly peripheral vessels indicated metastases (sensitivity–100%, specificity –98%).

Yonetsu K et al[62](2001) evaluated the diagnostic accuracy of sonography by using the single criteria of short axis diameter of the node or by combined criteria of short axis diameter and Doppler blood flow features i.e. absence or presence of normal hilar flow. Combined criteria increased the diagnostic accuracy of sonography at all levels in the neck. The best cut –off values were improved to 6,7 and 5mm for nodes at levels I, II,III & IV respectively. Combined criteria yielded a high sensitivity (>89%) and specificity (> 94%).

Anil et al[63](2001) has described in his study that in the supraclavicular region the presence of hilar pattern vascularity or avascularity in nodes is suggestive of tuberculosis nodes and the presence of mixed vascular pattern or capsular vascular pattern is suggestive of metastastic nodes.

Yuen H and colleagues[64](2001) They found in their study reactive nodes tend to have prominent hilar vascularity due to increase in vessel diameter and blood flow. A metastatic nodes tend to have avascular area, increased peripheral vascularity, and with displacement of vessels.

Steincamp HJ, Wissgot C and Rademaker J[65](2002 July) stated that with power Doppler Sonography it is possible to characterize lymph nodes as reactively

enlarged, metastasis, malignant lymphoma and tuberculosis. They found out that in their study the reactive lymph nodes show increased central perfusion of the hilum, where as metastasis tends to show increased peripheral perfusion.

Eida S et al[66]62003) used combination of helical CT and Doppler sonography in follow up of patients with clinical N0 neck disease were done of which only 17 underwent surgery; nodal metastases was histopathologically confirmed in all 17 cases.

Node was diagnosed metastatic if it fulfilled the CT criteria for metastatic nodes (shortaxis diameter > cut off points for each level of the neck or central necrosis) and if it didnot exhibit Sonographic features for non metastatic nodes (normal hilar echogenicity and hilar flows). A combination was effective in revealing all 17 cases of metastatic nodes.

Meenu Walia[67](2006) conducted a study which included about 30 patients with cytological / histological confirmation of head and neck cancer. USG was performed using the B-mode grey-scale real-time imaging. A total of 338 lymphnodes were dissected, out of which 21 were pathologically involved. All of these metastatic nodes were picked up on USG, giving the method 100% sensitivity with no false negative results. The study demonstrates the superiority and effectiveness of USG as an affordable detection tool for metastatic lymphadenopathy.

L.Cvorovic et al[68](2007) A prospective study was performed on enlarged cervical lymph nodes in 60 patients with CT scan and used USG criteria for size, shape and vascularity for distinguishing metastatic and nonmetastatic nodes preoperatively and compared them with cytological and histopathological investigations. Fifty-two of 144lymph nodes were involved with metastasis on HPE. Respective values for ultrasound guided fine needle aspiration cytology showed high

sensitivity, specificity, (92% and 100 % respectively). USG evaluation is essential for diagnosis, staging and therapy choices.

Dangore SB et all[69](2008) concluded that nodal vascularity can be used to differentiate benign from malignant lymphadenopathy. Correlation of patterns of colour Doppler flow signals with pathological diagnosis showed that central flow for benign nodes and peripheral flow for malignant nodes were highly significant parameters.

Sonographic features of cervical lymphnodes [3]

On ultrasound, normal and reactive nodes tend to be hypoechoic compared with adjacent muscles and oval (short axis–to–long axis ratio [S/L] < 0.5). On color Doppler, power Doppler, and 3D sonography, normal cervical nodes show hilar vascularity and reactive nodes predominantly show hilar vascularity.

On USG, tuberculous nodes tend to be hypoechoic, round without echogenic hilus and tend to show intranodal cystic necrosis, nodal matting, and adjacent soft-tissue edema. On color Doppler and power Doppler the vascular distribution of tuberculous nodes is varied which simulates neoplastic and non neoplastic nodes. However, displacement of hilar vascularity is common in tuberculous nodes and is due to the high incidence of intranodal cystic necrosis, displaces the vessels, in tuberculous nodes.

On ultrasonography, metastatic lymph nodes are hypoechoic, round and without echogenic hilus. Presence of coagulation necrosis may be seen in metastatic nodes, intra nodal cystic necrosis is common in metastasis from squamous cell carcinomas. Eccentric cortical hypertrophy is a useful sign to indicate focal tumor infiltration. In Hodgkin's lymphoma and non- Hodgkin's lymphoma, lymph nodes tends to be round, hypoehoic without echogenic hilus and may show intra nodal reticulation. On color Doppler and power Doppler, metastatic and lymphomatous nodes usually show peripheral or mixed vascularity.

MATERIALS AND METHODS

SOURCE OF DATA:

A total of eighty three cases referred for ultrasonography of neck to the Department of Radio Diagnosis, Sri R.L. Jalappa Hospital and Research Center over a period of 16 months from December 2011 to April 2013 are included in this study.

METHOD OF COLLECTION OF DATA:

Data was collected from a total of eighty three cases referred for ultrasonography of neck by purposive sampling using a proforma.

All scans are done carried out by 5-10 MH linear transducer using SEIMENS G 40 / G 50 / Acuson Ax 300 ultrasound equipment.

Fig 9: **Acuson Ax 300 ultrasound equipment**

Inclusion criteria:

1. All patients came for ultrasound neck.
2. Patients more than 12 years of age and both sex.

Exclusion criteria:

1. Patients with other non lymphnodal neck masses.
2. Moribund patients.
3. Post operative cases.
4. Patients who didn't have FNAC/ histopathology report.

USG TECHNIQUE:

The patient was asked to lie down in supine position with a pillow placed below the shoulder and the neck extended. Ultrasound jelly was then applied evenly on both sides for good acoustic medium and ensures good contact of the transducer with the skin.

The ultrasonographic was done from superior to inferior aspect of the neck. The cervical lymph nodes classified into VII levels in the neck based on AJCC classification. The examination begins with a transverse scan of the Submental region. After that the patient's head is turned towards the left side and the scanning is followed with a sequence from the submandibular area to the posterior triangle on right,The same procedure is followed on left side.

The sequence is: submandibular region → parotid → upper cervical, middle cervical, lowercervical → supraclavicular fossa → Superior mediastinal nodes and to the posterior triangle.

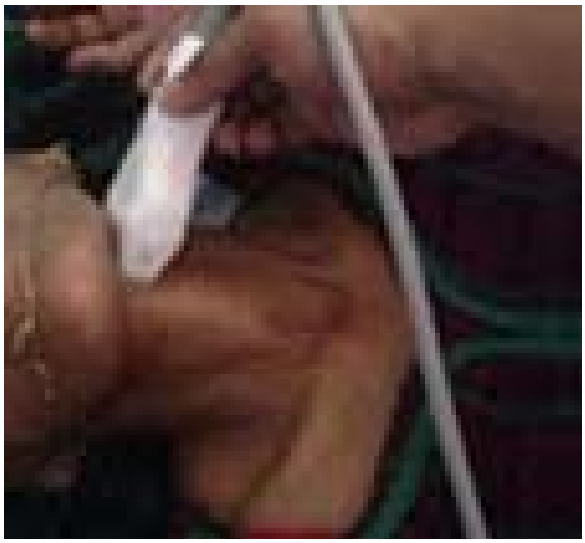

Fig 10: A patient undergoing ultrasound neck

Table 2 - Common ultrasound scan planes used in the examination of cervical nodes in different regions of the neck.

Regions	Scan plane(s)
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 Largest or most suspicious lymph node in each level was identified and charecterised with respect to USG .The largest and most suspicious lymphnode on USG was marked and sent for FNAC. In some of the patients who underwent

surgical resection more than one node was described on histopathology and this findings are correlated with before done ultrasound findings The criteria that are followed in this study are:

1. Distribution – level
2. Number
3. Size
4. Shape – besides L/S ratio
5. Echogenic hilus – wide/narrow/ absent
6. Border – sharp /unsharp
7. Homogenecity / heterogenecity
8. Solid/Central(coagulative) necrosis / cystic necrosis
9. Matting
10. Vascularity: hilar vessels, peripheral vessels, mixed vessels, focal absence of perfusion and absence of perfusion.

Non neoplastic lymph nodes include reactive and tubercular. Lymph nods which werein shape oval shape (L/S ratio > 2) unsharp border, echogenic hilum, homogenous echotexture and hilar vascularity were considered as reactive lymphadenopathy, nodes which showed matting with soft tissue edema were considered tubercular lymphadenitis.

Nodes which are round shape(L/S ratio < 2)absent hilum, sharp border, heterogenous echotexture, cystic or coagulative necrosis, capsular vessels(peripheral), mixed vascularity, displacement of vessels and focal absence of perfusion were considered neoplastic (malignant)lymph nodes. Since there was no difference between primary malignancy and metastasis sonologically[30] results of examination were grouped as malignant.

If nodes showed mixed characteristics of both nonneoplastic and neoplastic it was included under neoplastic (malignant) category.

FNAC technique

Under aseptic precaution the node was held between left index finger and thumb. A 22 or 23 gauge needle fitted to 10 ml syringe was used for aspiration of lymph nodes. The needle is introduced into the node, the plunger of the syringe was pulled to create the negative pressure .With the negative pressure intact the needle was moved to and fro within the node atleast two to three times, to aspirate adequate material . The negative pressure was released and needle along with syringe withdrawn from the node. The pressure was applied to the area with sterile cotton swab after needle was withdrawn .The needle was detached from the syringe, air was drawn into the syringe, needle was reattached and material was dispensed on to the slides. Four smears were made; two of them are fixed in fixative containing ethyl alcohol, later stained with PAP and H&E. Two smears were dried followed by staining with MCG and ZN stain.

Interpretation was done to find out whether aspirate is benign or malignant as mentioned in table below

Benign aspirate	Malignant aspirate
Sparse cellularity	Abundant cellularity
Well differentiated	Tumour cells with lack of differentiation.
No necrosis	Necrosis and haemorrhage
No mitosis	Increased mitosis
Regular chromatin	Abnormal chromatin pattern

Histopathology examination

The specimen was received fresh in the laboratory immediately after excision, bisected. The node was embedded in paraffin (which should not exceed more than 3 mm thickness) was processed. As a routine intial examination of preparation stained with haemtoxylin- eosin is perfectly adequate, followed by whatever additional stains and special technique the nature of case may require (which may range from very many to none)

Method of Statistical Analysis :

The following methods of statistical analysis have been used in this study.

The results for each parameter (numbers and percentages) for discrete data are presented in Tables and Figures. 1) Proportions were compared using Chi-square test of significance.

Chi-Square ($\chi 2$) test for (r x c tables)

DF = (r-1)*(c-1), where r=rows and c=columns

DF = Degrees of Freedom (Number of observation that are free to vary after certain restriction have been placed on the data).

In the above test the "p" value of less than 0.05 was accepted as indicating statistical significance.

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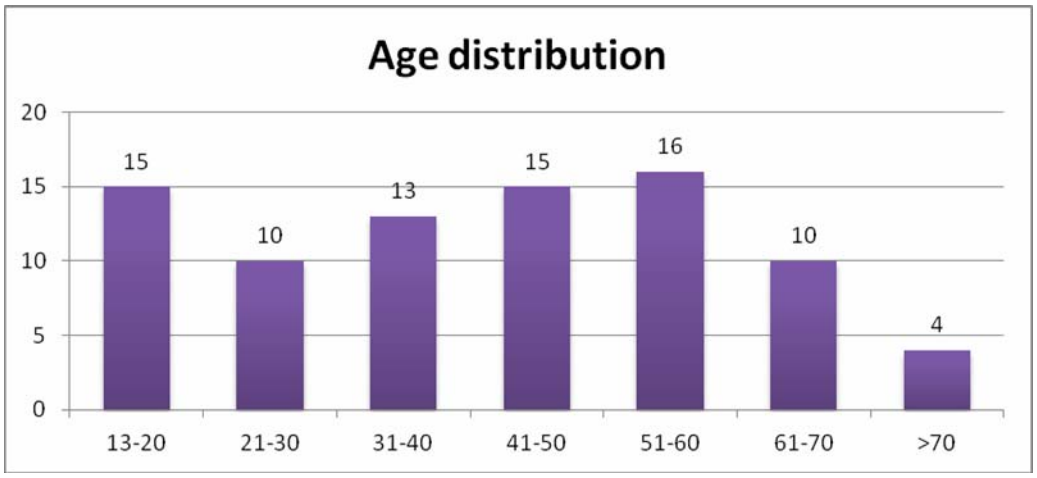
OBSERVATION AND RESULTS

A total of 83 patients with cervical lymphadenopathy who were referred for Ultrasounds to the Department of Radiodiagnosis in Sri Jalappa Research Centre, kolar were included in this prospective study. They were examined using

Grey Scale ultrasound, Doppler Sonography and the final diagnosis on USG was confirmed by FNAC/histopathology.

AGE DISTRIBUTION:



Graph 1 : Age distribution of cervical lymph adenopathy

N-83

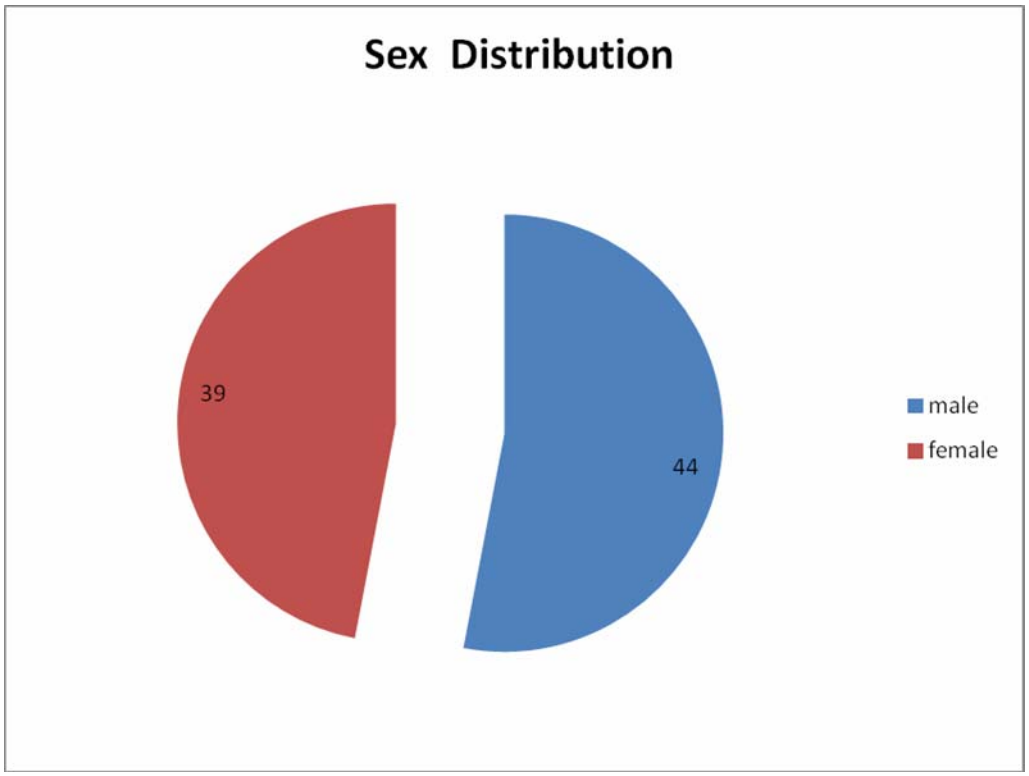
Minimum -13yrs

Maximum – 80 yrs

Mean – 42 yrs

SEX DISTRIBUTION:

Of the 83 cases, 44 were males (53%) and 39 were female(47%)



Graph 2 : Sex distribution of cervical lymphadenopathy

DIAGNOSIS OF CERVICAL LYMPHADENOPATHY ON USG

Table 3 – Diagnosis of cervical lymphadenopathy on USG

Diagnosis on USG	No of lymphnodes
Malignant	49
Tubercular	16
Reactive	25
Total	**90**

On USG 49 lymphnodes were malignant, 16 were tubercular and 23 were reactive lymphnodes**.**

DIAGNOSIS OF CERVICAL LYMPHADENOPATHY ON FNAC / HISTOPATHOLOGY

Table 4 : Diagnosis of cervical lymphadenopathy on FNAC / histopathology

Diagnosis on USG	No of lymphnodes
Malignant	42
Tubercular	23
Reactive	25
Total	**90**

On FNAC/ histopatholgy 42 lymphnodes were malignant , 23 were tubercular and 26 were reactive lymphnodes.

Out 42 malignant cases – 32 were squamous cell carcinoma, 2 were lymphoma, 3 were adenocarcinoma deposits ,1 from papillary carcinoma of thyroid,4 were metastasis from unknown origin.

COMPARISON OF USG DIAGNOSIS WITH FNAC DIAGNOSIS (Table 5):

The below table shows comparative study of USG diagnosis with FNAC diagnosis.

Table 5 -Comparison of USG diagnosis with FNAC diagnosis

USG D* FNAC D

Ultrasound Diagnosis	**FNAC DIAGNOSIS**			
	Malignant	**Tubercular**	**Reactive**	**Total**
Malignant	**38**	**6**	**5**	**49**
Tubercular	**0**	**16**	**0**	**16**
Reactive	**4**	**1**	**20**	**25**
Total	**42**	**23**	**25**	**90**

In our study out of 41 non neoplastic nodes (reactive and tubercular) only 37 nodes were identified as nonneoplastic on ultrasound prior to FNAC/histopathology. Out of 49 neoplatic (malignant) nodes detected on ultrasonography only 38 lymph nodes turned out to be neoplastic (malignant) on FNAC/ histopathology

Our study had a high sensitivity of 90.4%, Specificity of 74%, positive predictive value of 90.2% and also a negative predictive value of 77.5% in differentiating neoplastic from nonneoplastic lymphadenopathy.

DISTRIBUTION OF LYMPH NODES : table 6(graph 3)

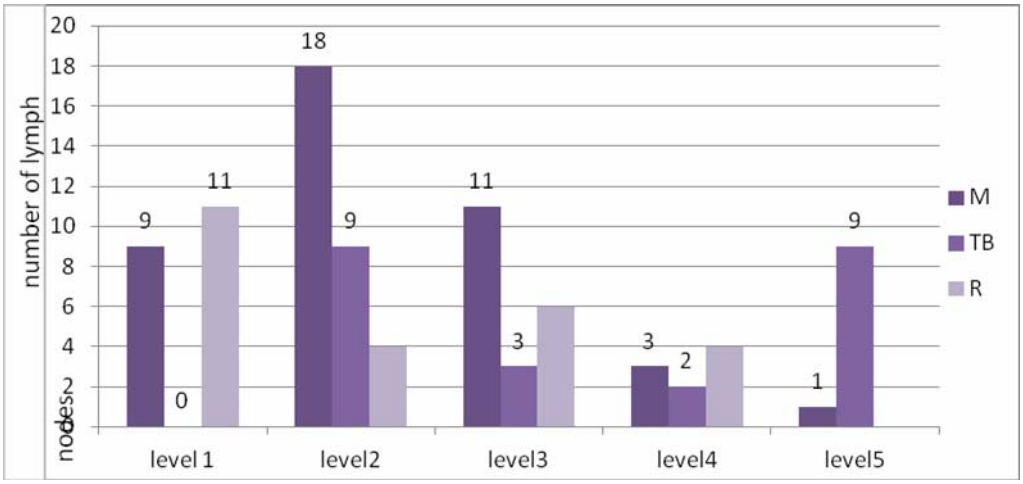
Table 6 : Distribution of lymph node level according to AJCC classification

LEVELS ON USG vs FNAC D

	Malignant	Tubercular	Reactive	Total
Level 1	9(43%)	0	11(53%)	20
Level 2	18 (58%)	9(29%)	4 (12%)	31
Level3	11 (57%)	3 (23%)	6 (31%)	20
Level 4	3 (25%)	2 (16%)	4(13%)	9
Level5	1(1%)	9(99%)	0	10
Total	42	23	25	90

Chi square – 38.8 p value < 0.01

This table shows that majority of nodal level affected was level II showing maximum of 31 nodes out of 90 of which majority are malignant and most of tubercular nodes are noted in level V (posterior triangle) , majority of reactive lymphnodes are distributed in level I



Graph 3 : Distribution of lymph nodal level according to AJCC classsification

DISTRIBUTION OF L/S RATIO ON USG ACCORDING TO FNAC/HISTOPATHOLOGY DIAGNOSIS :table 7 (graph 4)

Usually metastatic lymphnodes tend to be more round or spherical than benign /reactive nodes, which tend to assume more oval or oblong shape.

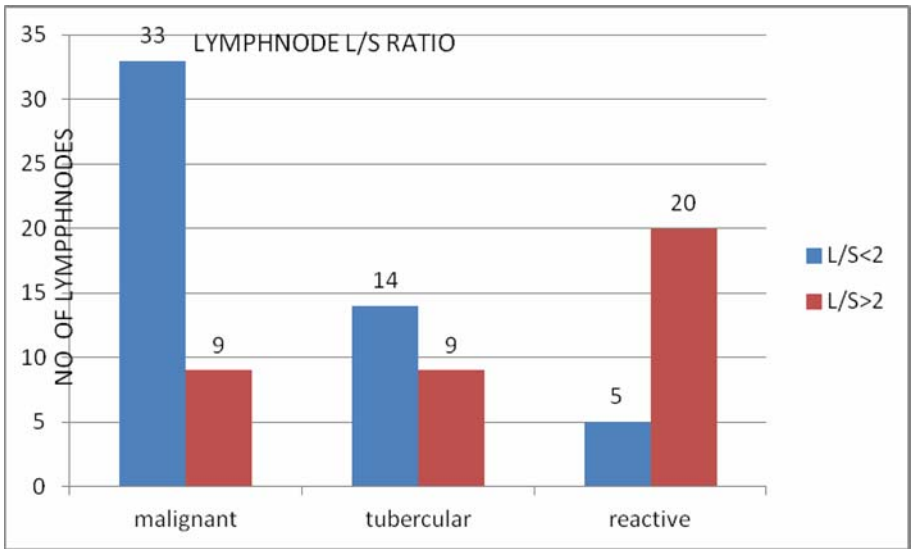
Table 7: Distribution of L/S ratio on USG according to FNAC /histopathology diagnosis

FNAC/histopathology D * L/S RATIO ON USG

	L/S <2	**L/S>2**	**TOTAL**
Malignant	33(79%)	9(33%)	42
Tubercular	14(60%)	9(40%)	23
Reactive	5(20%)	20(80%)	25
Total	**52(59%)**	**38(42%)**	**90**

Chi square – 22.16 p value <0.001

The shape of the lymph node can be assessed objectively by taking the long to short axis ratio (L/S ratio) of the enlarged lymphnodes. The tendency of benign / reactive nodes to be "oval" (L/S >2) and malignant nodes to be "spherical" (L/S <2) have been reported by many observers[30,35].In this study the p value for the L/S ratio was 0.001, which showed the association to be highly significant 79% of malignant nodes showed L/S < 2, 60% of tubercular nodes showed L/S < 2 and 80% of reactive nodes showed L/S > 2.



Graph 4 : Distribution of L/S ratio on USG according to FNAC /histopathology diagnosis

DISTRIBUTION OF BORDER ACCORDING TO USG IN COMPARISION WITH FNAC/HISTOPATHOLOGY DIAGNOSIS:table 8(graph 5)

Table 8 : Distribution of border according to USG in comparison with FNAC/histopathology diagnosis

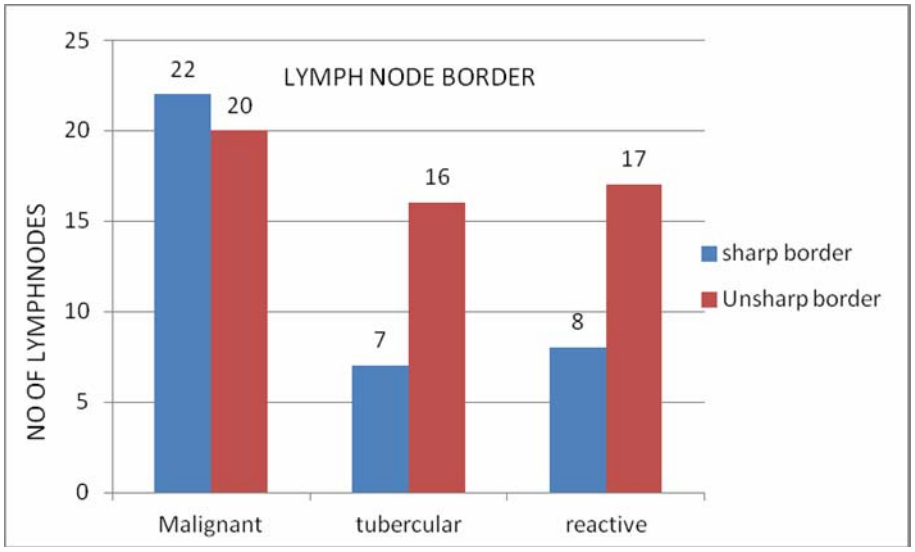
FNAC/histopathology D *border on USG

	Sharp border	**Unsharp border**	**Total**
Malignant	22(52%)	20(48%)	42
Tubercular	7(31%)	16(69%)	23
Reactive	8(32%)	17(68%)	25
Total	**37(41%)**	**53(59%)**	**90**

Chi square – 4.6 p value –0.1

The above table shows that malignancy/metastasis nodes are having more of sharp borders and benign nodes are having more of unsharp borders.

In our study out of 42 malignant nodes 22(52%) shows sharp border, out of 25 reactive 17 (68%)shows unsharp border, out of 23 tubercular 16 (69%) shows unsharp border. In this study the p value for the border was 0.1, which showed the association to be not significant



Graph 5: Distribution of border according to USG in comparison with FNAC diagnosis/histopathology diagnosis

DISTRIBUTION OF THE HILUM ON USG IN COMPARISION WITH FNAC/ HISTOPATHOLOGY DIAGNOSIS: table 9 (graph 6)

Table 9: Distribution of hilum on USG in comparison with FNAC/ histopathology diagnosis

FNAC/ histopathology D*hilum on USG

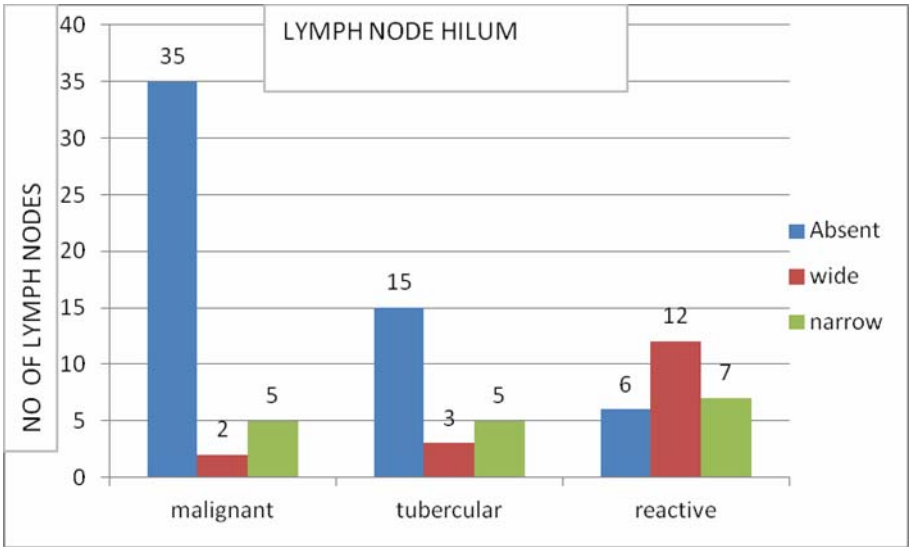
	Absent	**Wide**	**Narrow**	**Total**
Malignant	35(83%)	2(5%)	5(12%)	42
Tubercular	15(64%)	3(15%)	5(21%)	23
Reactive	6(20%)	12(48%)	7(32%)	25
Total	**56(62%)**	**17(18%)**	**18(19%)**	**90**

Chi square 27.32 pvalue <0.01

The above table shows that majority of malignant/metastatic nodes are having absent hilum and narrow hilum. But reactive lymph nodes show more of widened hilum.

In our study 83% of malignant nodes showed absent hilus, 64% of tubercular nodes showed absent hilus, 48 % of reactive nodes showed wide hilus.

The p value <0.01 shows significant association



Graph 6 : Distribution of hilum on USG in comparison with FNAC/ histopathology diagnosis

DISTRIBUTION OF ECHOTEXTURE ACCORDING TO USG IN COMPARISION WITH FNAC/HISTOPATHOLOGY DIAGNOSIS:

table 10(graph 7)

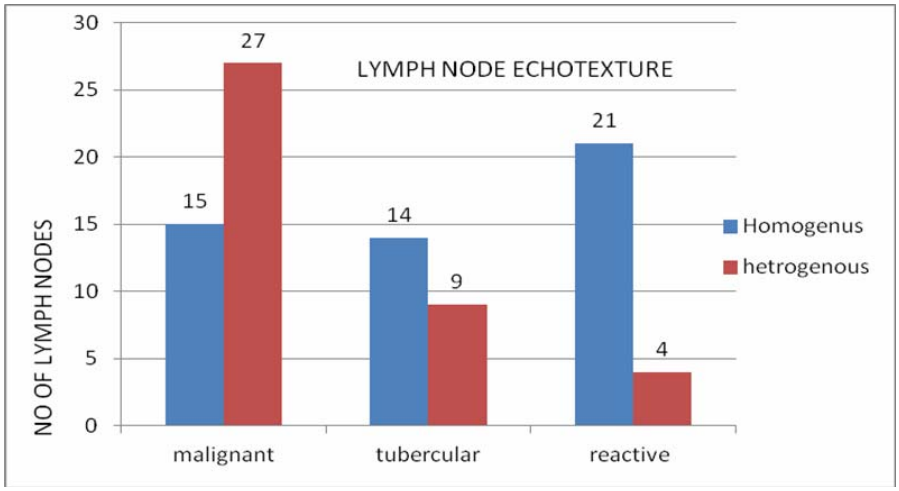
Table 10:Distribution of echotexture according to USG in comparison with FNAC / histopathology diagnosis:

	Homogenous	**Heterogeneous**	**Total**
Malignant	15(35%)	27(73%)	**42**
Tubercular	14(60%)	9(40%)	**23**
Reactive	21(84%)	4(16%)	**25**
Total	**50 (54%)**	**40 (66%)**	**90**

Chi square – 15.04 p value 0.0015

The above table shows that malignant/metastatic nodes are showing heterogeneous pattern, while reactive nodes show homogenous pattern. This is also one of important criteria to distinguish between reactive and malignant variety.

Our study shows 84% of reactive lymph nodes are homogenous, 60% of tubercular lymphnodes are heterogeneous and 73% of the malignant lymph nodes are heterogeneous. The p value for this criterion was 0.0015, which showed the association to be Significant.



Graph 7 : Distribution of echotexture according to USG in comparison with FNAC / histopathology diagnosis:

DISTRIBUTION OF NECROSIS ACCORDING TO USG IN COMPARISION WITH FNAC / HISTOPATHOLOGY DIAGNOSIS :table 11 (graph 8)

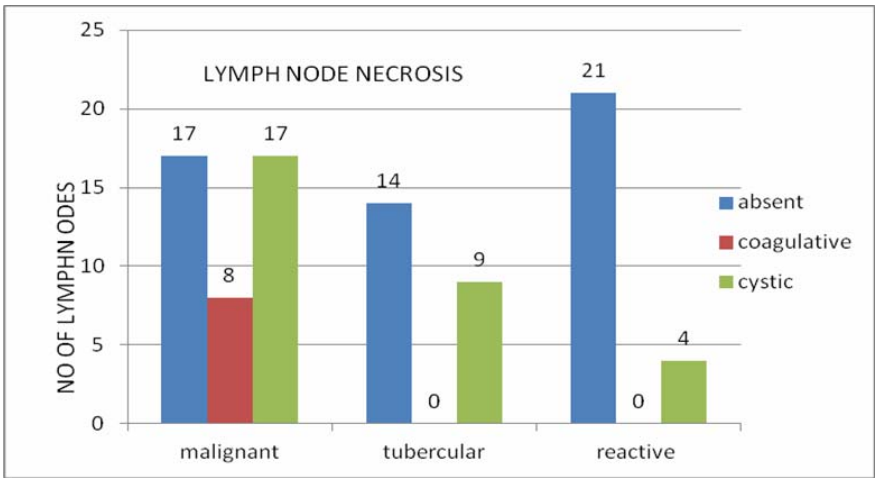
Table 11: Distribution of necrosis according to USG in comparison with FNAC / histopathology diagnosis:

FNAC/ histopathology D * Necrosis on USG

	Absent	Coagulative	Cystic	Total
Malignant	17(41%)	8(18%)	17(41%)	42
Tubercular	14(60%)	0	9(40%)	23
Reactive	21(84%)	0	4(16%)	25
Total	**52(58%)**	**8(9%)**	**30(33%)**	**90**

Chi square- 11.08 p value – 0.08

Intranodal necrosis may be seen as a cystic (cystic or liquefaction necrosis) or echogenic (coagulation necrosis) area within the node.In our study, out of 90 nodes, 38 showed necrosis. 30 nodes showed cystic necrosis of which 17 were malignant and 9 were tubercular. 8 nodes showed central (coagulative) necrosis and all of them were malignant (100%). In our study 40 % of malignant nodes and tubercular nodes showed cystic necrosis. Benign/ reactive nodes showed 16% cystic necrosis. The p value for this criterion was 0.083, which showed the association to be not significant.



Graph 8: Distribution of necrosis according to USG in comparison with FNAC/ histopathology diagnosis

COMPARISON OF USG DIAGNOSIS OF MATTING IN COMPARISION WITH FNAC/HISTOPATHOLOGY:

Ying et all[2] stated that Matting is one of the important criteria to diagnose tubercular lymph nodes, because of the surrounding soft tissue edema the tubercular lymph nodes results in matting of the lymph nodes.

Ahuja et al[53] stated that matting and adjacent soft tissue oedema are more common in tuberculous nodes, but it can be seen rarely in malignancy. The soft tissue edema surrounding the lymph nodes causes matting of the lymph nodes.

In our study out of 90 nodes 16 showed matting all of which were tubercular (100%). Reactive and malignant lymphnodes showed no matting

DISTRIBUTION OF VASCULAR PATTERN OF LYMPH NODES

HILAR VASCULARITY: Table12: (graph 9)

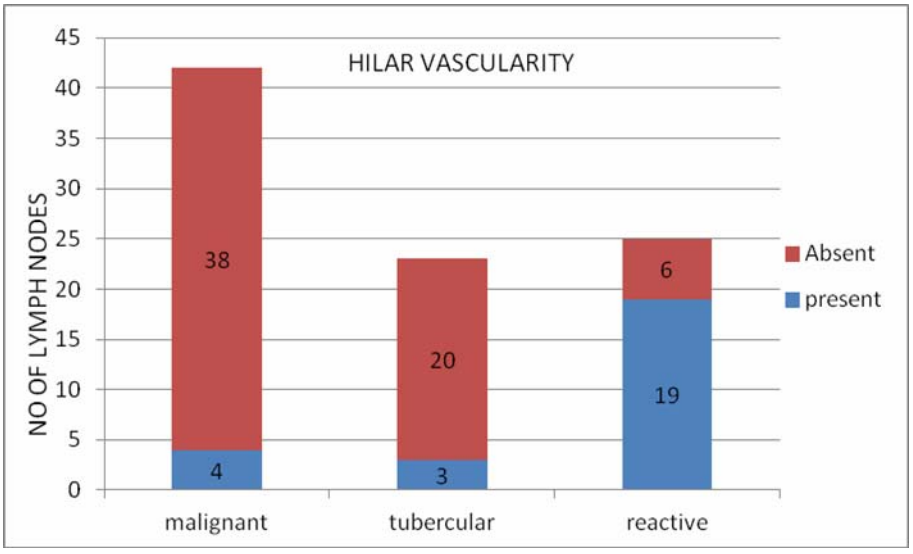
Table12 :Hilar Vascularity

FNAC / histopathology D * hilar vascularity on USG

	Present	**Absent**	**Total**
Malignant	4(10%)	38(90%)	**42**
Tubercular	3(13%)	20(78%)	**23**
Reactive	19(76%)	6(24%)	**25**
Total	**26(28%)**	**64(72%)**	**90**

Chi square -36.9 p value < 0.01

Benign / Reactive nodes tend to have a prominent hilar vascularity due to increase in the vessel diameter and blood flow as the infection progresses .In our study of 90 lymphnodes. Malignant 10%, tubercular 13 % and reactive 76% showed hilar vessels. The p value for this criterion was less than 0.01, which showed the association to be very significant



Graph 9 : Hilar Vascularity

FOCAL ABSENCE OF PERFUSION: Table 13 (Graph 10)

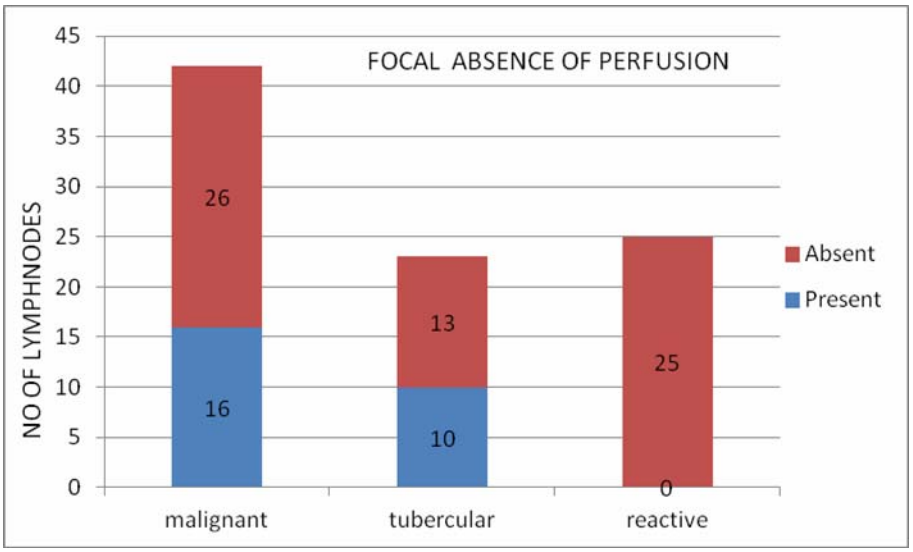
Table 13:focal absence of perfusion

FNAC/ histopathology D * focal absence of perfusion on USG :

	present	Absent	Total
Malignant	16(39%)	26(61%)	**42**
Tubercular	10(43%)	13(57%)	**23**
Reactive	0(0%)	25(100%)	**25**
Total	**26(28%)**	**74(73%)**	**90**

Chi square -26.6 pvalue< 0,01

The above table shows malignant (39%) and tubercular (43%) lymph nodes showed focal absence of perfusion which is significant and specific.



Graph 10:Focal absence of perfusion

CAPSULAR VASCULARITY: table 14 (Graph 11)

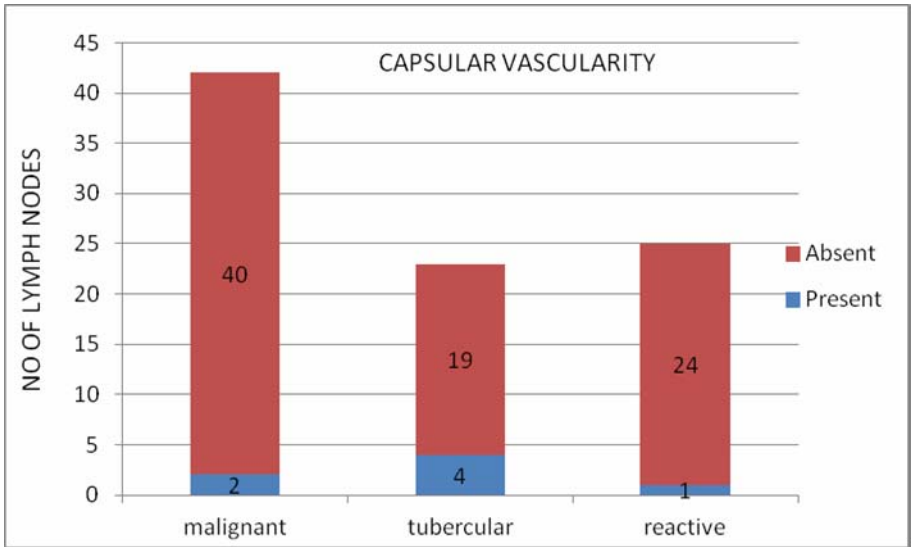
Table 14 – capsular vascularity

FNAC/ histopathology D * capsular vascularity on USG

	Present	Absent	Total
Malignant	2(8%)	40(92%)	**42**
Tubercular	4(17%)	19(83%)	**23**
Reactive	1(4%)	24(96%)	**25**
Total	**8(9%)**	**82(91%)**	**90**

Chisquare – 7.53 p value – 0.02

The above table shows malignant (8%) and tubercular (17%) lymph nodes showed only capsular vascularity the p value is 0.02 which showed the association to be significant.



Graph 11 : Capsular Vascularity

MIXED(BOTH PERIPHERAL AND HILAR) VASCULARITY:table 15 (Graph 12)

Table 15: Mixed Vascularity

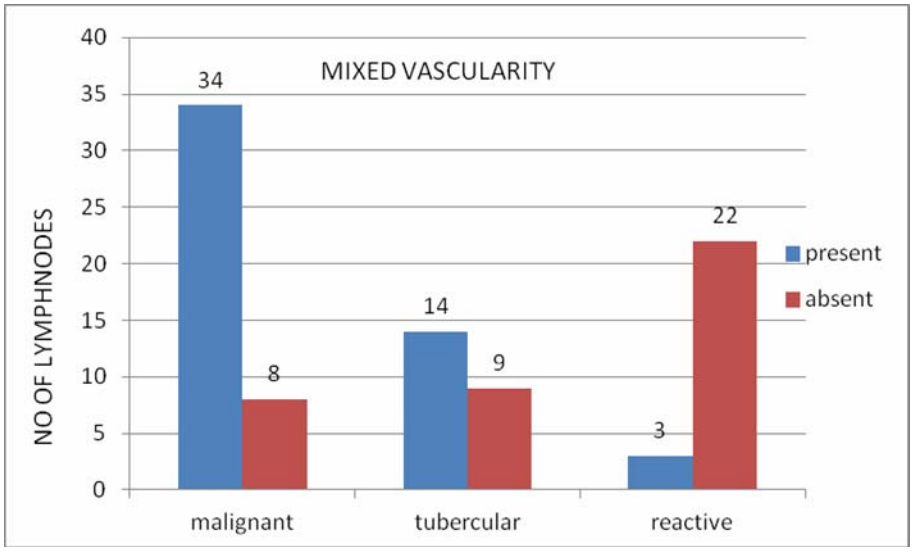
FNAC/ histopathology D * mixed vascularity on USG

	Present	**Absent**	**Total**
Malignant	34(76%)	8(34%)	42
Tubercular	14(60%)	9(40%)	23
Reactive	3(12%)	22(88%)	25
Total	**51(56%)**	**39(64%)**	**90**

Chi square test – 32.2 p value <0.001

This mixed vascularity flow is usually seen in tubercular and more of malignant nodes.

In our study of 90 lymph nodes, malignant 76%, reactive 12% and tubercular 60% showed mixed vascularity. The p value for this criterion was less than 0.01 Which showed the association to be significant.



Graph 12 : Mixed Vascularity

NO PERFUSION: table 16 (Graph 13)

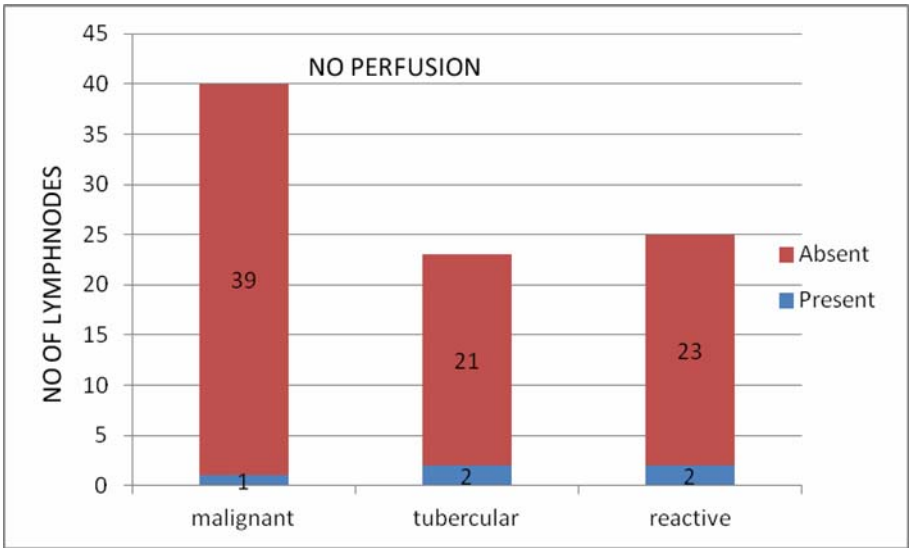
Table 16 : No perfusion

FNAC D * No perfusion on USG

	Present	**Absent**	**Total**
N	1(3%)	39(97%)	42
TB	2(8%)	21(91%)	23
R	2(6%)	23(94%)	25
Total	**4**	**86**	**90**

The above table shows most of reactive, malignant and tubercular lymph nodes

Showed perfusion



Graph 13: No perfusion

DISCUSSION

The present study is done to show the high resolution ultrasonography, colour and power Dopplers efficacy and usefulness in differentiating malignant, tubercular and reactive cervical lymphadenopathy.

The diagnosis of metastatic lymphnodes helps in therapeutic planning,[30] as the presence or absence of metastasis also helps in planning treatment, risk of recurrence and the survival.

Ultrasound is preferred over CT and MRI in evaluation cervical lymphadenpathy because

1. In differentiating benign and malignant lymph nodes the size cannot be considered as sole criteria.
2. The presence of central nodal necrosis is thought to be one of the most specific sign of metastatic involvement with a specificity of 95% - 100%. In CT the nodal necrosis is observed as central low attenuation. The infection and other causes can also appear as a central nodal necrosis in CT.[36]
3. CT sometimes cannot detect cervical lymph nodes that are smaller than 0.5cms as most cervical nodes are aligned with their long axis parallel to the long axis of the body and because CT demonstrates only the transverse plane of the nodes in which plane all nodes appears to be round.[46]
4. Increased fatty deposition in the lymph nodes of the elderly can appear as central nodal necrosis in the CT.
5. Finally, CT and MRI are expensive and not readily accessible for repeated use during follow up of the patients.

Ultrasonography is cost effective, easily available, radiation free, non invasive, safe and is primary investigation to differentiate malignant, tubercular, and reactive

cervical lymphadenopathy.[36] Ultrasound examination of the lymph nodes can be done in all planes so that exact nodal size and shape can be evaluated.[32]

The criteria considered in this study to evaluate the differentiation between benign and malignant cervical lymphadenopathy are :

1. Level and site
2. Shape
3. L/S ratio
4. Nodal border : sharp and unsharp
5. Hilum : widened, narrow and absent
6. Echotexture: Homogenous , heterogenous
7. Necrosis : cystic and central
8. Matting.
9. Angioarchitecture: hilar vessels, focal absence of perfusion, capsular vessels (peripheral), displacement, mixed flow.

Ultrasound correlation with FNAC / histopathology:

In a study done by Danniger et al[73] Ultrasonography sensitivity and specificity for detecting malignant nodes was 96% and 69% respectively.

In another study done by Ahuja et al[53] sonographic sensitivity and specificity was 95% and 83% for characterization of cervical lymph nodes.

Ahuja et al[74] concluded that ultrasound was 95% sensitive and 83 % specific for classifying metastatic / non metastatic lymph nodes.

On USG 49 lymphnodes were malignant, 16 were tubercular and 23 were reactive lymphnodes.

On FNAC/ histopatholgy 42 lymphnodes were malignant , 23 were tubercular and 26 were reactive lymphnodes

In our study out of 41 non neoplasticnodes (reactive and tubercular) only 37 nodes were identified as on ultrasound prior to FNAC/histopathology. Out of 49 possible malignant nodes detected on ultrasonography only 38 lymph nodes turned out to be neoplastic (malignant) on FNAC/ histopathology .There was a slight amount of over diagnosis by our study particularly with regard to neoplastic (malignant) nodes. The reason for this was mainly due to inclusion of all grey scale and colour Doppler parameters in diagnosis of neoplastic (malignant) and nonneoplastic nodes (reactive and tubercular) cervical lymphadenopathy. Certain parameters like cystic / central necrosis and borders were considered as not significant parameters at end of study.

In our study the Ultrasonography sensitivity, specificity, positive and negative predictive values are 90%, 74%, 77% and92% respectively for differentiating neoplastic from non neoplastic cervical lymphadenopathy.

Thus our study Confirmed the reliability of ultrasound sensitivity and specificity in evaluating cervical lymph nodes on ultrasound as reported in literature.

Lymph nodes which shows disagreement between FNAC / Histopathology:

False negative are 4 lymphnodes which are thought to be reactive as there were oval in shape with homogenous echotexure and no necrosis on USG , there was hilar vascularity or no perfusion on Doppler evaluation, but on FNAC or histopathology they were proved to be malignant.

False positive are 11 out of which 6 lymphnodes which are hetrogenous echotexture with cystic necrosis, without matting, either mixed vascularity or capsular

vascularity on Doppler thought to be malignant on USG they were tubercular lymphadenopathy on FNAC.

And 5 lymphnodes which were either round shape /hetrogenous echotexture with necrosis, with no hilar vascularity on doppler thought to be malignant on USG proved to be reactive on FNAC.

SHAPE AND L/S RATIO:

In one study done by Vasallo et al[30], out of the 26 benign/ reactive nodes, 85% showed L/S ratio>2 and 15% showed L/S ratio <2. Of 68 malignant nodes 85% of nodal metastasis showed L/S ratio < 2 and 15% were L/S ratio >2.

In another study done by Na DG et al[33] , in 64 malignant lymph nodes, 85% of the nodes showed L/S ratio < 2 and 15% were L/S ratio >2.

Toriyabe et al[35] 68% of reactive/ benign lymph nodes are S/l<0.6(oval) and in 81 % of malignant lymph nodes are more round in shape S/L >0.6

In our study79% of malignant nodes showed L/S < 2, 80% of reactive nodes showed L/S > 2 and 60% of tubercular nodes showed L/S < 2, the p value for the L/S ratio was 0.001, which showed the association to be highly significant

LYMPH NODE BORDER– sharp and unsharp border.

Ahuja et al[48] Sharp borders in malignancy is due to the infiltrating tumour cells which replaces normal lymphoid tissues and it causes an increasing acoustic impedance difference between lymph nodes and surrounding tissues where as unsharp borders in malignant nodes indicate invasion into adjacent structures. But in benign because of edema or active inflammation of the surrounding tissues, they will have

unsharp borders. In their experience, border sharpness is not helpful in differential diagnosis.

In our study out of 42 malignant nodes 22(52%) shows sharp border , out of 25 reactive 17 (68%)shows unsharp border, out of 23 tubercular 16 (69%) shows unsharp border .In this study the p value for the border was 0.09, which showed the association to be not significant.

LYMPH NODE HILUS – Widened, Narrow and Absent:

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 centre resulting in widening of hilum.

In one study done by Vasallo et al [30], 26 of benign nodes 58% showed a wide central hilus, 35% showed a narrow hilus and 8% no hilus. Of 68 Malignant nodes only 6% of nodal metastasis exhibited a wide central hilus, 48% exhibited no hilus and 46% of malignancies/metastasis showed narrow hilus.

In our study 83% of malignant nodes showed absent hilus,12% of malignat nodes showed narrow hilus, 64% of tubercular nodes showed absent hilus, 21% with narrow hilus, 48 % of reactive nodes showed wide hilus. The p value <0.01 shows significant association.

ECHOTEXTURE OF THE LYMPH NODES- homogenous and hetrogenous :

In one study done by Toriyabe et al[35], 17 of 19 nodes showed heterogeneous echotexture were proved as malignant and 30 out of 33 lymphnodes which are homogenous echotexture were proved benign/reactive by histopathology study.

Our study shows 84% of reactive lymph nodes are homogenous and 73% of the malignant lymph nodes are heterogeneous correlating with previous study.

The p value for this criterion was 0.0015, which showed the association to be significant.

INTRANODAL NECROSIS (Cystic & Central / Coagulation) :

Intranodal necrosis may be seen as a cystic (cystic or liquefaction necrosis) or echogenic (coagulation necrosis) area within the node. Cystic necrosis is the more common form of intranodal necrosis which appears as an echolucent area within the nodes. Coagulation necrosis is a less common sign, and appears as an echogenic focus within lymph nodes but is not continuous with the surrounding fat and does not produce acoustic shadowing. Intranodal necrosis may be found in metastatic and tuberculosis nodes, and regardless of nodal size, the presence of intranodal necrosis should be considered pathologic.[53]

In our study, out of 90 nodes 35 showed necrosis. 28 nodes showed cystic necrosis of which 17 were malignant and 8 were tubercular . 8 nodes showed central (coagulative) necrosis and all of them were malignant (100%). In our study 41% of malignant nodes showed cystic necrosis which was all malignant on FNAC correlation. Where as 40% of tubercular nodes showed cystic necrosis. Benign/ reactive nodes showed 12% cystic necrosis .The p value for this criterion was 0.083, which showed the association to be not significant.

MATTING :

Ying et all[2] stated that Matting is the important criteria to diagnose tubercular lymph nodes. Because of the soft tissue edema surrounding the affected lymph nodes results in matting of the lymph nodes.

Ahuja et all[53] stated that matting and adjacent soft tissue oedema are common in tuberculous nodes, however they can be seen rarely in malignancy.

In our study out of 90 nodes 16 showed matting all of which are tubercular(100%). Reactive and malignant lymphnodes show no matting

VASCULAR PATTERN:

Hilar vascular pattern :

Benign / Reactive nodes tend to have a prominent hilar vascularity due to increase in the vessel diameter and blood flow as the infection progresses.

In a study done by NaDG et al[33], 97% of benign / reactive and 18% of malignant lymph nodes showed hilar vessels

In our study of 90 lymphnodes: Malignant 10%, tubercular 13% and reactive 76% showed hilar vessels. The p value for this criterion was less than 0.01, which showed the association to be very significant

Capsular (Peripheral) Flow :

In a study done by Na DG et al[33] there is peripheral vascularity with loss of cenntral nodal vascularity is tubercular nodes (24%) and metastic (6%).

Our study shows malignant (8%) and tubercular (17%) lymphnodes showed only capsular vascularity which was statistically significant.

Mixed vascular pattern:

In a study done Na DG et al[33] 85% of malignant and 76% of tubercular nodes showed mixed vascular pattern

In our study of 90 lymph nodes: malignant 76%, reactive 8% and tubercular 60% showed mixed vascularity. The p value for this criterion was less than 0.001 showed the association to be statically significant.

This mixed vascularity flow is usually seen in tubercular and more of malignant nodes.

Limitations of Doppler:

- According to Na et al [33]It is very difficult to detect superficially located, slow flow signals,
- There is significant overlap in Doppler findings between inflammatory nodes, tubercular and neoplastic nodes.
- It is difficult to obtain Doppler spectral wave forms in non cooperative patients

CONCLUSION

THIS STUDY CONCLUDES THAT :

1. High resolution Sonographic and color Doppler examination proved as a valuable primary investigation to identify lymph nodes and helps to differentiate neoplastic (malignant) and non neoplastic(reactive and tubercular) lymphnodes
2. Ultrasound evaluation proved as a radiation free, cost effective, noninvasive and safe method for cervical lymphadenopathy.
3. Ultrasound evaluation is very sensitive in differentiating between cystic / necrotic foci and solid swellings.
4. Adjacent soft tissue edema and matting are particularly useful to identify Tuberculosis, as malignant and tubercular lymph nodes almost same characteristics expect matting .
5. Ultrasound helps in indentifying abnormal nodes and useful for guided FNAC.

At the end of our study we present evaluation criteria that help for differentiating Nonneoplastic and neoplastic cervical lymphnodes:

1. Grey scale findings of size, shape, long axis/ short axis ratio, nodal Echogenic hilum, lymphnode Echogenicity, matting and nodal necrosis.

2. Doppler findings of focal absence of perfusion, capsular vessels, displacement, hilar vascularity and mixed vascularity.

SUMMARY

Eighty three patients included in the study, ranging from 13- 80 years with mean age 42 yrs, referred for neck ultrasonography to the department of Radiodiagnosis, Sri R.L. Jalappa Hospital and Research Center, Tamaka, Kolar were subjected to high resolution Sonographic examination to differentiate reactive, tubercular and malignant cervical lymphadenopathy.

The criteria that were followed in this study to differentiate between nonneoplastic (reactive, tubercular) and neoplastic (malignant) cervical lymphadenopathy are:

1. Distribution – includes levels and side
2. Number
3. Size
4. Shape – L/S ratio
5. Echogenic hilus – wide/narrow /absent
6. Border – sharp /unsharp
7. Homogenecity /heterogenecity
8. Solid /Central or coagulative necrosis /cystic necrosis
9. Matting and soft tissue edema
10. Vascularity and angioarchitecture: hilar vessels, displacement of vessels, mixed vessels , focal absence of perfusion, capsular vessels.

The results of ultrasonographic examination were compared with the fine needle aspiration cytology/ histopathology study.

1. In our study we found **Malignant** lymph nodes showed following characteristics.

   Grey scale: Absent echogenic hilus, Heterogenous echotexture, Round shaped (L/S ratio < 2) and Necrosis (central or coagulative /cystic).

   Doppler: capsular vessels, Displacement, Focal absence of perfusion, mixed vascularity

2. In our study we found **Tuberculous** lymph nodes showed following characteristics.

   Grey scale: Absent echogenic hilus, Heterogenous echotexture, Round or oval shaped, Cystic necrosis, Matting and soft tissue oedema.

   Doppler: capsular vessels, Displacement, Focal absence of perfusion and mixed vascularity

3. In our study we found **Reactive** lymph nodes showed following characteristics.

   Grey scale: Echogenic hilus, Homogenous echotexture, Oval shaped and L/S ratio >2

   Doppler: Hilar vascularity

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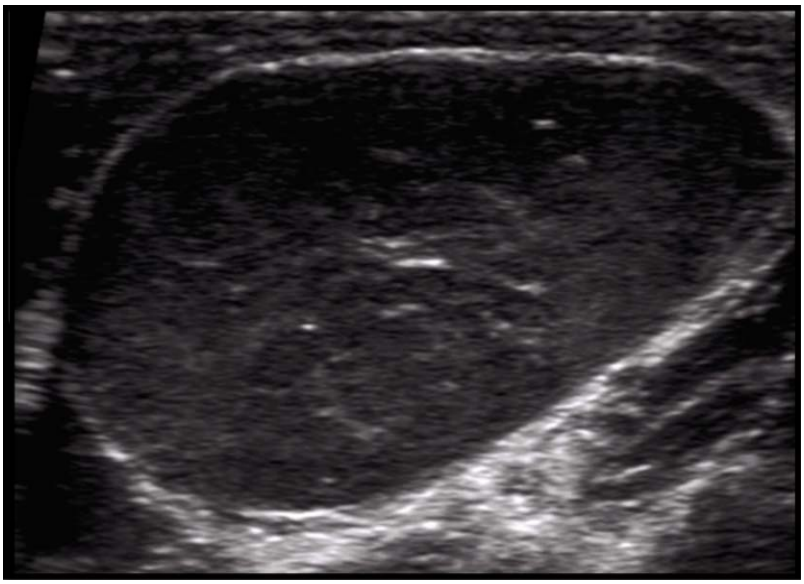
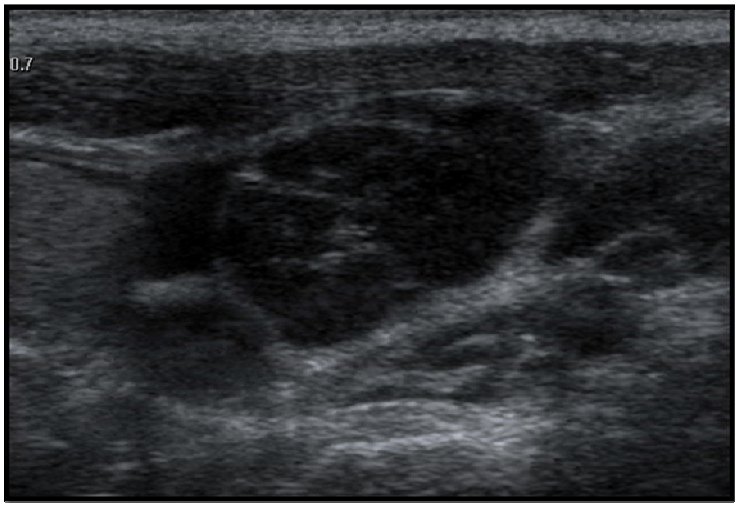
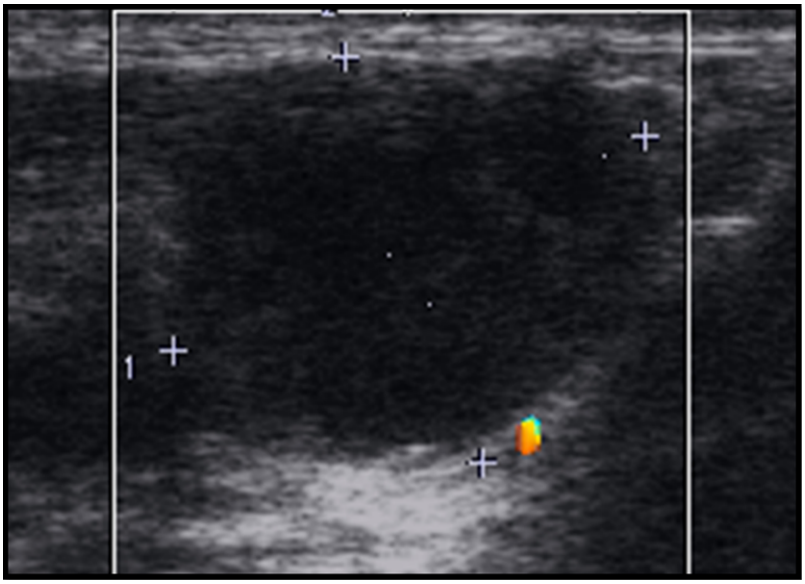
PHOTOGRAPHS



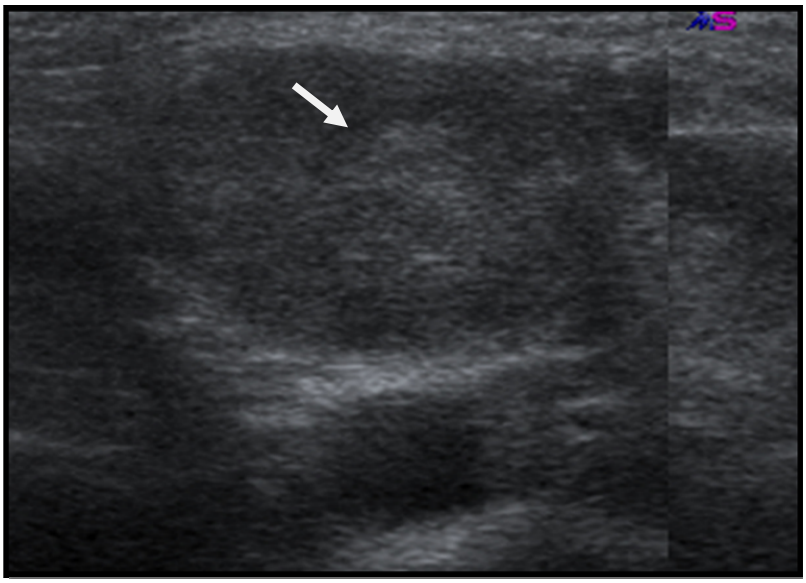
15yr old male, Known case of lymphoma on USG there is enlarged level I lymph node with absent hilum , sharp borders and heterogeneous echo texture proved on histopathology



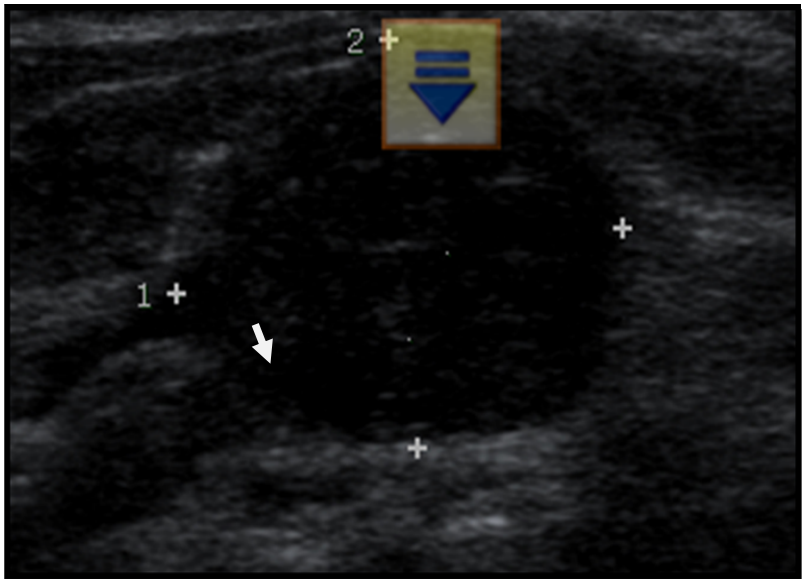
19 yr old male ,Known case of lymphoma on USG there is enlarged level II round lymph node with absent hilum , sharp borders and heterogeneous echo texture proved on FNAC .



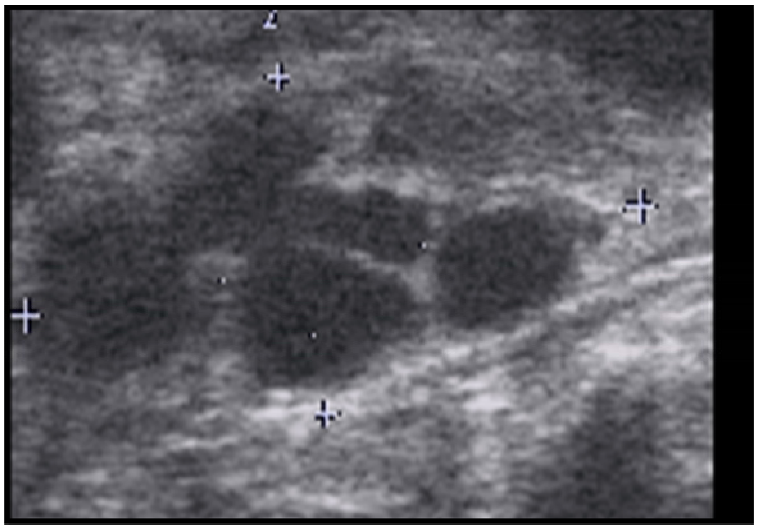
42 yrs old male with swelling in neck on USG at level IV an enlarged round lymphnode with absent hilum , illdefined border with extracapsular spread heterogeneous echo texture and cystic necrosis - suggestive of metastatic lymph node proved on USG guided FNAC.



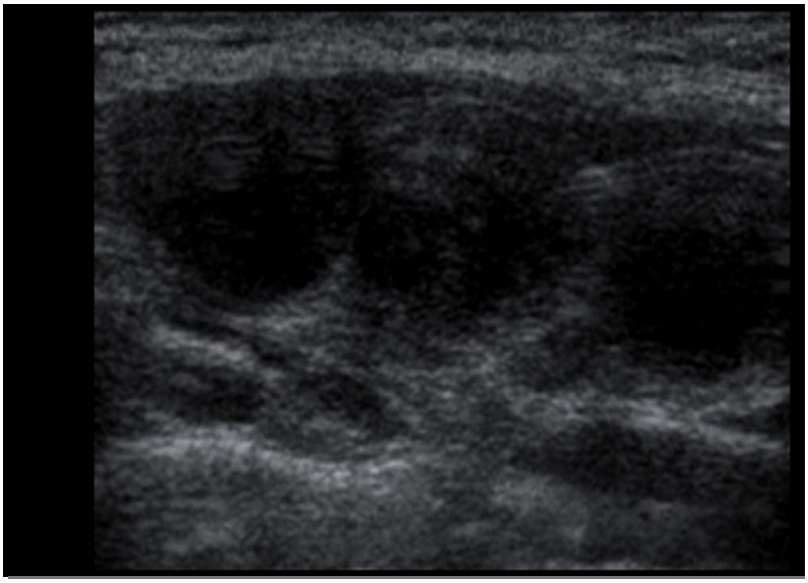
52 yrs old male known case of papillary ca of thyroid on USG at level II an enlarged round hyper echoic lymphnode with absent hilum , sharp borders, heterogeneous echo texture and coagulative necrosis (arrow)- suggestive of metastatic lymph node proved on histopathology.



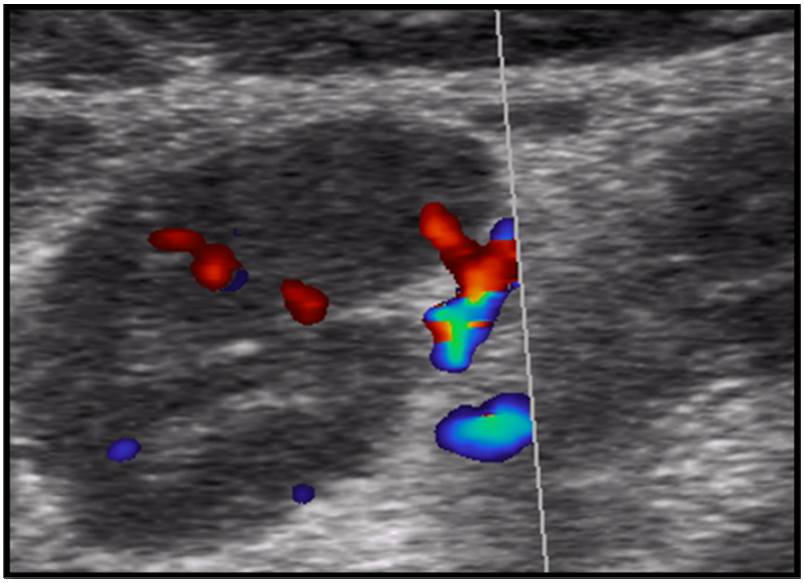
57yrs old male known case of ca of buccal mucosal mucosa on USG at level III an enlarged round lymphnode with absent hilum , sharp borders, heterogeneous echo texture and cystic necrosis (arrow)- suggestive of metastatic lymph node proved on FNAC.



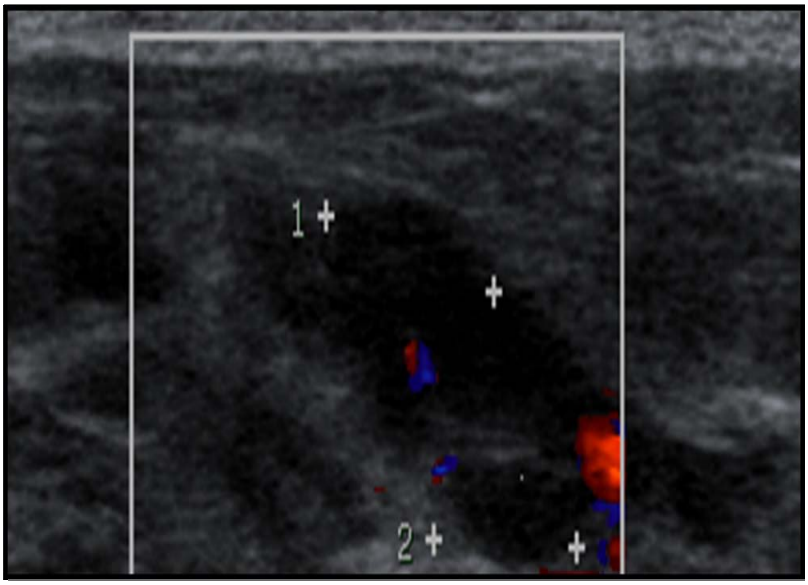
A 40 yrs old female with swelling in neck on USG at level V there are multiple enlarged lymph nodes with matting and adjacent soft tissue edema – suggestive tubercular lymphadenopathy proved on FNAC



A 35yrs old female with swelling in neck on USG at level II there are multiple enlarged lymph nodes with matting and adjacent soft tissue edema – suggestive tubercular lymphadenopathy proved on FNAC

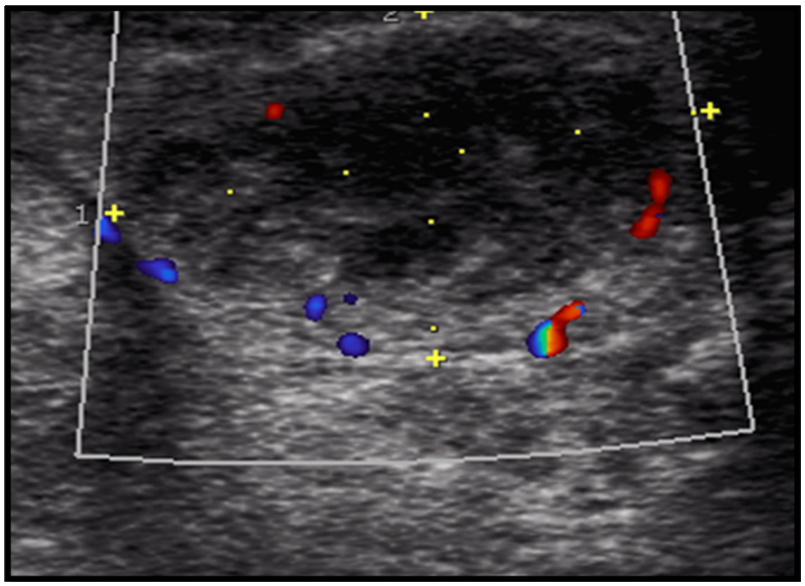


15yrs old male presented with swelling in neck On USG at level I an oval lymph node with maintained Hilum and hilar vascularity suggestive of reactive lymphnode confirmed on FNAC.

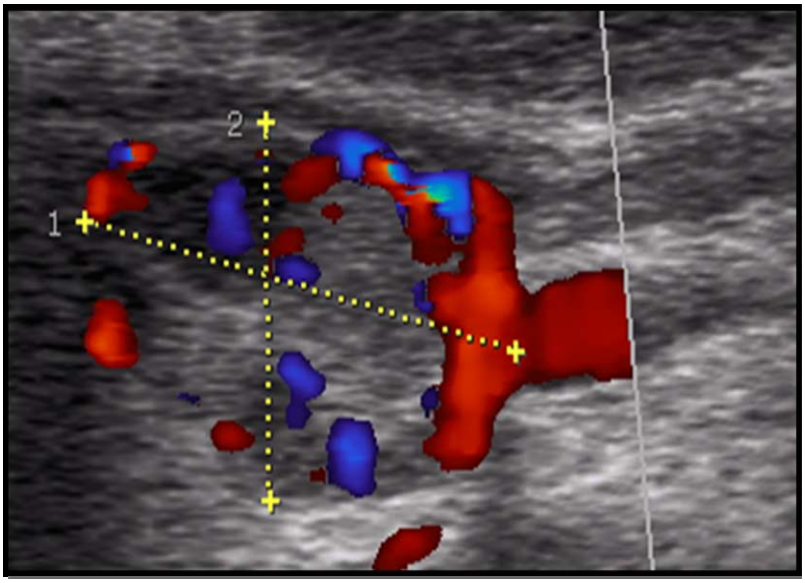


18 yrs old male presented with swelling in neck

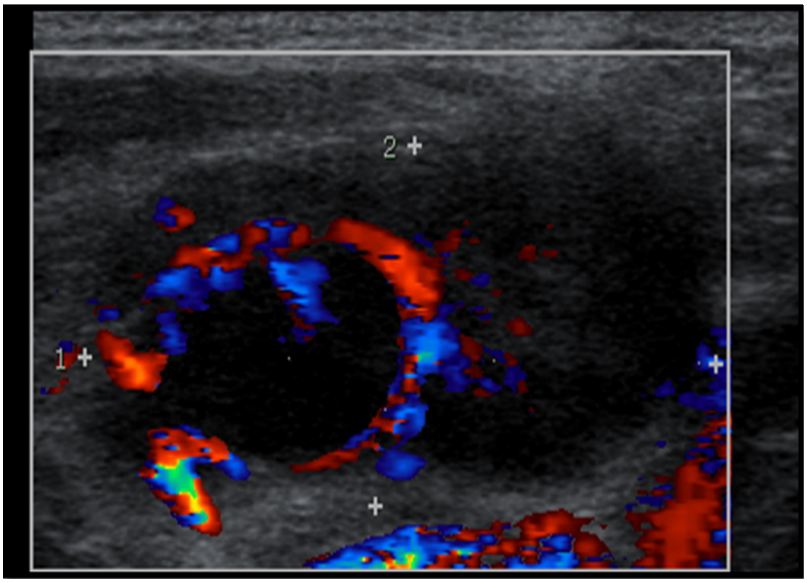
On USG at level I oval lymph node with maintained Hilum and increased hilar vascularity suggestive of reactive lymph node confirmed on FNAC



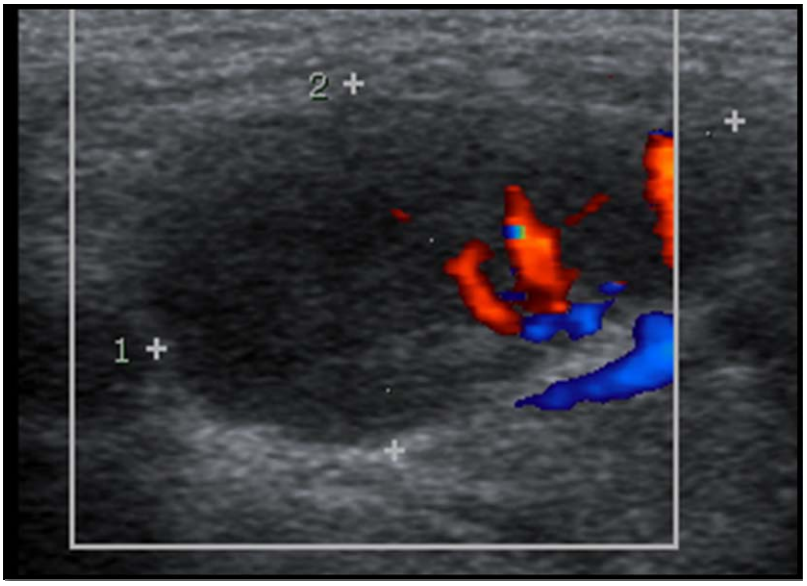
52 yrs old male a known case of ca of buccal mucosa on USG at level III an enlarged round hyper echoic lymphnode with absent hilum , sharp borders, heterogeneous echo texture and capsular vascularity (peripheral vascularity)- suggestive of metastatic lymph node proved on histopathology.



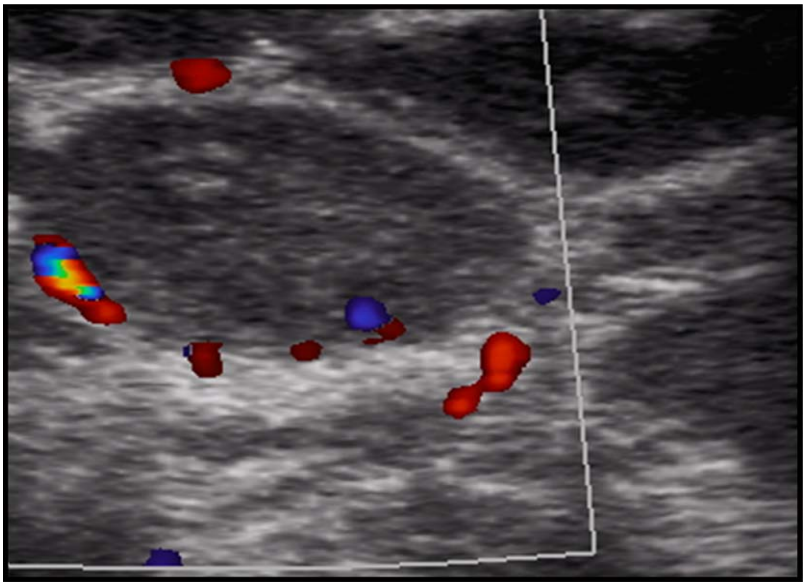
Tubercular lymph node with absent hilum showing capsular and hilar vascularity (mixed) on Doppler evaluation.



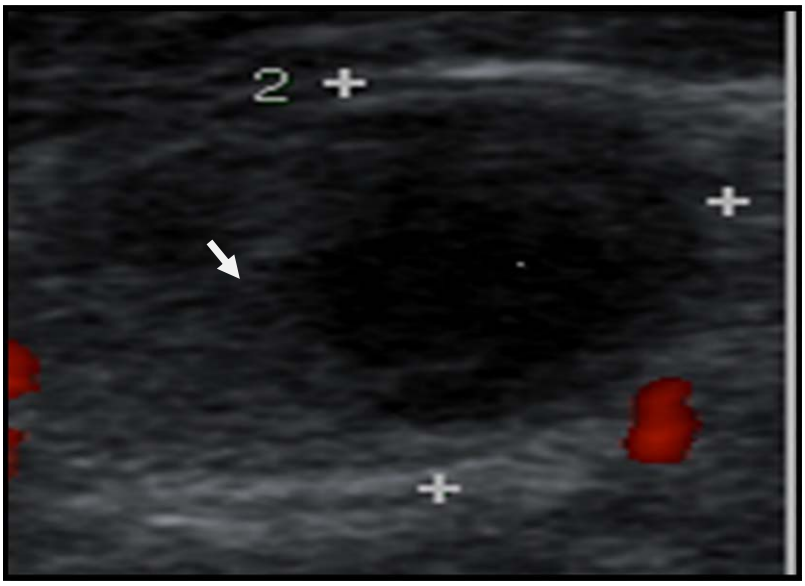
Tubercular lymph node with absent hilum and cystic necrosis showing Mixed vascularity with focal absence of perfusion and displacement of hilar vessels on Doppler evaluation.



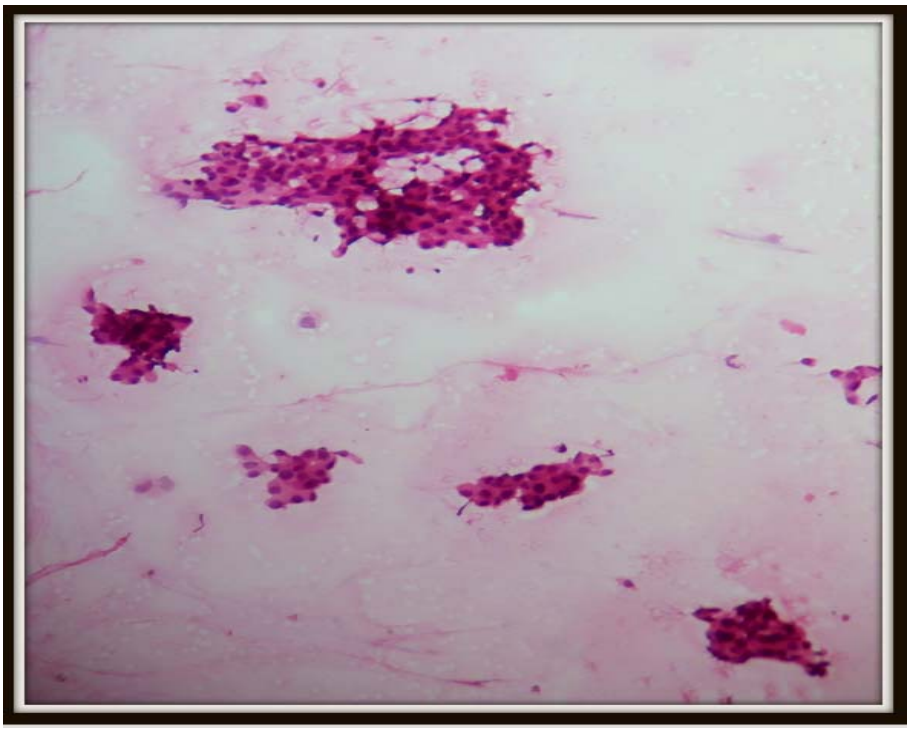
60yrs old female presented with a known case of ca of buccal mucosa On USG oval lymph node at level I with maintained Hilum and hilar vascularity suggestive of reactive lymph node but on histopathology it was proved to be malignant.

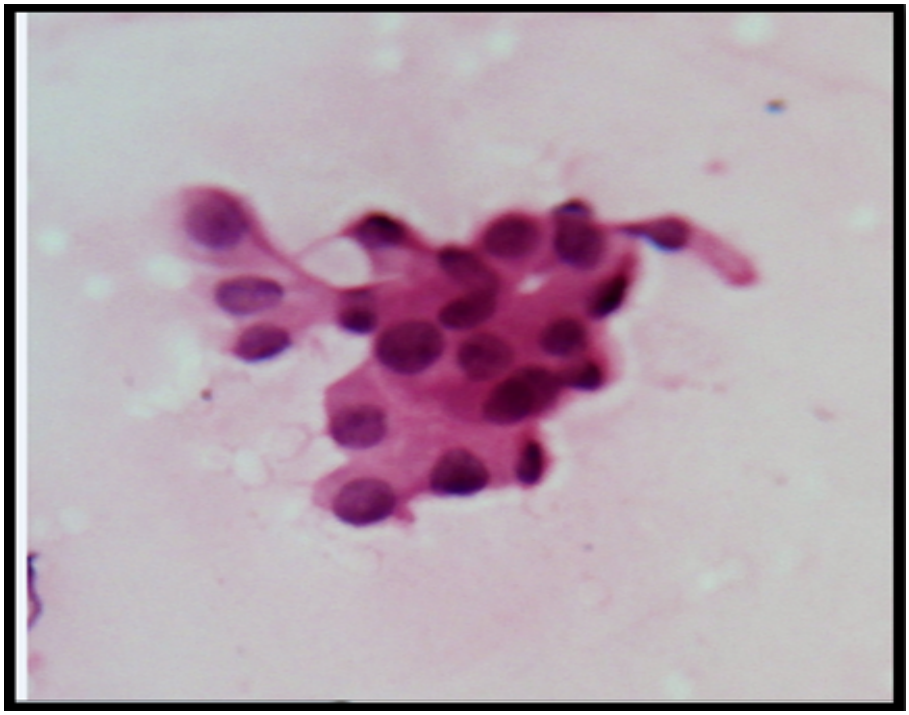


75 yrs old male with swelling in neck on USG at level I an enlarged round lymphnode with absent hilum , sharp borders, heterogeneous echo texture with absent necrosis and capsular vascularity (peripheral vascularity)- suggestive of metastatic lymph node on FNAC it was proved to be reactive.



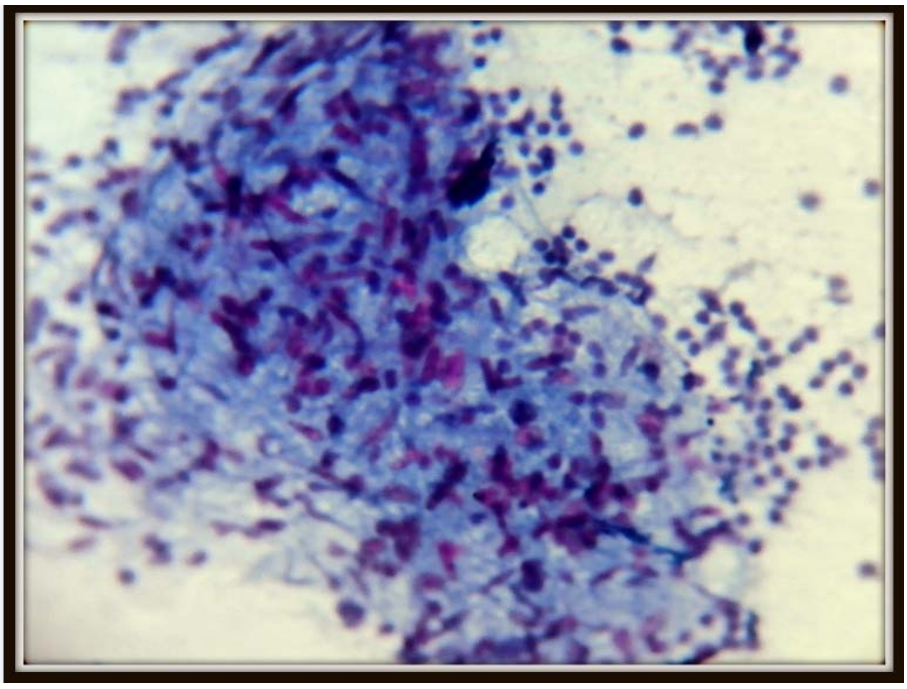
45 yrs old male with neck swelling on USG at level V there was an enlarged lymphnode with hetrogenous echotexture and cystic necrosis (arrow) with no matting on USG, thought to be malignant but proved as tubercular lympahadenitis on FNAC .



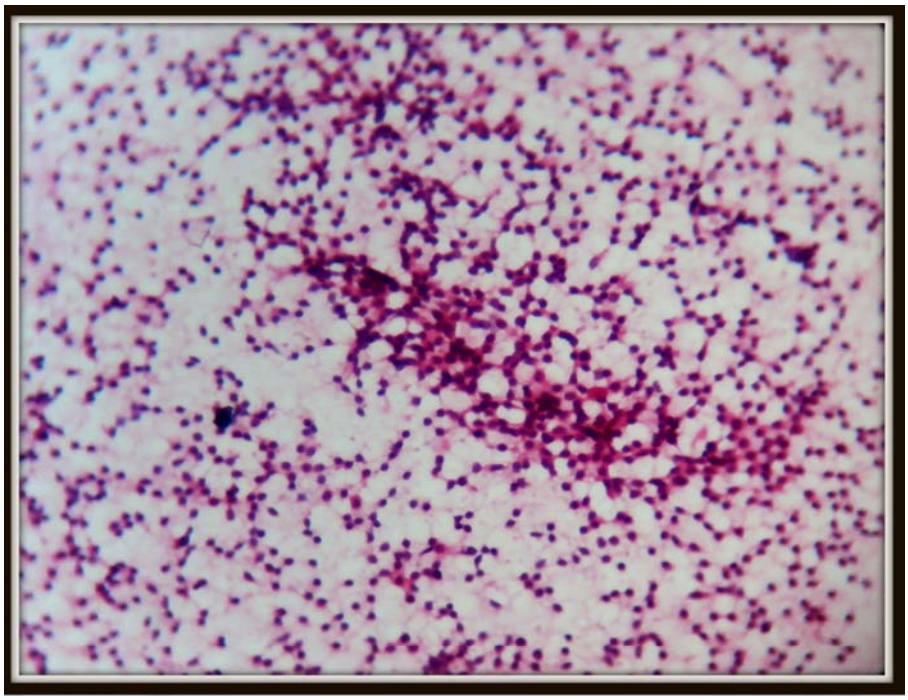


(H & E, 10x)and b(H & E, 40x)

Microphotograph showing metastatic deposits.



(H&E, 10x) Microphotograph showing caseous necrosis typical of tuberculosis



(H&E,10x) Microphotograph of a reactive lymph node showing polymorphous population of lymphocytes

ANNEXURES

PROFORMA

Name **Age**	**date** **sex**	**opd no** **martial status**
Occupation;		
Address		
Chief complaints		

1.ULTRASOUND-

Number–

	I	II	III	IV	V	VI	VII
Size **L/T ratio** **Nodal border**							
Echogenic hilus **Echogenicity**							
Intra nodal necrosis **Matting**							

Color doppler **Hilar vessels**	I	II	III	IV	V	VI	VII
Peripheral vascularity							
Mixed vascularity							
Focal absence of perfusion							
No perfusion							

2. <u>USG DIAGNOSIS</u>

3.<u>FNAC DIAGNOSIS</u>

KEY TO MASTER CHART

SI.NO	Serial number
Sex	m- Male , f- Female
Necrosis	AB – absent CE- Central (coagulative) CY – Cystic
L/S ratio	Long/Short axis ratio
Shape	R- Round , O- Oval
Border	US – Unsharp, S-Sharp
Hilum	W- Wide, N-Narrow, Ab-Absent
Echotexture	HO-Homogenous, HE –Heterogenous
Hilar vessels	HV
Focal absence of perfusion	FAP
capsular vessels (peripheral)	CV
mixed flow	MV
No perfusion	NP
M	Malignant,
R	Reactive lymphadenitis, T-Tubercular L- lymphoma
USG D	Ultrasonography Diagnosis :
FNAC D	Fine needle aspiration cytology histopathology diagnosis :
0	Absent 1- Present

MASTER CHART

SL No.	NAME	AGE & SEX	HOSP NO.	LEVEL	SIZE	SHAPE	LA/SA	BORDER		HILUM			TEXTURE		NECROSIS			MATTING	COLOR DOPPLER					USG DIAG	FNAC DIAG
								S	U S	W	AB	N	HO	HE	AB	CE	CY		HV	CV	MV	FAP	NP		
1	laxmidevamma	36y/f	784049	II	2.8x2.1	R	1.02	0	1	0	1	0	0	1	0	1	0	0	0	0	1	0	0	M	M
2	naryanappa	65y/m	810962	II	1.2x0.9	R	1.3	1	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0	M	M
3	narayanappa	45y/m	782859	I	2.6X1.5	R	1.7	0	1	0	1	0	0	1	0	0	1	0	0	0	1	1	0	M	M
4	madan kumar	15y/m	765626	I	2.1x2	O	2.7	1	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	R	R
5	Apsara	15y/f	811668	III	1.9X0.9	O	2.1	0	1	0	1	0	1	0	1	0	0	0	1	0	0	0	0	R	R
6	parijatha	20y/f	874983	II	2.8x3.6	R	1.5	0	1	0	1	0	1	0	1	0	0	1	0	0	1	1	0	TB	TB
7	thippa reddy	57y/m	811564	III	3.1X2.5	R	1.24	0	1	0	1	0	0	1	0	0	1	0	0	0	1	0	0	M	M
8	Venkataswamy	59ym	738082	I	2.2X1.3	R	1.24	1	0	0	1	0	1	0	1	0	0	0	0	0	1	1	0	M	M
9	maulanasajeed	49y/m	803416	I	1.5X1.0	R	1.5	0	1	0	1	0	0	1	0	0	1	0	0	0	1	0	0	M	M
1	narayanappa	60y/m	835620	II	2.2X1.3	R	1.3	1	0	0	0	1	1	0	1	0	0	0	0	0	1	1	0	M	M
11	kamakasham ma	60y/f	891395	I	2.2x1.1	O	2.1	0	1	0	1	0	1	0	0	0	1	0	0	0	0	0	1	M	R
				III	2.5X1.2	O	2.2	0	1	1	0	0	1	0	1	0	0	0	1	0	0	0	0	R	R
				II	2.8x2.1	R	1.2	0	1	0	1	0	1	0	1	0	0	0	0	0	1	1	0	M	M
12	Narayanamma	50y/f	869733	II	1.6X1	R	1.6	0	1	0	1	0	0	1	0	0	1	0	0	0	1	0	0	M	M
13	shyla	34y/f	841059	II	2.5X1.6	R	1.1	1	0	0	1	0	1	0	1	0	0	0	1	0	0	1	0	M	M
14	Syed ahmed	24y/m	805029	II	3.3X1.8	R	1.8	1	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	M	R
15	amaravathi	25y/f	878204	III	2.4x1.1	O	2.1	0	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	M	TB
16	zakiya	23y/f	701347	V	3.2x1.5	O	2.1	0	1	0	1	0	0	1	0	0	1	1	0	0	1	0	0	TB	TB
17	gopamma	80y/f	893284	III	1.8X1	R	1.8	0	1	0	1	0	1	0	1	0	0	0	0	0	1	0	0	M	M
18	nagaraj	36y/f	916046	II	2.5x1.9	R	1.5	1	0	0	0	1	1	0	1	0	0	1	1	0	0	1	0	TB	TB
19	muniyamma	45y/f	927187	II	2.5x2.8	R	1.9	0	1	0	1	0	0	1	0	0	1	0	0	0	1	1	0	M	TB
2	narshima reddy	60y/m	878532	III	1.7X1.2	R	1.4	1	0	0	0	1	1	0	0	1	0	0	0	0	1	1	0	M	M
21	Umesh	13y/m	795982	I	1.9X0.8	O	2.3	0	1	0	0	1	1	0	1	0	0	0	1	0	0	0	0	R	R
22	sandhya	16y/m	877416	I	2.4X1.1	O	2.1	1	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0	R	R
23	bhevan sai	13y/m	856305	II	3.8x1.3	O	3.1	0	1	0	1	0	1	0	1	0	0	1	0	0	0	0	1	TB	TB
24	veranarappa	65y/m	878923	II	3.7X2.0	R	1.5	0	1	0	1	0	0	1	0	0	1	0	0	0	1	0	0	M	M
25	srikanth	19y/m	925328	II	2.7X1.3	O	2.07	1	0	0	1	0	0	1	0	0	1	0	0	0	1	1	0	M	L
26	kanappa	22y/m	839100	III	3x2.2	R	1.3	0	1	0	1	0	0	1	0	0	1	1	0	1	0	0	0	TB	TB
27	suraj	15y/m	841790	V	2.5x1.2	O	2.1	0	1	1	0	0	1	0	1	0	0	0	1	0	0	0	0	R	TB
28	venkataswamy	35y/m	92477	I	1.6X1.3	R	1.2	0	1	0	1	0	0	1	0	1	0	0	0	0	1	0	0	M	M

MASTER CHART

29	venkateshappa	60y/m	890029	II	1.7X1.2	R	1.6	0	1	0	1	0	0	1	0	0	1	0	0	0	1	0	0	M	M
3	sushelamma	60y/f	846013	V	2.5x1.5	O	2.3	1	0	0	1	0	1	0	1	0	0	1	0	0	1	1	0	TB	TB
31	supriya	16y/f	852618	III	3.3x1.8	R	1.8	0	1	0	0	1	1	0	1	0	0	1	0	0	1	0	0	TB	TB
32	narayanamma	65y/f	838716	III	2.2X1.2	O	2.1	1	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	R	M
33	narayanappa	65y/m	835620	II	2.5X1.8	R	1.9	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	M	M
34	priyadarshini	22y/f	891048	II	3.1x1.5	O	2.06	1	0	1	0	0	0	1	0	1	0	1	0	0	1	1	0	TB	TB
35	kumara	21y/f	891395	V	1.6x1.1	R	1.5	0	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	M	TB
36	muneer	45y/m	810364	IV	2.2X1.2	R	1.8	0	1	0	1	0	1	0	0	1	0	0	0	0	1	1	0	M	M
37	jayalaxmi	50y/f	842858	II	1.7X1.2	R	1.6	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0	0	M	M
38	azhira	15y/m	896028	I	2.5x1.1	O	2.1	0	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	R	R
39	pushpamma	60y/m	921188	I	1.8X0.7	O	2.5	0	1	1	0	0	1	0	1	0	0	0	1	0	0	0	0	R	R
4	rathnabamma	50y/m	927648	III	2.1X1	O	2.1	0	1	0	0	1	1	0	1	0	0	0	1	0	0	0	0	R	R
41	venkateshamma	60y/f	918231	I	2.2x1	O	2.1	1	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0	R	M
42	thriveni	25y/f	810810	V	1.8x1	R	1.8	1	0	0	1	0	0	1	0	0	1	1	0	0	1	1	0	TB	TB
43	murthy	35y/m	821739	II	3.5x1.2	O	2.3	0	1	0	0	1	1	0	1	0	0	1	0	0	1	1	0	TB	TB
44	muniyamma	70y/m	908434	II	3X2.2	R	1.5	1	0	0	1	0	1	0	0	1	0	0	0	0	1	1	0	M	M
45	narayanaswamy	62y/m	894643	I	2.5X1.8	R	1.9	0	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	M	M
46	chandrika	42y/f	810549	V	2.7x1.1	O	2.1	0	1	0	0	1	0	1	0	0	1	0	0	0	1	1	0	M	TB
47	manjula	25y/f	927448	IV	1.8x1.5	R	1.2	0	1	0	1	0	1	0	1	0	0	1	0	0	0	0	1	TB	TB
48	yarappa	40y/m	814913	V	2.9x1.5	R	1.8	0	1	0	0	1	0	1	0	0	1	0	0	0	1	0	0	M	TB
49	venkatamma	65y/f	852924	II	2.7X1.7	R	1.6	0	1	0	1	0	0	1	0	0	1	0	0	0	1	1	0	M	M
5	saraswathamma	45y/f	811801	II	1.9X1	R	1.9	1	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	M	M
51	kamallama	50y/f	831389	IV	1.8x.9	O	2.3	0	1	0	0	1	1	0	1	0	0	0	1	0	0	0	0	R	R
52	kumara	21y/f	872191	III	1.9x.7	O	2.2	0	1	1	0	0	1	0	1	0	0	0	1	0	0	0	0	R	R
53	shankarappa	50y/m	884231	III	2.5X1.8	R	1.4	0	1	0	0	1	1	0	1	0	0	1	0	0	0	0	0	R	M
54	ramaraju	40y/m	811091	IV	2.4X1.1	O	2.2	1	0	0	1	0	0	1	0	1	0	0	0	1	0	0	0	M	M
55	laxamma	75y/f	794013	III	1.8X1.5	R	1.2	1	0	0	1	0	0	1	0	0	1	0	0	0	1	1	0	M	M
56	muninarayanappa	60y/m	785225	III	1.8X1.1	R	1.5	1	0	0	1	0	0	1	1	0	0	0	0	0	1	0	0	M	M
57	laxmidevamma	40y/f	782000	III	1.7X1.2	R	1.6	0	1	0	1	0	1	0	1	0	0	0	0	0	1	0	0	M	M
58	muniyappa	58y/m	777206	II	3.5X1.7	R	1.6	1	0	0	1	0	0	1	0	0	1	0	0	0	1	1	0	M	M
59	narayanappa	70y/m	773457	II	2.8X2.1	R	1.1	0	1	0	1	0	0	1	0	0	1	0	0	0	1	0	0	M	M
6	putamma	45y/f	906171	III	2.7X1.3	O	2.07	1	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	M	M
61	rafiq	75y/m	908855	I	2.8X1.3	R	2.1	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	M	R
				I	1.6X1.0	R	1.6	0	1	0	0	1	1	0	1	0	0	0	0	0	1	0	0	M	R

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				III	1.8x.7	O	2.2	1	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	R	R
62	naveen	19y/f	792800	V	1.6x1.1	R	1.5	1	0	0	1	0	0	1	0	0	1	1	0	0	1	1	0	TB	TB
63	akbar	30y/m	783348	II	1.9x1	R	1.9	0	1	1	0	0	1	0	1	0	0	1	0	0	1	0	0	TB	TB
64	radhamma	45y/f	932592	I	3.1X1.9	R	1.6	1	0	0	0	1	1	0	1	0	0	0	0	1	0	0	0	M	M
65	amaravathi	35y/f	881475	II	2.2X1	O	2.2	1	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	M	M
66	venkateshappa	60y/m	890029	IV	2.5x1.8	R	1.4	0	1	0	1	0	0	1	0	1	0	0	0	0	1	0	0	M	M
67	chalapathi	35y/m	924904	I	1.6X1	O	1	1	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	R	R
68	paravathamma	50y/f	792054	IV	2.5x1.2	R	1.8	0	1	0	1	0	0	1	0	0	1	1	0	0	1	0	0	TB	TB
69	gopamma	65y/f	750532	V	2.3x1.2	O	2.1	1	0	0	1	0	1	0	0	1	0	0	0	1	0	0	0	M	TB
7	anandamma	25y/f	877156	IV	2.5X1.2	O	2.8	0	1	0	0	1	1	0	1	0	0	0	0	0	1	0	0	R	R
71	manju	35y/f	781763	I	2.7X1.3	O	2.2	0	1	0	0	1	0	1	1	0	0	0	1	0	0	0	0	R	R
72	sowmya	35y/f	926054	II	3.5x2	R	1.6	0	1	0	1	0	1	0	1	0	0	1	0	1	0	0	0	TB	TB
73	shammana	70y/m	874137	I	2.8x1.6	R	1.5	0	1	0	1	0	1	0	0	1	0	0	0	0	1	0	0	M	M
74	shylaja	21y/f	341059	III	2.7X1.3	O	2.07	1	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	R	M
75	jayamma	60y/f	873525	II	1.6x1.1	R	1.5	1	0	0	1	0	1	0	0	1	0	0	0	0	1	1	0	M	M
				v	2.5X1	O	2.5	0	1	0	1	0	0	1	0	0	1	0	0	0	1	0	0	M	M
76	sushail	18y/m	895568	I	1.9X0.8	O	2.1	1	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	R	R
77	chikamunivenkattapa	55y/m	814924	III	1.7X1.2	R	1.5	1	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	M	L
78	charan	15y/m	851492	I	2.7X1.3	O	2.3	1	0	0	1	0	0	1	0	0	1	0	0	0	1	1	0	M	M
79	udhayan ramkumaran	50y/m	845254	III	1.8X1.5	R	1.2	0	1	0	1	0	1	0	1	0	0	0	1	0	0	0	0	R	R
8	suraj	14y/m	841790	IV	1.8X1.5	R	1.2	0	1	1	0	0	1	0	0	0	1	0	1	0	0	0	0	R	R
81	nagarathnamma	52y/f	905733	I	1.8XO.9	O	2.1	0	1	0	1	0	0	1	1	0	0	0	1	0	0	0	0	M	R
				II	2.2X1.1	O	2.1	0	1	1	0	0	1	0	1	0	0	0	1	0	0	0	0	R	R
				IV	1.6X0.7	O	2.02	1	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	R	R
82	harisha	16y/f	837866	II	2.5X1.2	O	2.1	0	1	1	0	0	0	1	1	0	0	0	1	0	0	0	0	R	R
83	srinivas	45y/m	787391	II	2.8X1.6	R	1.5	1	0	0	1	0	1	0	1	0	0	1	0	0	1	1	0	TB	TB