CHAPTER ONE

1.1 Introduction

With the advent of multidetectors computed tomography MDCT, routine evaluation of abdominal lymph nodes is now possible. For the first time, normal abdominal lymph nodes may be reliably identified noninvasively. Because of the increasing volume of cross-sectional imaging examinations being performed, lymph nodes in the abdomen are being detected with increasing frequency. This is often an unsuspected finding. Although the detected lymph nodes may be normal, there is a large number of disease processes that may lead to abdominal lymphadenopathy.(Stephanie, et al.2011).

The most common causes of abdominal lymphadenopathy are neoplastic, inflammatory, and infectious processes. Many of these causes may also result in lymphadenopathy elsewhere in the body. It is important to recognize abdominal lymph node enlargement in patients with a history of a primary carcinoma because the lymphadenopathy affects the staging of the disease, which in turn will affect further management. In addition, abdominal lymphadenopathy may be the only indicator of an underlying inflammatory or infectious process causing abdominal pain. (Stephanie, et al.2011).

The distribution of the lymph nodes may indicate the exact nature of the underlying disease process, and the correct treatment may then be instituted. Besides neoplastic, inflammatory, and infectious processes, many other disease processes may occasionally result in abdominal lymphadenopathy, likely as a result of these nodes not being readily detectable before the development of MDCT. In our current day-to-day practice, with routine use of MDCT, we frequently detect small lymph nodes at the mesenteric root and scattered throughout the

abdomen that previously were not clearly identifiable. .(Stephanie, et al.2011).

To the knowledge, no data defining the size of normal abdominal lymph nodes have been published in the MDCT era. In clinical practice, the radiologist must decide if these nodes, which often measure only a few millimeters in diameter, are of any clinical significance and decided to determine the frequency with which lymph nodes are identified on MDCT, both at the mesenteric root and throughout the abdomen , in a group of patients without known malignancy or intra abdominal inflammatory diseases.(Stephanie, et al.2011).

1.2 Problem of the study:

The affected abdominal lesions as inflammatory changes and tumors my change the lymph nodes size and may lead to enlargement and changing in texture.

The type of lesion related to lymph node involvement is need to be study properly in order to clarify the presence of malignancy rather than inflammatory Process.

1.3 Objective of the study:

1.3.1General objectives:

To assess the presence of abdominal lymph node enlargement by using multidetectors computed tomography MDCT and find the incidence.

1.3.2 Specific objectives:

To classify the abdomen lesions by CT

To correlate the findings with lymph node involvement

To measure the lymph node dimensions and CT number

To evaluate the affected abdominal organs CT number correlated to lymph nodes changes

To assess the finding with age and gender

1.4 Significance of the study:

This study will provided to detect that if the enlargement in size of abdominal lymph nodes related to malignancy rather than inflammatory lesions .

1.5 Overview of the study:

This study consisted of five chapters. Chapter one is an introduction which include: problem, objective of the study, significance of the study and overview of the study. Chapter two is anatomy , physiology ,pathology , Equipment , technique, literature review and previous studies. Chapter three is material and methods. Chapter four is results Chapter five is discussion, conclusions and recommendations.

CHAPTER TWO

2.1 lymph nodes anatomy :

A lymph node is an oval-shaped organ of the lymphatic system, distributed widely throughout the body including the armpit and stomach and linked by lymphatic vessels. Lymph nodes are major sites of B, T, and other immune cells. Lymph nodes are important for the proper functioning of the immune system, acting as filters for foreign particles and cancer cells. Lymph nodes do not deal with toxicity, which is primarily dealt with by the liver and kidneys.

Lymph nodes are bean or oval shaped and range in size from a few millimeters to about 1–2 cm long. (Warwick et al., 1973) Each lymph node is surrounded by a fibrous capsule, and inside the lymph node the fibrous capsule extends to form trabeculae. The substance of the lymph node is divided into the outer cortex and the inner medulla. The cortex is continuous around the medulla except at the hilum, where the medulla comes in direct contact with the hilum (Warwick et al., 1973)

Thin reticular fibers and elastin form a supporting meshwork called a reticular network inside the node. White blood cells (leukocytes), the most prominent ones being lymphocytes, are tightly packed in the follicles (B cells) and the cortex (T cells). Elsewhere in the node, there are only occasional leucocytes. As part of the reticular network there are follicular dendritic cells in the B cell follicle and fibroblastic reticular cells in the T cell cortex. The reticular network not only provides the structural support, but also the surface for adhesion of the dendritic cells, macrophages and lymphocytes. It allows exchange of material with blood through the high endothelial venules and provides

the growth and regulatory factors necessary for activation and maturation of immune cells.(Kaldjian et al., 2001).

The number and composition of follicles can change especially when challenged by an antigen, when they develop a germinal center. (Warwick et al., 1973) Lymph enters the convex side of the lymph node through multiple afferent lymphatic vessels, to flow through the sinuses. A lymph sinus which includes the subcapsular sinus, is a channel within the node, lined by endothelial cells along with fibroblastic reticular cells and this allows for the smooth flow of lymph through them .The endothelium of the subcapsular sinus is continuous with that of the afferent lymph vessel and is also with that of the similar sinuses flanking the trabeculae and within the cortex. All of these sinuses drain the filtered lymphatic fluid into the medullary sinuses, from where the lymph flows into the efferent lymph vessels to exit the node at the hilum on the concave side. (Warwick et al., 1973) . These vessels are smaller and don't allow the passage of the macrophages so that they remain contained to function within the lymph node. In the course of the lymph, lymphocytes may be activated as part of the adaptive immune response. (Warwick et al., 1973)

2-2 Capsule

The lymph node capsule is composed of dense irregular connective tissue with some plain muscle fibers, and from its internal surface are given off a number of membranous processes or trabeculae, consisting, in man, of connective tissue, with a small admixture of plain muscle fibers; but in many of the lower animals composed almost entirely of involuntary muscle. They pass inward, radiating toward the center of the gland, for about one-third or one-fourth of the space between the circumference and the center of the node. In some animals

they are sufficiently well-marked to divide the peripheral or cortical portion of the gland into a number of compartments (follicles), but in man this arrangement is not obvious. The larger trabeculae springing from the capsule break up into finer bands, and these interlace to form a mesh-work in the central or medullary portion of the gland. In these spaces formed by the interlacing trabeculae is contained the proper gland substance or lymphoid tissue. The gland pulp does not, however, completely fill the spaces, but leaves, between its outer margin and the enclosing trabeculae, a channel or space of uniform width throughout. This is termed the subcapsular sinus (lymph path or lymph sinus). Running across it are a number of finer trabeculae of reticular connective tissue, the fibers of which are, for the most part, covered by ramifying cells. (Warwick et al., 1973)

2-3 Subcapsular sinus

The subcapsular sinus (lymph path, lymph sinus, marginal sinus) is the space between the capsule and the cortex which allows the free movement of lymphatic fluid and so contains a sparsity of lymphocytes. (Warwick et al., 1973)

It is continuous with the similar lymph sinuses that flank the trabeculae. (Warwick et al., 1973).

The lymph node contains lymphoid tissue, i.e., a meshwork or fibers called reticulum with white blood cells enmeshed in it. The regions where there are few cells within the meshwork are known as lymph sinus. It is lined by reticular cells, fibroblasts and fixed macrophages. (Warwick et al., 1973).

The subcapsular sinus has clinical importance as it is the most likely location where the earliest manifestations of a metastatic carcinoma in a lymph node would be found. (Warwick et al., 1973).

2-4 Cortex:

The cortex of the lymph node is the peripheral portion underneath the capsule and the subcapsular sinus. (Katakai etal., 2004). The subcapsular sinus drains to trabecular sinuses, and then the lymph flows into the medullary sinuses.

The outer cortex consists mainly of the B cells arranged as follicles, which may develop a germinal center when challenged with an antigen, and the deeper cortex mainly consisting of the T cells. There is a zone known as the subcortical zone where T-cells (or cells that are mainly red) mainly interact with dendritic cells, and where the reticular network is dense. The predominant site within the lymph nodes which contain T cells & accessory cells is also known as paracortex (reticular network). (Katakai et al., 2004) .

2-5 Medulla

The medulla contains large blood vessels, sinuses and medullary cords that contain antibody-secreting plasma cells. (Warwick et al., 1973).

The medullary cords are cords of lymphatic tissue, and include plasma cells, macrophages, and B cells. The medullary sinuses (or sinusoids) are vessel-like spaces separating the medullary cords. Lymph flows into the medullary sinuses from cortical sinuses, and into efferent lymphatic vessels. Medullary sinuses contain histiocytes (immobile macrophages) and reticular cells. (Katakai et al., 2004) .

Lymph is derived from interstitial fluid and originates in the interstitial spaces of most of the body's tissues. A vast system of converging lymphatic vessels funnels lymph to the thorax where it is returned to the circulation via the thoracic duct. When foreign antigens

invade the body, antigenic material, antigen presenting cells known as dendritic cells (DCs) and inflammatory mediators generated by local immunological activity at the site of infection are all picked up by the lymphatic vessels and swept along in the flow of lymph. The system of lymphatic vessels has been called an "information superhighway" because lymph contains a wealth of information about local inflammatory conditions in upstream drainage fields (von Andrian and Mempel, 2003). At many sites along the lymphatic highways where lymphatic vessels converge, lymph flows through soft, pale tan, rather lumpy looking lymph nodes that contain large numbers of lymphocytes, macrophages and antigen presenting cells (APCs) (Tilney1971).The humans have about 450 Inside the lymph nodes, APCs and naive lymphocytes are brought together to initiate primary immune responses (Kaldjian et al., 2001). APCs display antigens to lymphocytes, reactive lymphocytes undergo clonal expansion to produce new lymphocytes and plasma cells, and the resulting plasma cells secrete antibodies into the lymph. Theseimmunological processes take place in a specialized stromal structure called the reticular meshwork that supports, guides and organizes interactions between lymphocytes and APCs (Gretz et al., 1996, 1997). Particulate antigens are also filtered out of the lymph and destroyed by macrophages. Lymph nodes consist of multiple lymphoid lobules surrounded by lymph-filled sinuses and enclosed by a capsule. The complex three dimensional lobules and their surrounding sinuses present a variety of appearances in tissue sections depending on the plane of section (Sainte-Marie et al., 1990).

A detailed understanding of lobular architecture is helpful for recognizing the range of variation in normal lymph nodes due to anatomical location, age, diet and antigen exposure, compensating for the inevitable odd plane of section and accurately interpreting lymph

node changes. The anatomy of the lymphoid lobule and the role of the reticular meshwork are emphasized below, drawing on classical older works, particularly those of Saint-Marie, Belisle and Peng, on recent studies using modern molecular and imaging techniques and on personal observations made in a contract research laboratory setting. Detailed illustrations of an idealized lymphoid lobule (Figure 2-1) and lymph node (Figure 2-2) are provided to illustrate anatomical features discussed in the text.

Lymph nodes are traditionally regarded as having three compartments, the cortex, parcortex and medulla. B and T cells home to separate areas within these compartments, interact with antigen presenting cells, and undergo clonal expansion. This paper provides structural and functional details about how the lymph node brings lymphocytes and antigen presenting cells together. The concept of the lymphoid lobule as the basic functional and anatomic unit of the lymph node is developed and utilized to provide a framework for understanding lymph node pathobiology. Understanding the histomorphologic features of the lymphoid lobule and the role of the reticular meshwork scaffolding of the lymph node and how these related to the cortex, parcortex and medulla provides a unique approach to understanding lymph node structure and function (Cynthia L. 2006).

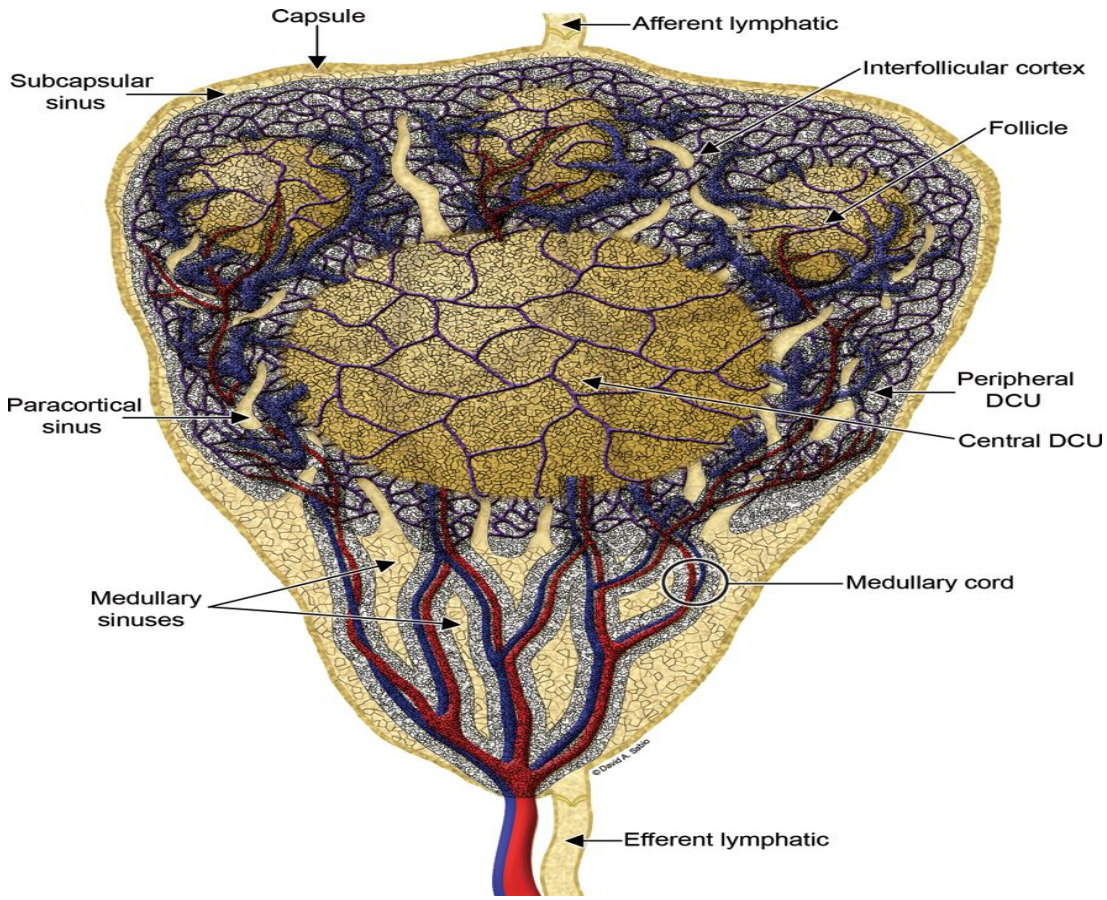

***figure** 2.1: Lymphoid lobule: (Cynthia L. 2006).*

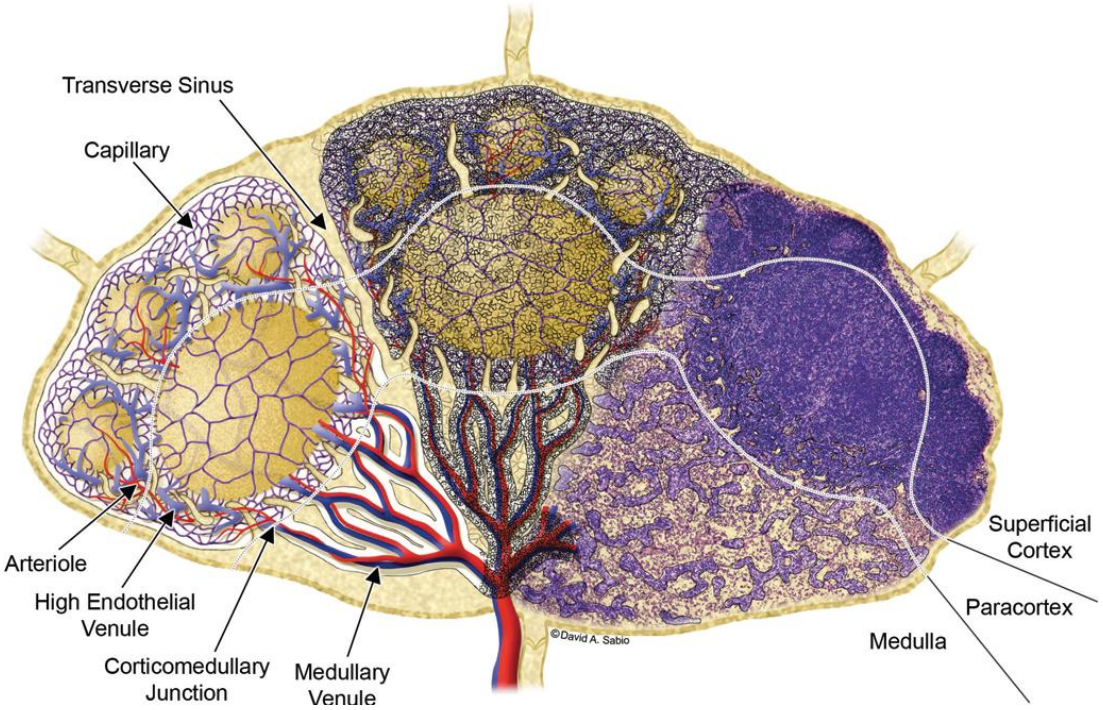

figure 2.2: Lymph node: (Cynthia L. 2006).

2-6 The lymphoid lobule

The lymphoid lobule is the basic anatomical and functional unit of the lymph node. The smallest lymph nodes may contain only a few lobules or even just one, while large lymph nodes may contain a great many. Lobules were described in lymph nodes as early as 1975 (Kelly, 1975) although some authors have described them as physiological compartments (Belisle and Sainte-Marie, 1990). Lobules have been mentioned in more recent work (Gretz et al., 1997), but they have not been described in detail and their relevance to understanding lymph node function and pathology is not widely recognized. Current best practice guidelines for the examination of a lymph node call for a detailed examination of the cortex, paracortex and medulla (Haley et al., 2005). These compartments contain specific lobular structures so changes in these compartments reflect alterations in the lobules. The lymphoid lobule is as potentially useful and necessary in understanding lymph node function and pathology as the hepatic lobule is to understanding liver function and pathology. Lymphoid lobules are arranged side-by-side and radiate capsad from the hilus (Figure 2.2). Each lobule has a bulbous apex and a base of slender cords that gives it a medusoid appearance (Figure 1.2). Lobules are anchored in the hilus by their vascular roots but they are otherwise separated from the capsule by the subcapsular sinus. The apex forms part of the nodal cortex and the base forms part of the nodal medulla. The nodal cortex is bilayered and consists of a superficial cortex and a deep cortex. By common convention, pathologists usually apply the term cortex to the superficial cortex and refer to the deep cortex as the paracortex. The (superficial) cortex contains spherical follicles that are surrounded and separated by interfollicular (or diffuse) cortex. The paracortex consists of deep cortical units (DCUs). Each lobule has a single DCU that can be

anatomically and functionally divided into a central DCU and a surrounding peripheral DCU (Sainte-Marie et al., 1982, 1990). DCUs of adjacent lobules often fuse into large multiunit complexes (Belisle and Sainte-Marie, 1981a).

Subcompartmentalization of the lobule creates separate areas for T and B cells to interact with their APCs and to undergo clonal expansion. B lymphocytes home to primary follicles to survey follicular dendritic cells (FDCs). Stimulated B cells proliferate within the follicles forming distinctive germinal centers and the follicles are then referred to as secondary follicles. T lymphocytes home to the paracortex and interfollicular cortex to survey DCs. Stimulated T lymphocytes proliferate in the paracortex and enlarge it but do not produce structures analogous to germinal centers. The peripheral DCU and the interfollicular cortex also serve as transit corridors for lymphocytes migrating to and from the B and T cell areas. Plasma cell precursors produced by B cell proliferation migrate to the medullary cords where they mature and secrete antibodies that are released into the lymph. Each lobule is surrounded by a complex system of lymphatic sinuses that are divided into subcapsular, transverse and medullary sinuses. In large animals, lymph nodes with trabeculae also have trabecular sinuses. A single afferent lymphatic vessel delivers a constant stream of lymph to the subcapsular sinus over each lobule. Lymph spreads through the subcapsular sinus over the lobule's apex, flows down the sides of the lobule through transverse sinuses and then flows into the medullary sinuses. Lymph from all the lobules drains into a single efferent lymphatic vessel that exits the node at the hilus (Sainte-Marie et al., 1982). Because each afferent lymphatic collects lymph from a different drainage field, each lobule is potentially exposed to a different set of antigens, APCs and inflammatory mediators (Sainte-Marie et al., 1982).

As a result of varying immunological stimulation, lobules within the same lymph node may have different levels of immunological activity and the cortical, paracortical and medullary compartments composed of these lobules will not necessarily have a uniform appearance (Sainte-Marie et al., 1982). In particular, the size of the DCUs can vary widely so that the paracortex may have a very uneven appearance.

2.7 Lymphatic drainage of the abdomen and pelvis

2.7.1 Lymphatic drainage of the anterior abdominal wall:

Accompany the subcutaneous blood vessels. Vessels from the lumbar and gluteal regions run with the superficial circumflex iliac vessels. Those from the infra umbilical skin run with the superficial epigastric vessels. Both drain into the superficial inguinal nodes. The supra-umbilical region is drained by vessels running obliquely up to the pectoral and subscapular axillary nodes, and there is some drainage to the parasternal nodes The superficial lymphatic vessels .(Anne M.R et al.,2005).

2.7.2 The deep lymphatic vessels:

Accompany the deep arteries. The vessels from the posterior portion of the abdominal wall pass with the lumbar arteries to drain into the lateral aortic and retro-aortic nodes. Vessels from the upper anterior abdominal wall run with the superior epigastric vessels to the parasternal nodes. Vessels of the lower abdominal wall drain into the circumflex iliac, inferior epigastric and external iliac nodes.(Anne M.R et al.,2005).

2.7.3 Lymph drainage of the posterior abdominal wall

The lymphatic drainage of the muscles, deep tissues and integument of the posterior abdominal wall is broadly divided into four regions. The small upper left and upper right regions drain to the lateral aortic nodes and the lateral axillary lymph nodes. Some lymphatic drainage may occur across the diaphragm from the bare area of the liver

and the uppermost retroperitoneal tissues, but this is probably of little clinical consequence other than during obstruction of the thoracic duct. The larger lower left and lower right portions drain to the lateral and retroaortic lymph nodes, although some drainage also occurs to the left and right superficial inguinal nodes .(Anne M.R et al.,2005).

The lymphatic drainage of the abdominal viscera occurs almost exclusively through the cisterna chyli and the thoracic duct. .(Anne M.R et al.,2005).

2.8 Lymph drainage of the abdominal organs:

2.8.1 Lymph drainage of the testis

Four to eight collecting trunks ascend in the spermatic cord and accompany , the testicular vessels on psoas major, ending in the lateral aortic and preaortic nodes. .(Anne M.R et al.,2005).

2.8.2 Lymph drainage of the stomach:

The stomach has a rich network of lymphatics that connect with lymphatics draining the other visceral organs of the upper abdomen. At the gastrooesophageal junction the lymphatics are continuous with those draining the lower oesophagus. In the region of the pylorus they are continuous with those draining the duodenum. In the main, they follow the course of the arteries supplying the stomach, however many separate node groups are now recognized. The relationship of separate node groups to the regions of the stomach and the vascular territories supplied is of great importance during resection.(Anne M.R et al.,2005).

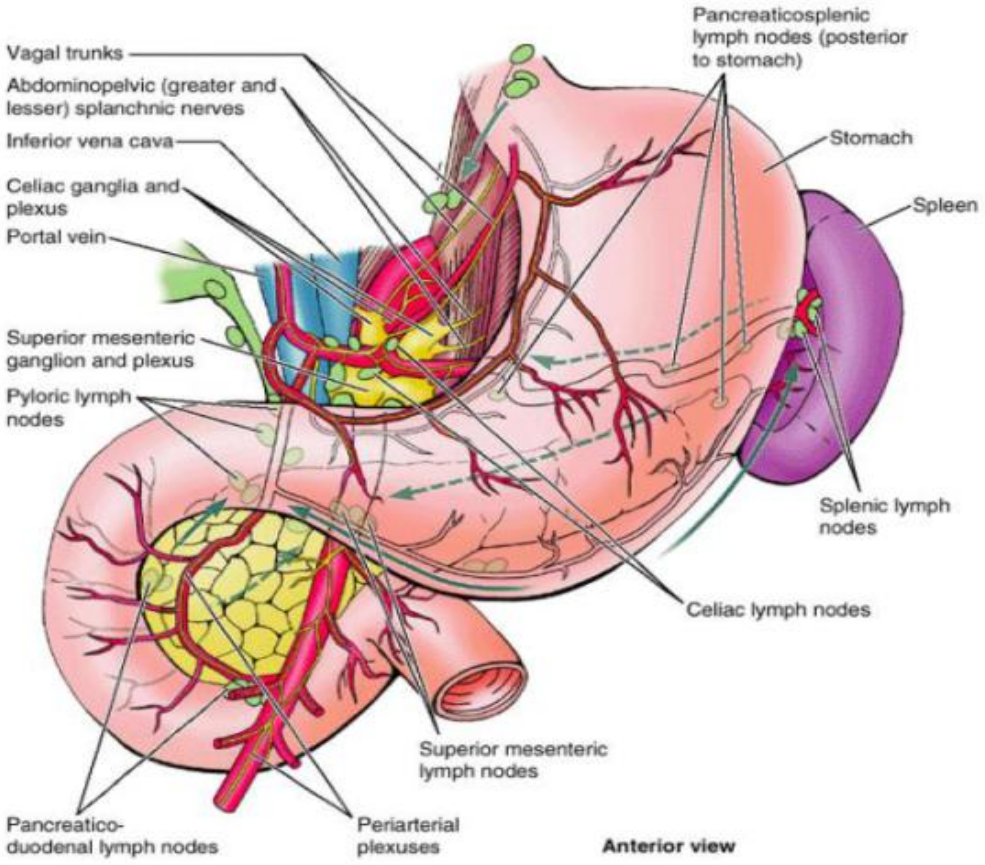

figure 2.3: Lymph drainage of the stomach (Anne M.R et al.,2005).

2.8.3 Lymph drainage of the small intestine

2.8.3 .1 Duodenum:

Duodenal lymphatics run to anterior and posterior pancreatic nodes that lie in the anterior and posterior grooves between the pancreatic head and the duodenum. These drain widely into the suprapyloric, infrapyloric, hepatoduodenal, common hepatic and superior mesenteric nodes.(Anne M.R et al.,2005).

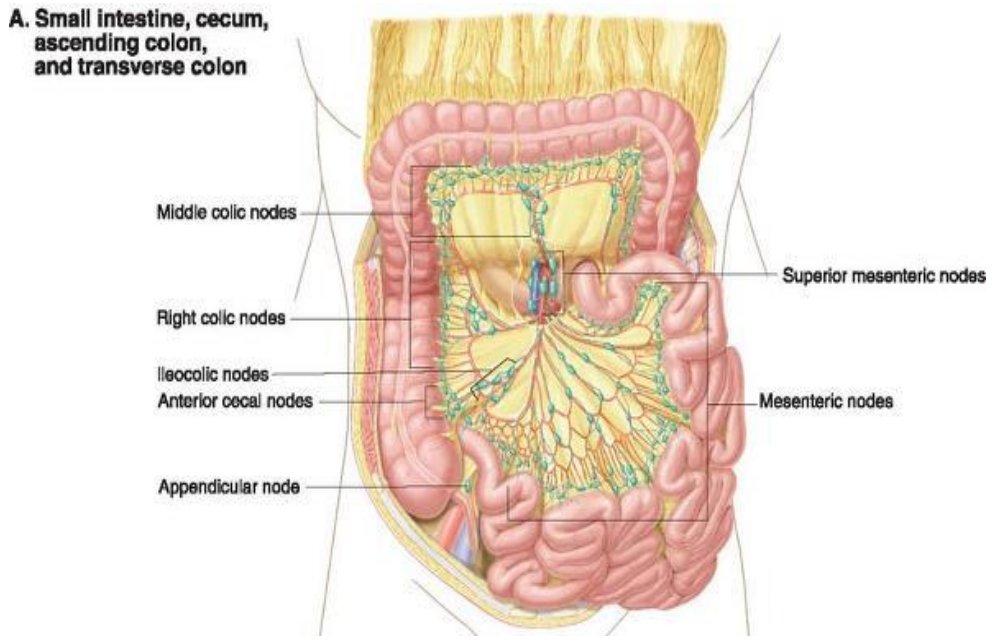

figure 2.4: Lymph drainage of the small intestine (Anne M.R et al.,2005).

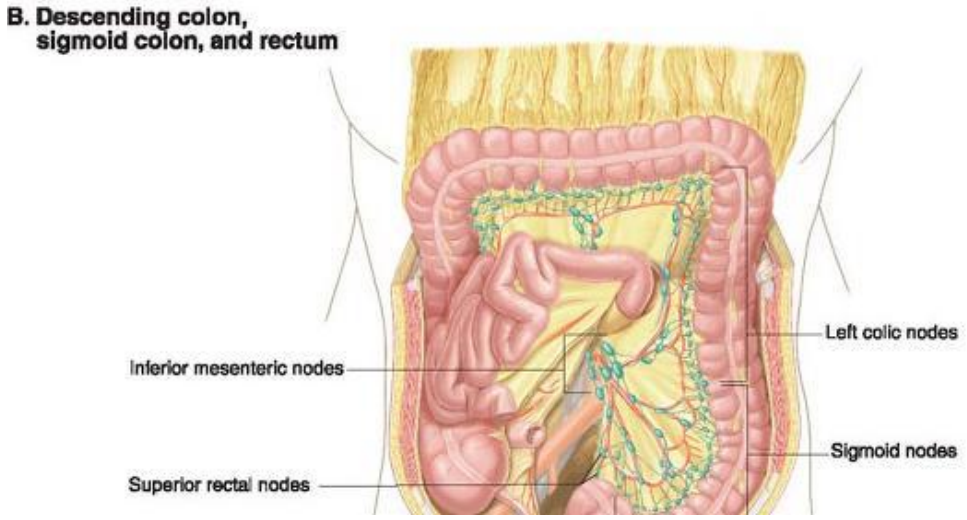

figure 2.5: Lymph drainage of the Large intestine (Anne M.R et al.,2005).

2.8.3 .2 Jejunum and Ileum:

They drain into a series of mesenteric lymph nodes arranged around the root of the superior mesenteric artery within the mesentery which follow the same distribution as the regional arterial supply and which may form a 'chain' along the major arteries. Elsewhere in the ileal and jejunal mesentery they form an extensive network that affords a relatively wide field of lymph node drainage.(Anne M.R et al.,2005).

2.8.4 Lymph drainage of the large intestine:

Anterior lymphatic vessels pass in front of the caecum and drain to the anterior ileocolic nodes and nodes of the ileocolic chain; posterior vessels ascend behind the caecum to the posterior and inferior ileocolic nodes. Lymph drains from the nodes in the ileocolic chain into the superior mesenteric nodes in the root of the small bowel mesentery.

Lymph vessels from descending colon drain into nodes along the left colic artery and subsequently into the inferior mesenteric nodes.(Anne M.R et al.,2005).

Lymphatics from the upper anal mucosa, internal anal sphincter and conjoint longitudinal coat drain upwards into the submucosal and intramural lymphatics of the rectum. The lower anal canal epithelium and external anal sphincter lymphatics drain downwards via perianal plexuses into vessels which drain into the external inguinal lymph nodes.(Anne M.R et al.,2005).

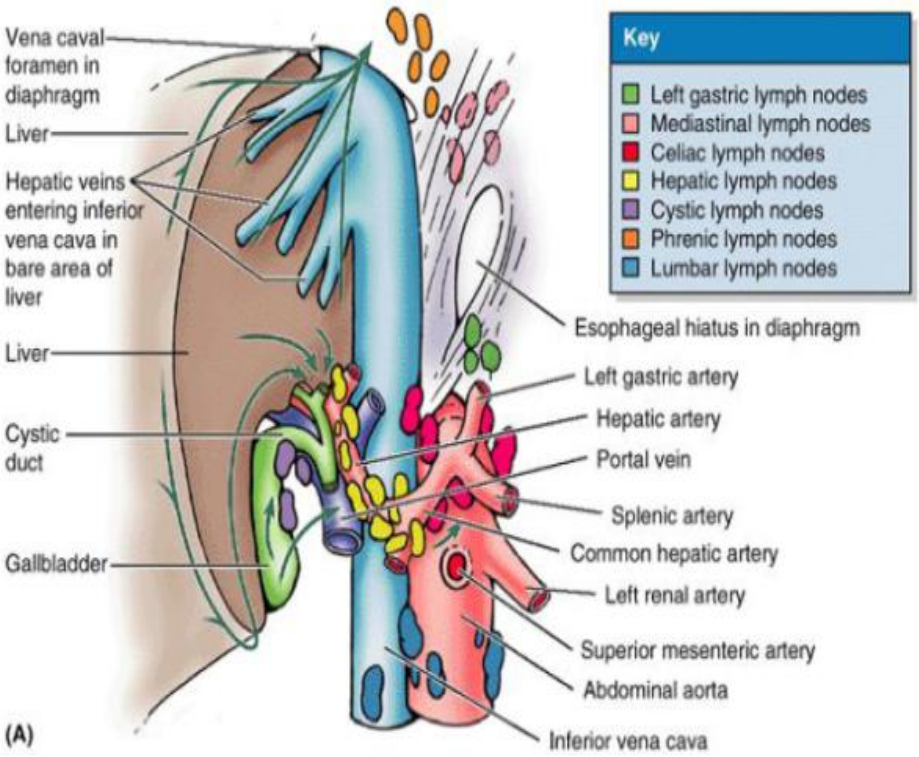

figure 2.6: Lymph of the abdomen (Anne M.R et al.,2005).

2.8.5 Lymph drainage of the liver:

2.8.5.1 The superficial vessels :

run in subserosal areolar tissue over the whole surface of the liver and drain in four directions. Lymph vessels from the majority of the posterior surface, the surface of the caudate lobe, and the posterior part of the inferior surface of the right lobe, accompany the inferior vena cava and drain into pericaval nodes. Vessels in the coronary and right triangular ligaments may directly enter the thoracic duct without any intervening node. .(Anne M.R et al.,2005).

2.8.5.2 The Deep lymphatics:

The great majority of the liver parenchyma is drained by lymphatic vessels within the substance of the liver. The fine lymphatic vessels merge to form larger vessels. Some run superiorly through the parenchyma to form the ascending trunks. They accompany the hepatic veins and pass through the caval opening in the diaphragm to drain into nodes round the end of the inferior vena cava. Vessels from the lower portion of the liver form descending trunks which emerge from the porta hepatis to drain into the hepatic nodes.(Anne M.R et al.,2005).

2.8.6 Lymph drainage of the gall bladder:

Numerous lymphatic vessels run from the submucosal and subserosal plexuses on all aspects of the gallbladder and cystic duct. Those on the hepatic aspect of the gallbladder connect with the intrahepatic lymph vessels. The remainder drain into the cystic node, which usually lies above the cystic duct . This node, and some lymphatic channels which bypass the cystic node, drain into a node lying in the anterior border of the free edge of the lesser omentum. Hepatic nodes lying in the porta hepatis collect lymph from vessels accompanying the hepatic ducts and the upper part of the bile duct. Lymphatics from the lower part of the common bile duct drain into the inferior hepatic and upper pancreaticosplenic nodes.(Anne M.R et al.,2005).

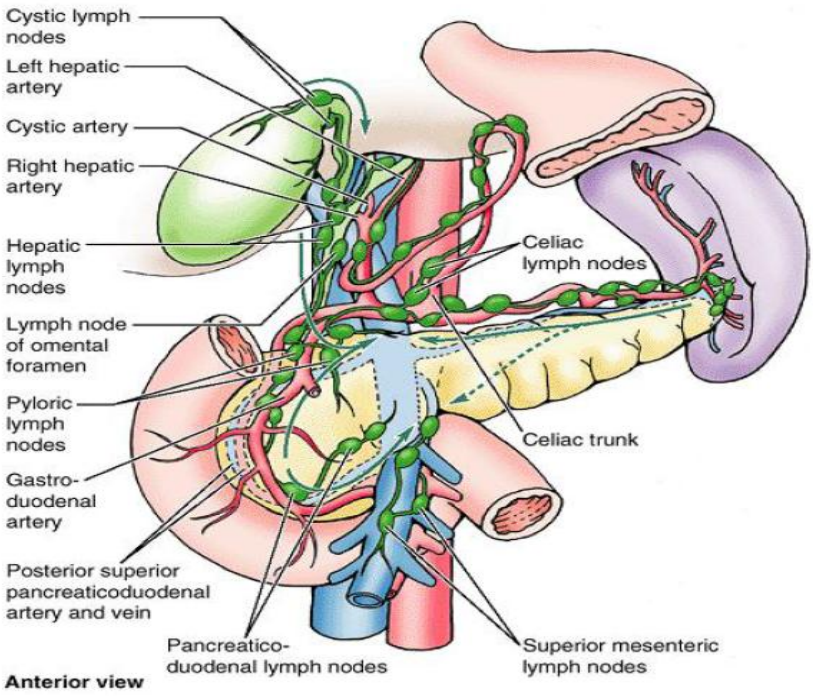

figure 2.7: Lymph drainage of the gall bladder (Anne M.R et al.,2005).

2.8.7 Lymph drainage of the pancreas

Lymphatics from the tail and body drain mostly into the pancreaticosplenic nodes, although some drain directly to pre-aortic nodes. Lymphatics from the neck and head drain more widely into nodes along the pancreaticoduodenal, superior mesenteric and hepatic arteries, and some also drain to the preaortic nodes and coeliac axis nodes. There is no evidence of lymphatic channels within the pancreatic islets. .(Anne M.R et al.,2005).

2.8.8 Lymphatic drainage of the spleen:

Lymphatic vessels drain along the splenic trabeculae and pass out of the hilum into lymphatic vessels that accompany the splenic artery and vein and drain into the coeliac nodes. .(Anne M.R et al.,2005).

2.8.9 Lymph drainage of the kidney:

Collecting vessels from the intrarenal plexus form four or five trunks which follow the renal vein to end in the lateral aortic nodes; the subcapsular collecting vessels join them as they leave the hilum. The perirenal plexus drains directly into the same nodes.(Anne M.R et al.,2005).

2.9 Lymph node groups of the abdomen:

(Table.2.1) Lymph channels in the abdomen travel with the arteries Most lymph drains to nodes around the abdominal aorta These are arranged into four groups.(Anne M.R et al.,2005):

- preaortic
- right para-aortic
- left para-aortic
- retroaortic

All of these drain to the cisterna chyli , which is an elongated lymph channel that continues in the thorax as the thoracic duct.(Stephanie et al., 2011).

Table 2-1: Normal lymph node size in the abdomen

Location of node	Maximum short axis diameter
Retrocrural	**6 mm**
Gastrohepatic ligament	**8 mm**
Upper para-aortic	**9 mm**
Porta hepatis	**7 mm**
Portacaval	**10 mm**
Lower para-aortic	**11 mm**

(Dorfman et al, 1991)

2.9 .1 Superior mesenteric and inferior mesenteric nodes:

The superior and inferior mesenteric nodes lie anterior to the aorta near the origins of their respective arteries. The superior and inferior mesenteric nodes are preterminal groups for the alimentary canal from the duodenojejunal flexure to the upper anal canal. They collect from outlying groups, including the mesenteric , ileocolic, colonic and pararectal nodes and drain into the coeliac nodes.(Stephanie et al., 2011).

The superior and inferior mesenteric nodes drain the bowel from the duodenojejunal flexure to the anal canal Lymph drainage from the small bowel is to mesenteric nodes, from the terminal ileum and colon to ileocolic nodes, and from the rectum to pararectal nodes From here, lymph drains along the arterial supply to more proximally located nodes along the arterial supply and to nodes at the origins of the superior and inferior mesenteric arteries All nodes lie on the mesenteric side of the bowel, and lymphatic channels run in the mesentery Perirectal nodes may lie anywhere around the rectum within the perirectal fat They drain to a superior rectal group with the superior rectal artery and thence to an inferior mesenteric group They also drain to the internal and common iliac nodes The lower part of the anal canal drains to external iliac nodes.(Stephanie et al., 2011).

2.9 .2 Para-aortic nodes

These nodes lie on either side of the aorta in relation to its lateral paired branches They lie anterior to the medial margin of psoas and the crura of the diaphragm They receive lymph from the structures supplied by these branches, including the posterior abdominal wall, the diaphragm, the kidneys and adrenals and the gonads On the right, nodes lie anterior to and on both sides of the inferior vena cava Nodes lying between the aorta and inferior vena cava are referred to as aortocaval nodes A node lying between the IVC and the portal vein is frequently

identified and is referred to as the portacaval node.(Stephanie et al., 2011)

Lymph from the legs drains via the deep inguinal and external and common iliac nodes to the para-aortic nodes Lymph from the pelvis drains via internal and common iliac nodes to the para-aortic nodes. (Stephanie et al., 2011).

Efferent vessels from the para-aortic nodes unite to form the right and left lumbar trunks.(Stephanie et al., 2011).

2.9 .3 Lateral aortic group:

The lateral aortic nodes lie on either side of the abdominal aorta anterior to the medial margins of psoas major, diaphragmatic crura and sympathetic trunks. On the right, some nodes lie lateral and anterior to the inferior vena cava near the end of the right renal vein. Nodes rarely lie between the aorta and inferior vena cava where they are closely related. The lateral aortic nodes drain the viscera and other structures supplied by the lateral and dorsal aortic branches.(Stephanie et al., 2011).

The lateral aortic group drains into the two lumbar lymph trunks, one on each side, which terminate in the confluence of lymph trunks. A few vessels may pass to the pre-aortic and retro-aortic nodes and others cross the midline to flow into the contralateral nodes, forming a loose plexus. (Stephanie et al., 2011).

2.9 .4 Preaortic group:

These are arranged around the anterior branches of the aorta , the coeliac trunk and the superior and inferior mesenteric arteries They drain lymph in the areas supplied by these arteries, that is, the gastrointestinal tract, the liver, gallbladder, pancreas and spleen Lymph from these viscera passes through visceral nodes, such as the nodes in the porta hepatis and nodes near the intestinal wall, and along the course of the

arteries before reaching the preaortic nodes Lymph from the preaortic nodes passes in the right and left intestinal trunks to the cisterna chyli.(Stephanie et al., 2011).

2.9 .5 Coeliac nodes:

The coeliac nodes lie anterior to the abdominal aorta around the origin of the coeliac artery. They are a terminal group and receive lymph draining from the regional lymph nodes around the branches of the coeliac artery (left gastric, hepatic and pancreaticosplenic nodes) and from the lower preaortic groups (the superior mesenteric and inferior mesenteric). The coeliac nodes give rise to right and left intestinal lymph trunks.(Stephanie et al., 2011).

These receive gastric, hepatic and pancreaticosplenic nodes The gastric nodes have three groups: left gastric, gastro- epiploic and pyloric.(Stephanie et al., 2011).

The left gastric nodes lie in the lesser curve and drain the lower oesophagus as well as the stomach These nodes are usually smaller than the para-aortic group; over 8 mm is considered abnormal The gastroepiploic group lie low on the greater curve, near the pylorus, and are related to the right gastroepiploic artery These drain to the pyloric group – a group of approximately five nodes which lie in the bifurcation of the gastroduodenal artery at the junction of the first and second part of the duodenum.(Stephanie et al., 2011)

2.9 .6 Gastric group

There are numerous gastric lymph node groups. They drain the stomach, upper duodenum, abdominal oesophagus and the greater omentum into the coeliac group.(Stephanie et al., 2011).

2.9 .7 Retro-aortic group

These nodes drain no area in particular and are really only posteriorly placed nodes of the lateral group They are worthy of mention only because very little else lies between the aorta and the vertebral bodies, and a mass posterior to the aorta is therefore likely to have arisen in lymph nodes.(Stephanie et al., 2011).

The retro-aortic group is the smallest of all the para-aortic lymph nodes and has no particular areas of drainage, although it may receive some lymph directly from the posterior abdominal wall. Retro-aortic nodes are effectively peripheral nodes of the lateral aortic groups and provide interconnections between surrounding groups.(Stephanie et al., 2011)

2.9 .8 Pancreaticosplenic

The pancreaticosplenic nodes drain the spleen, pancreas and part of the stomach into the coeliacnodes. The pancreaticosplenic nodes run with the splenic artery and lie above and behind the pancreas and in the gastrosplenic ligament These drain pancreas, spleen and stomach.(Stephanie et al., 2011).

2.9 .9 Cisterna chyli and abdominal lymph trunks

This thin-walled sac, 6 mm wide and 6 cm long, is really the dilated proximal end of the thoracic duct before it passes through the aortic hiatus of the diaphragm It lies in front of the bodies of L 1 and L 2 to the right crus of the aorta The cisterna chyli receives the intestinal trunk, the right and left lumbar trunks and paired descending intercostal trunks.(Stephanie et al., 2011).

The abdominal origin of the thoracic duct lies to the right of the midline at the level of the lower border of the 12th thoracic vertebral body or the thoracolumbar intervertebral disc. It receives all the lymph delivered by the four main abdominal lymph trunks, which converge to

an elongated arrangement of channels, referred to as the abdominal confluence of lymph trunks.(Stephanie et al., 2011).

The abdominal confluence of lymph trunks extends from the beginning of the thoracic duct, vertically downwards for 5–7 cm, and lies anterolateral to the right of the first and second lumbar vertebral bodies and their intervening discs. It lies immediately to the right of the abdominal aorta .(Stephanie et al., 2011).

The thoracic duct leaves the superior end of the cisterna chyli or the abdominal confluence and immediately passes through the aortic aperture of the diaphragm posterolateral to the aorta. (Stephanie et al., 2011).

2.9 .10 porta hepatis :

The hepatic nodes are related to the hepatic artery at the porta hepatis in the lesser omentum (gastrohepatic ligament) They are variable in size and number and drain liver, gallbladder and bile ducts, as well as stomach, duodenum and pancreas .(Stephanie et al., 2011)

Table 2.2: Normal lymph node size in the abdomen and pelvis (Stephanie et al., 2011)

Site	Group	Size (mm)
Abdomen(Callen PW et al., 1977)	**Gastrohepatic ligament**	**8**
	Porta hepatis	**8**
	Portacaval	**10**
	Coeliac axis to renal artery	**10**
	Renal artery to aortic bifurcation	**12**
Pelvis(Vinnicombe S et al.,1995)	**Common iliac**	**9**
	External iliac	**10**
	Internal iliac	**7**
	Obturator	**8**
Inguinal		**10**

1.10 Normal Anatomy of the Paraaortic and Iliopelvic Nodes

A solid understanding of the anatomy and nomenclature of the inguinopelvic and retroperitoneal nodal groups is essential for accurate staging of urogenital pelvic neoplasm's. These nodal groups are described briefly as the following (figure 2.8).

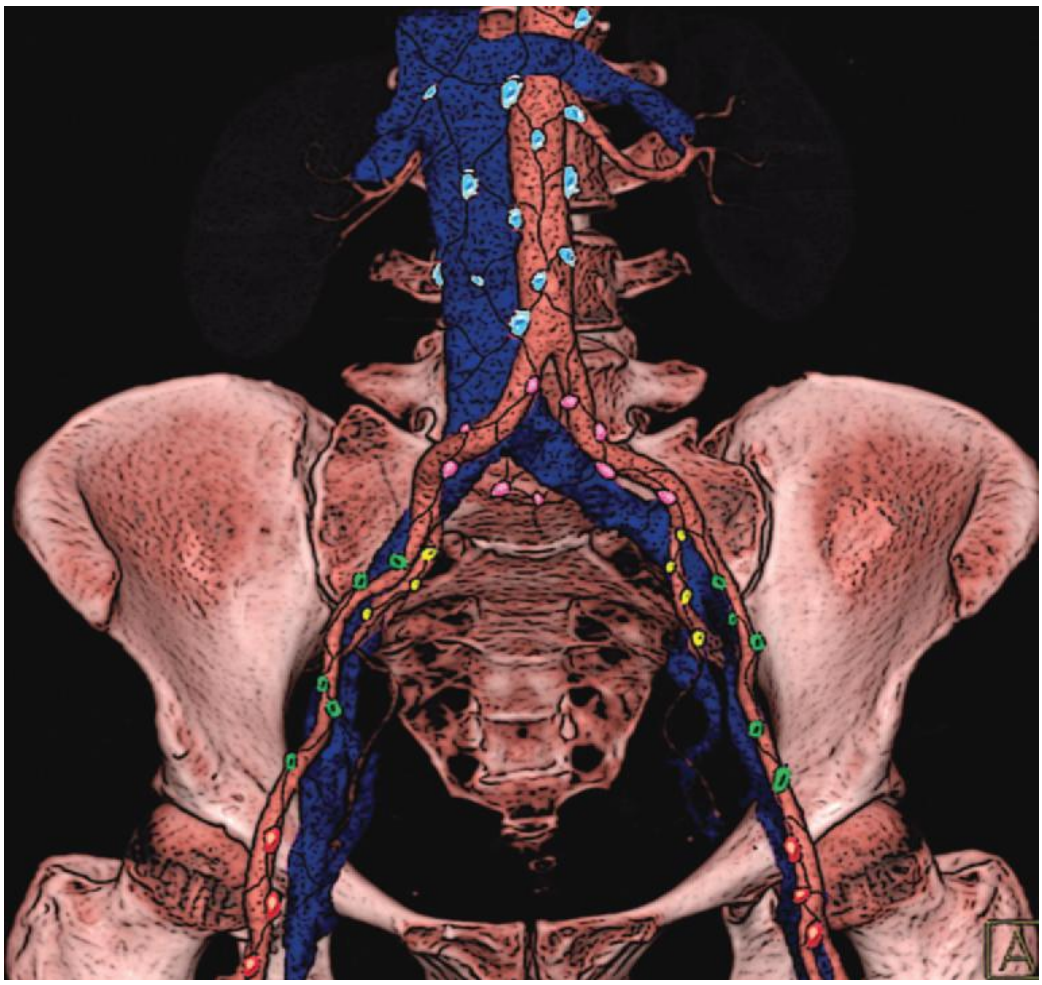

figure 2.8: Schematic shows the major pelvic and retroperitoneal lymph node groups: the inguinal (red), external iliac (green), internal iliac (yellow), common iliac (pink), and paraaortic (blue) nodes.(Blanca Pano et al., 2011)

2.10.1 Paraaortic Nodes

The paraaortic nodes can be divided into seven subgroups on the basis of the relationship of the node to the aorta and the inferior vena cava (figure 2.9). The lateroaortic, preaortic, and retroaortic nodes surround the aorta. The right lateroaortic subgroup is further divided into aortocaval, laterocaval, precaval, and retrocaval subgroups, with the nomenclature reflecting the location of the nodes in relation to the inferior vena cava (Park JM et al., 1994).

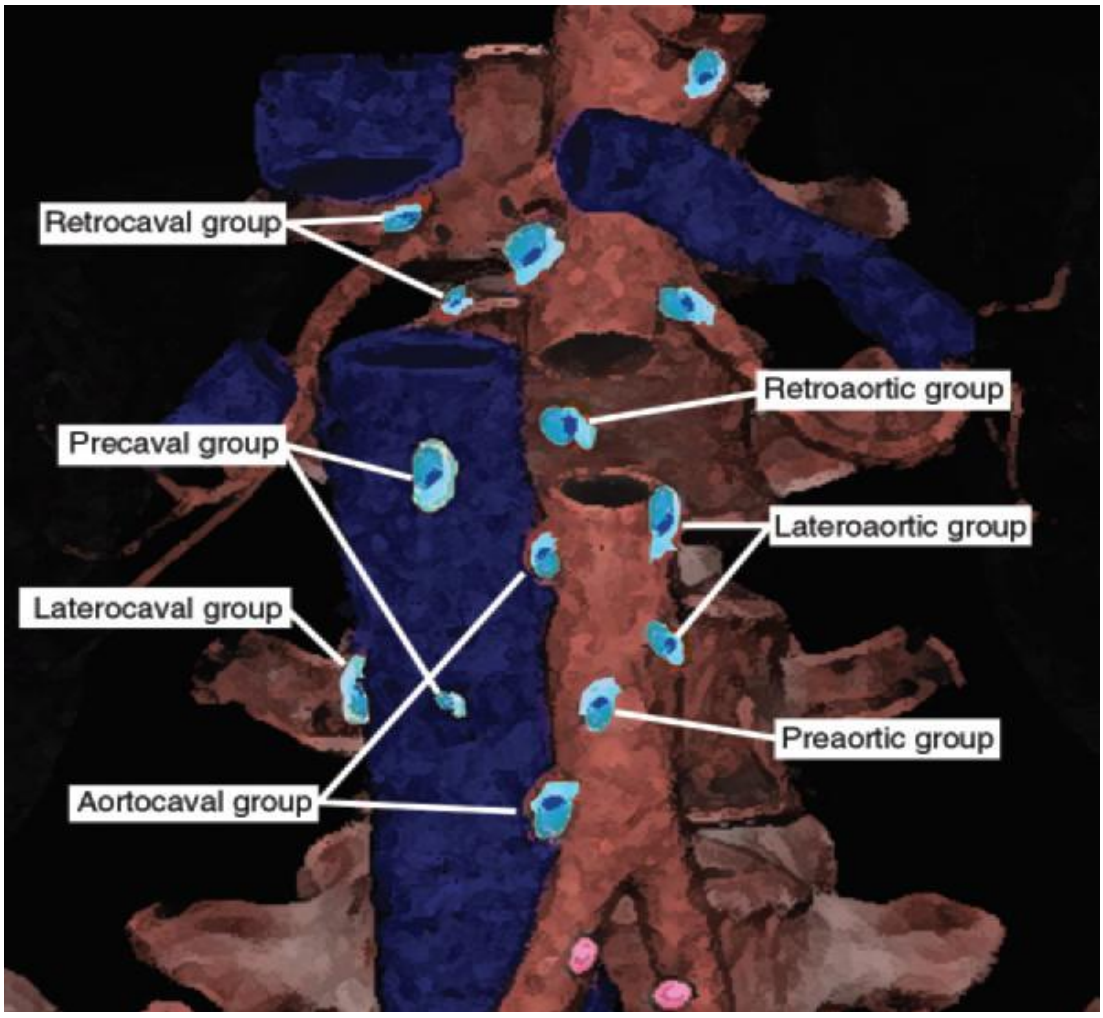

figure 2.9: Schematic shows the seven subgroups of paraaortic lymph nodes. The subgroups are distinguished from one another on the basis of their positions in relation to the aorta and the inferior vena cava.(Park JM et al., 1994).

2.10.2 Common Iliac Nodal Group

The common iliac nodal group consists of three chains: lateral, middle, and medial (figure 2.10). The first chain is an extension of the lateral chain of external iliac nodes located lateral to the common iliac artery. The medial chain occupies the triangular area bordered by both common iliac arteries from the aortic bifurcation to the bifurcations of the external and internal iliac arteries. Nodes at the sacral promontory are included in this chain. The middle chain nodes are located in the lumbosacral fossa (the area bordered posteromedially by the lower lumbar or upper sacral vertebral bodies, anterolaterally by the psoas muscle, and anteromedially by the common iliac vessels) and between the common iliac artery and common iliac vein (Park JM et al., 1994).

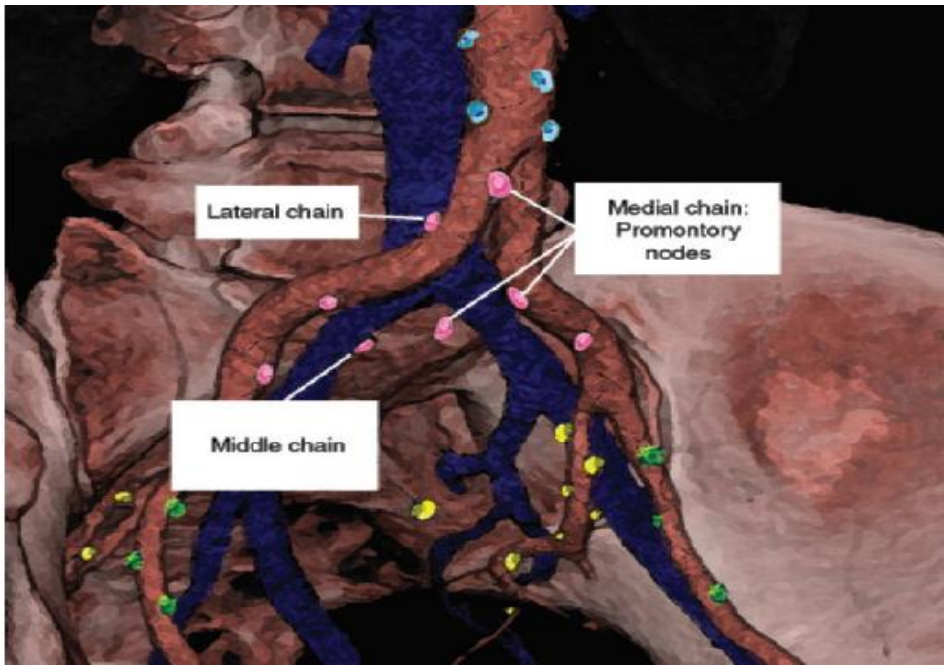

figure 2.10: Common iliac lymph nodes. Schematic show the common iliac nodal group, which consists of three chains. which is located lateral to the common iliac artery (a) and forms an extension from the lateral external iliac nodal chain; the medial chain , which occupies the triangular area bordered by both common iliac arteries and includes nodes at the sacral promontory; and the middle chain , which consists of nodes within the lumbosacral fossa. (Park JM et al., 1994).

2.10.3 Internal Iliac (Hypogastric) Nodal Group

The internal iliac nodal group, also known as the Hypogastric nodal group, consists of several nodal chains accompanying each of the visceral branches of the internal iliac artery (figure 2.11). Among the nodes of this group are the junctional nodes that are located at the junction between the internal and external iliac nodal groups. The junctional nodes have relevance for various pathways of lymphatic dissemination, as described in the section on "Common Pathways of Nodal Metastasis" (Park JM et al., 1994).

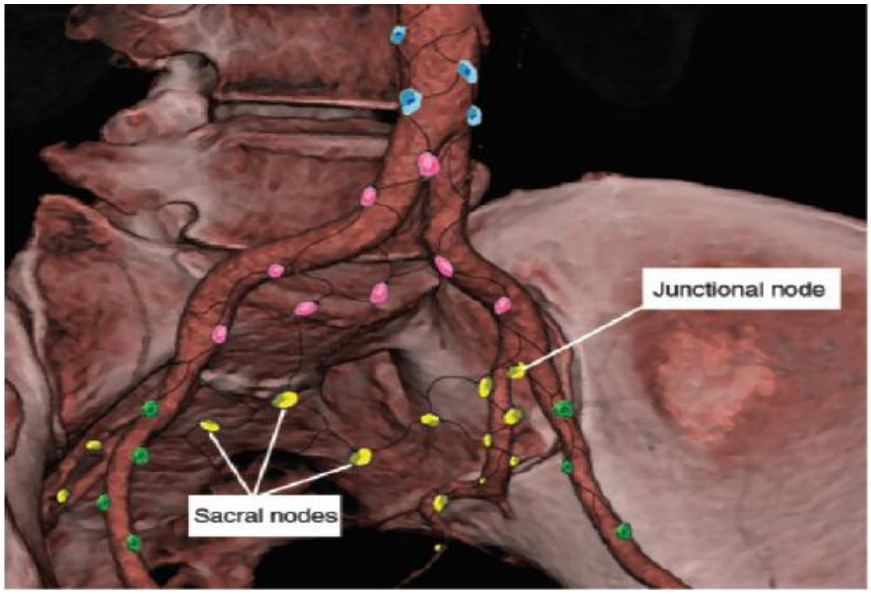

figure 2.11:Internal iliac lymph nodes. Schematic show the chains of internal iliac lymph nodes that accompany the visceral branches of the internal iliac vessels, the central location of the sacral nodes within the pelvis and the position of the junctional nodes between the internal and external iliac arteries are clearly visible. (Park JM et al., 1994).

2.10.4 External Iliac Nodal Group

The external iliac nodal group consists of three chains: lateral, middle, and medial (figure 2.12). The lateral chain includes nodes that are located along the lateral aspect of the external iliac artery. The

middle chain comprises nodes located between the external iliac artery and the external iliac vein. The medial chain contains nodes located medial and posterior to the external iliac vein. The medial chain nodes are also known as the Obturator nodes (Park JM et al., 1994).

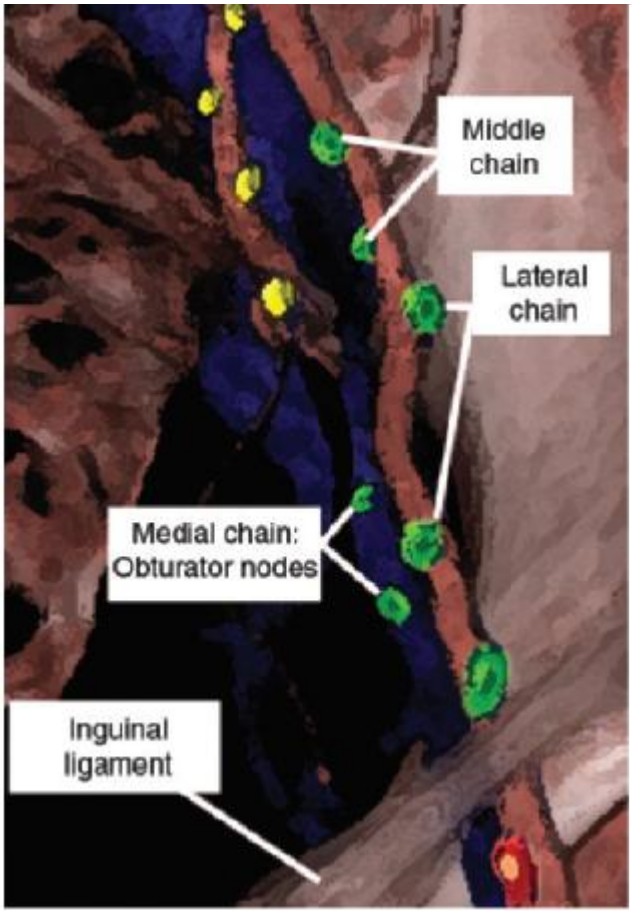

***figure 2.12*:External iliac lymph nodes. Schematic show the three chains of the external iliac nodal group. These are, as depicted , the lateral chain, positioned laterally along the external iliac artery; the middle chain, situated between the external iliac artery and external iliac vein; and the medial chain (also known as Obturator nodes), positioned medial and posterior to the external iliac vein. (Park JM et al., 1994).**

2.10.5 Inguinal Lymph Nodes

This group consists of superficial inguinal and deep inguinal nodes (figure 2.13). The superficial inguinal nodes, which are located in the subcutaneous tissue anterior to the inguinal ligament, accompany the superficial femoral vein and the saphenous vein. The sentinel nodes for the superficial subgroup are those situated at the saphenofemoral junction, where the great saphenous vein drains into the common femoral vein. The deep inguinal nodes are those located along the common femoral vessels. The landmarks that allow differentiation between the deep inguinal nodes and the medial chain of the external

iliac nodes are the inguinal ligament and the origins of the inferior epigastric and circumflex iliac vessels (Park JM et al., 1994).

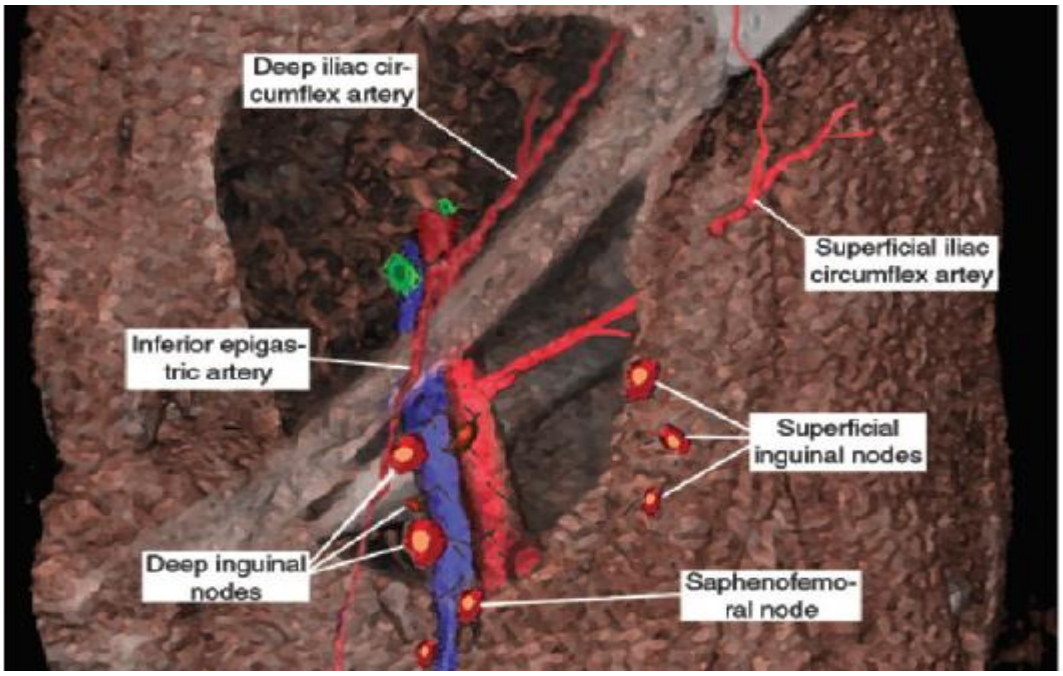

figure 2.13*:*Inguinal lymph nodes Schematic show the locations of the superficial and deep inguinal nodes in relation to the common femoral artery , common femoral vein and saphenous vein . The sentinel nodes in the superficial inguinal group are those located at the sapheno-femoral junction. (Park JM et al., 1994).

2.10.6 Normal Radiological features of the abdominal lymphatics

The ‘ bean-shaped ’ appearance of the normal node may be appreciated, with its fatty hilum, although the fatty hilum is not always evident The long axis is parallel to the direction of drainage Pathologically enlarged nodes tend to be more rounded in shape, and lose their fatty hilum Normal nodes vary in length from millimetres to several centimetres (Table 2.1) but are narrow in diameter In imaging, nodes are measured in their maximum short axis diameter In the abdomen the normal cross-sectional diameter is variable, but should normally be less than 10 mm, but this varies by location On MRI spatial resolution is less than with CT, but greater contrast resolution allows

easier differentiation of lymph nodes from nearby vessels, bowel loops and other retroperitoneal structures.(Stephanie et al., 2011).

2.11 The Pathology of Lymph Nodes Enlargement

Many different aetiological factors contribute to the enlargement of lymph nodes; in some cases the cause is obvious, in others obscure. The enlargement may be focal, regional or generalized, or the first two types may progress to the third. The enlargement may be the only clinical manifestation of disease or it may be accompanied by various signs and symptoms, such as pain, pyrexia, exanthemata, changes in the blood picture or pressure effects on viscera. (L.Woodhouse Price 1947).

The histological differential diagnosis of lymph node enlargement depends upon a proper appreciation of the normal structure of a lymph node and of the various changes which are common to several or peculiar to certain specific types of pathological processes. In some cases a consideration of the clinical condition alone is sufficient to establish a correct diagnosis. This applies especially to lymph node enlargement associated with inflammatory lesions, acute specific fevers and chronic infective granulomata. In other cases the. aid of histology and haematology is essential. The latter group comprises the primary lymphadenopathies and metastatic tumour deposits (L.Woodhouse Price 1947).

An investigation as to the cause of lymph node enlargement demands an account of the clinical appearance of the patient, the determination of the size, consistency and distribution of the enlarged nodes and a detailed report on the histology of a node excised for biopsy purposes, to which it is often advisable to add the macroscopic appearance of the hemisected node. In certain diseases the concomitant

pathological changes in other organs and tissues have to be considered also. (L.Woodhouse Price 1947).

Lymph node metastasis is frequently seen in most primary abdominal malignant tumors. The tumor cells enter lymphatic vessels and travel to the lymph nodes along lymphatic drainage pathways. The lymphatic vessels and lymph nodes generally accompany the blood vessels supplying or draining the organs. They are all located in the subperitoneal space within the ligaments, mesentery, mesocolon, and extra peritoneum. Metastasis to the lymph nodes generally follows the nodal station in a stepwise direction i.e. , from the primary tumor to the nodal station that is closest to the primary tumor and then progresses farther away but within the lymphatic drainage pathways. Metastasis to a nodal station that is farther from the primary tumor without involving the nodal station close to the primary tumor ("skip" metastasis) is rare. The key to understanding the pathways of lymphatic drainage of each individual organ is to understand the ligamentous, mesenteric, and peritoneal attachments and the vascular supply of that organ (Meyers MA et al., 2010) .

The benefits of understanding the pathways of lymphatic drainage of each individual organ are threefold. First, when the site of the primary tumor is known, it allows identification of the expected first landing site for nodal metastases by following the vascular supply to that organ (Granfield CA et al., 1992) . Second, when the primary site of tumor is not clinically known, identifying abnormal nodes in certain locations allows tracking the arterial supply or venous drainage in that region to the primary organ. Third, it also allows identification of the expected site of recurrent disease or nodal metastasis or the pattern of disease progression after treatment by looking at the nodal station beyond the treated site (Granfield CA et al., 1992).

The accuracy for characterizing malignant lymph nodes based on size criteria (Table 2.3) is low and has been described in published reports.

Normal-sized lymph nodes can be malignant and enlarged lymph nodes can be nonmalignant (see figure 2.14) (Dodd 3rd GD et al.,1997). Newer imaging technology such as Multidetectors computed tomography (MDCT) with nanoparticles may be superior for accurate nodal characterization (Frija J et al., 2005).

Table 2.3: Size criteria for detecting abdominal malignant lymph nodes (Dorfman RE et al., 1991)

Location	Short axis nodal diameter, mm
Retrocrural	**>6**
Paracardiac	**>8**
Mediastinal	**>10**
Gastrohepatic ligament	**>8**
Upper paraaortic	**>9**
Portacaval	**>10**
Portahepatis	**>7**
Lower paraaortic	**>11**

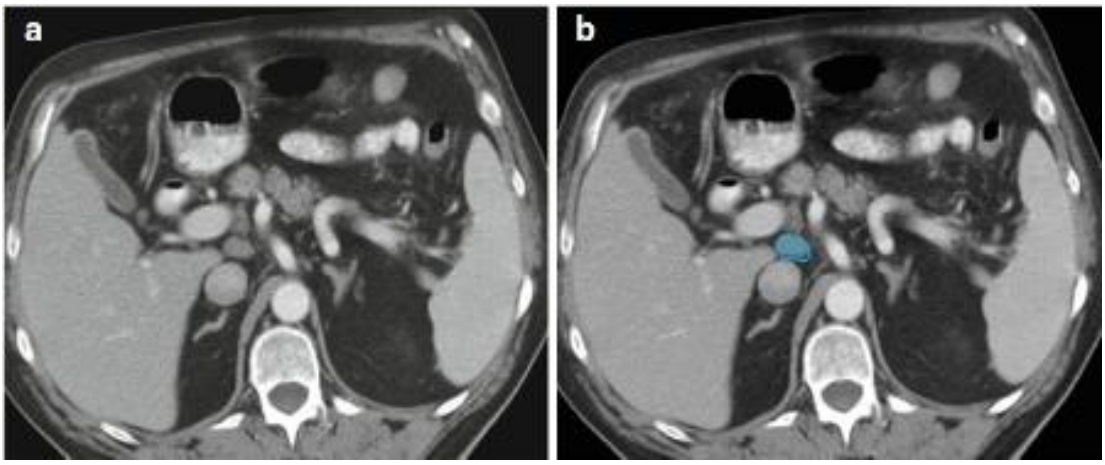

figure 2.14 *:(a , b) Axial CT image in a patient with cirrhosis shows a prominent portocaval lymph node (blue) (Dorfman RE et al., 1991)*

2.12 Lymphatic Spread of Malignancies

2.12.1 Liver

Hepatocellular carcinoma (HCC) is the most common primary visceral malignancy (Egner 2010) . Lymph node metastases (LNM) are rare and generally associated with poor prognosis in hepatocellular carcinoma (see figure 2.15). The median survival time of patients with single and multiple LNM after surgery was 52 and 14 months, respectively (Kobayashi S et al., 2011) .

Table 2.3 outlines the regional lymph nodes for hepatocellular carcinoma. There are several potential pathways for tumor spread, including superficial and deep pathways, below and above the diaphragm. The superficial lymphatic network (see figure 2.16) is extensive and is located beneath Glisson's capsule. The drainage of superficial lymphatics can be classified into three major groups:

1. Through the hepatoduodenal and gastrohepatic ligament pathway, it is the most common distribution of lymph node metastasis.
2. The diaphragmatic lymphatic plexus is another important pathway of drainage because a large portion of the liver is in contact with the diaphragm either directly at the bare area or indirectly through the coronary and triangular ligaments. However, nodal metastasis through this pathway is often overlooked.
3. The rare pathway for nodal metastasis is along the falciform ligament to the deep superior epigastric node in the anterior abdominal wall along the deep superior epigastric artery below the xiphoid cartilage.

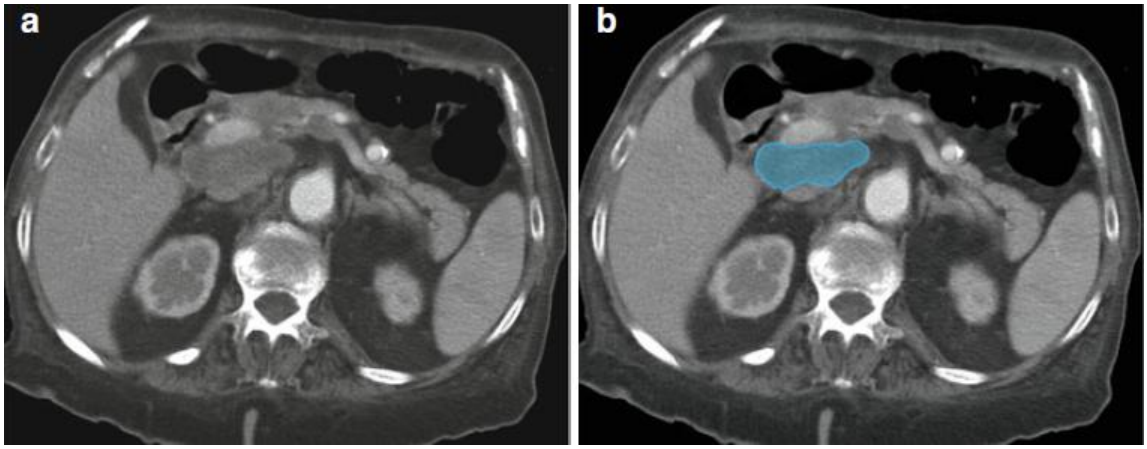

figure 2.15 :(a , b) Axial CT image in a patient with hepatoma shows a metastatic low density portocaval lymph node (*blue*) (***Dorfman RE et al., 1991)***

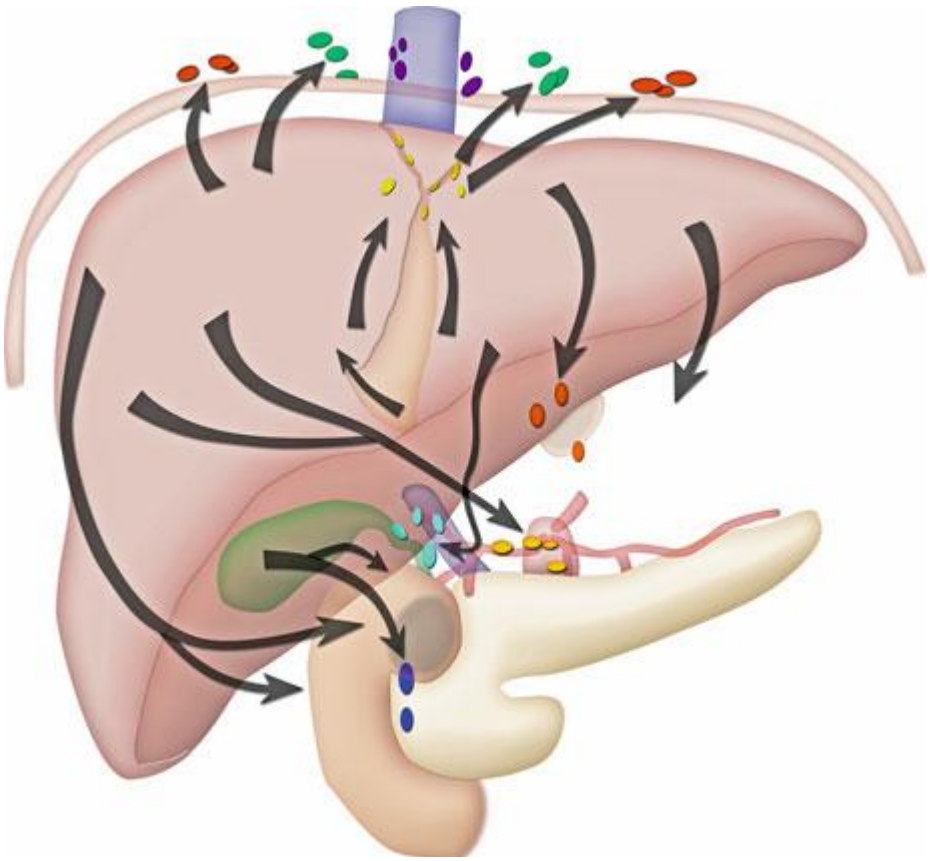

figure 2.16:Superficial pathways of lymphatic drainage for the liver. The anterior diaphragmatic nodes consist of the lateral anterior diaphragmatic group and the medial group, which includes the pericardiac nodes and the subxiphoid nodes behind the xiphoid cartilage. The nodes in the falciform ligament drain into the anterior abdominal wall along the superficial epigastric and deep epigastric lymph nodes. The epigastric and the subxiphoid nodes drain into the internal mammary nodes. (Dorfman RE et al., 1991)

The deep lymphatic network follows the portal veins, drains into the lymph nodes at the hilum of the liver, the hepatic lymph nodes, then to the nodes in the hepatoduodenal ligament. The nodes in the hepatoduodenal ligament can be separated into two major chains: the hepatic artery chain and posterior periportal chain (see figure 2.17and 2.18) The hepatic artery chain follows the common hepatic artery to the node at the celiac axis and then into the cisterna chyli. The posterior periportal chain is located posterior to the portal vein in the hepatoduodenal ligament (*see* figure 2.19).

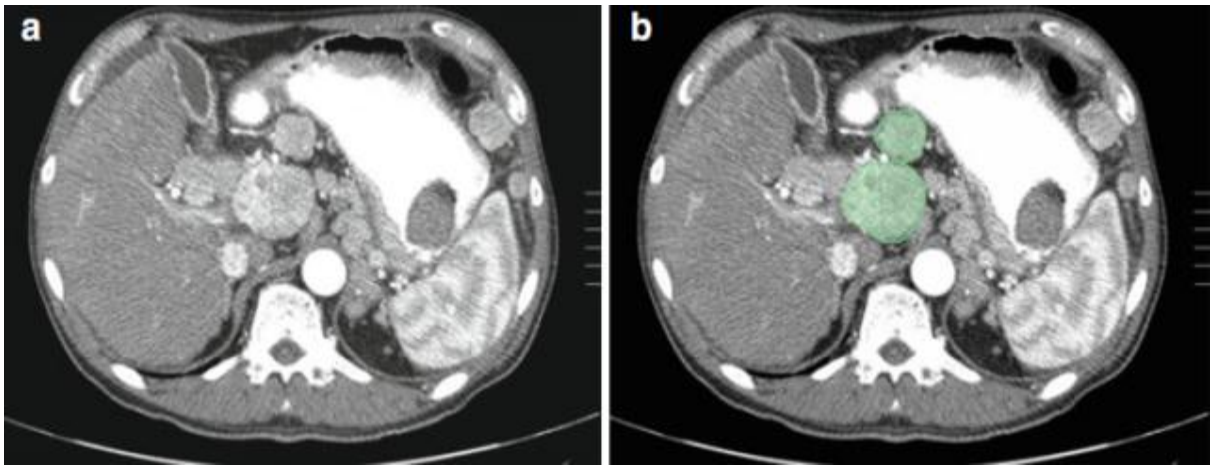

figure 2.17 (a , b) Axial CT image in a patient with hepatocellular carcinoma shows enlarged hypervascular nodes (*green*) ***in the periportal locations(Dorfman RE et al., 199)***

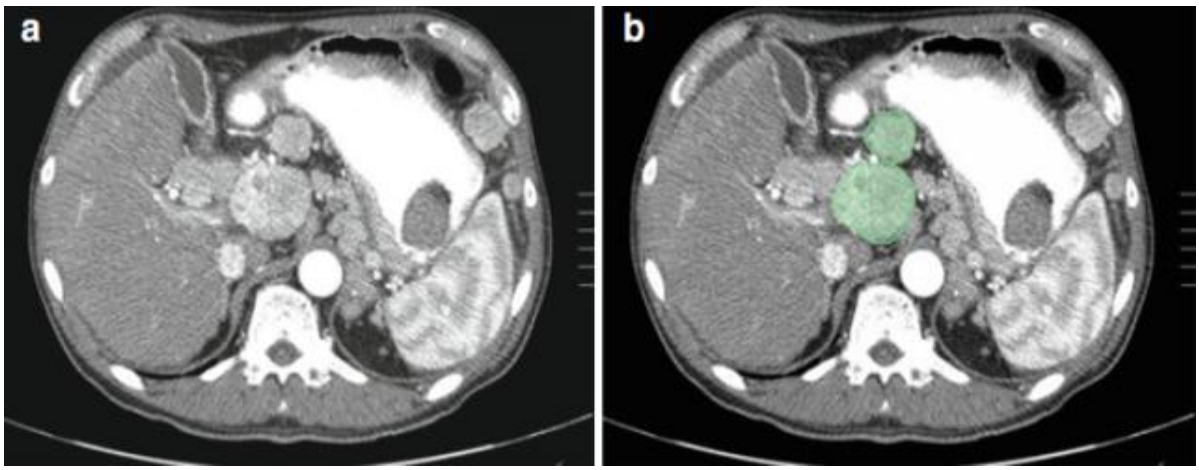

figure 2.18 (**a** , **b**) ***Axial CT image in a patient with hepatoma shows enlarged nodes in the periportal*** (*green*) ***and peripancreatic location causing secondary biliary obstruction(Dorfman RE et al., 1991)***

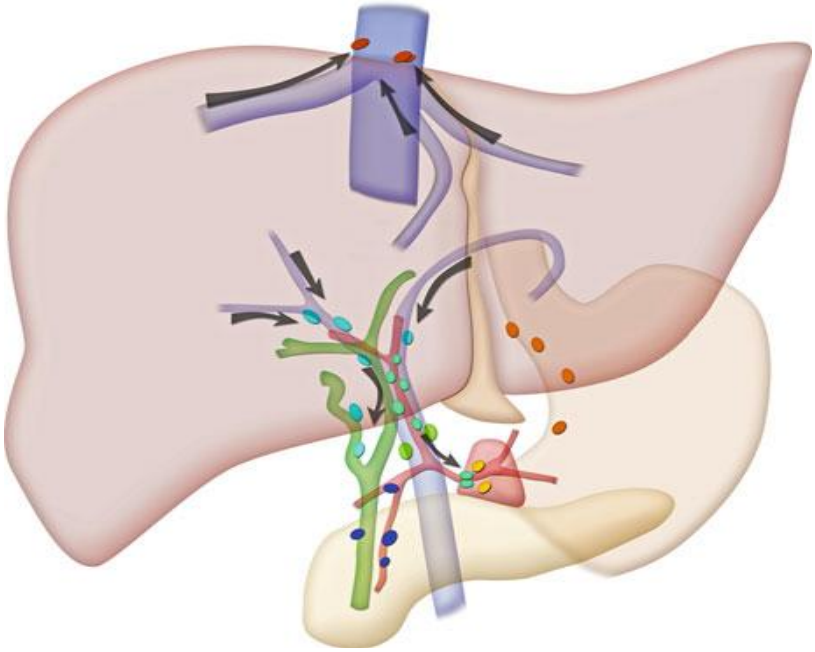

figure 2.19 Deep pathways of lymphatic drainage for the liver. The deep pathways follow the hepatic veins to the inferior vena cava nodes and the juxtaphrenic nodes that follow along the phrenic nerve. The pathways that follow the portal vein drain into the hepatic hilar nodes and the nodes in the hepatoduodenal ligament, which then drain into the celiac node and the cisterna chyli (Dorfman RE et al., 1991).

It drains into the retropancreatic nodes and the aortocaval node (*see* Fig. 2.20) and then into the cisterna chyli and the thoracic duct (Meyers MA et al., 2010).

No consensus has yet been reached on the treatment strategy for LNM from HCC. Long-term survival can be expected after selective lymphadenectomy, especially in patients with a single LNM. On the other hand, efficacy of selective lymphadenectomy for multiple LNM seemed equivocal due to its advanced and systemic nature of the disease (Kobayashi S et al., 2011) .

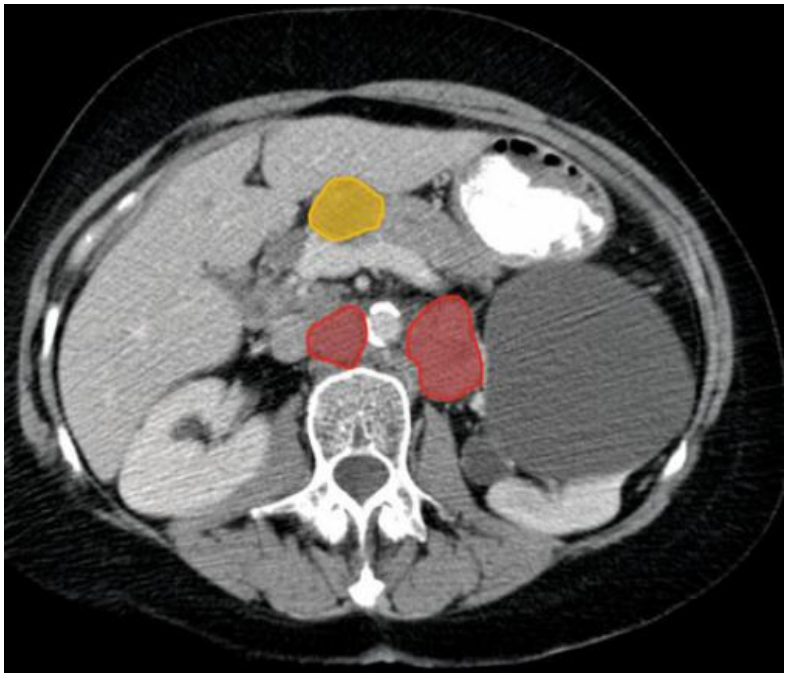

figure 2.20 :A***xial CT image in a patient with cholangiocarcinoma shows enlarged prepancreatic*** (*yellow*) ***and retroperitoneal lymph nodes*** (*red*)

2.12.2 Stomach

Gastric cancer is the third most common gastrointestinal malignancy (Morón FE et al., 2007). Lymph node metastasis in gastric cancer is common and the incidence increases with advanced stages of tumor invasion (Hartgrink HH et al., 2004) .The lymphatic drainage of the stomach consists of intrinsic and extrinsic systems (see figure 2.21). The intrinsic system includes intramural submucosal and subserosal

networks and the extrinsic system forms lymphatic vessels outside the stomach and generally follows the course of the arteries in various peritoneal ligaments around the stomach. These lymphatic vessels drain into the lymph nodes at nodal stations in the corresponding ligaments and drain into the central collecting nodes at the root of the celiac axis and the superior mesenteric artery (Meyers MA et al., 2010).

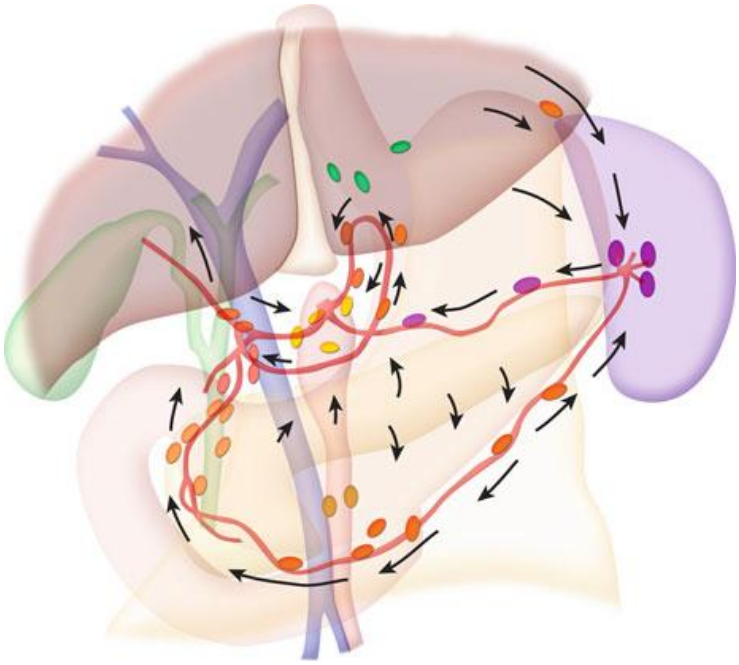

figure 2.21*:*Lymphatic drainage pathways for the stomach(Hartgrink HH et al., 2004)

2.11.2 .1 Nodal Metastases in the Gastrocolic Ligament

Primary tumors involving the greater curvature of the antrum of the stomach in the distribution of the right gastroepiploic artery spread to the perigastric nodes , accompanying the right gastroepiploic vessels that course along the greater curvature of the stomach. They drain into the nodes at the gastrocolic trunk (see figure 2.22) or the nodes at the origin of the right gastroepiploic artery and the nodes

along the gastroduodenal artery (the subpyloric or infrapyloric node). From there, they may proceed to the celiac axis or the root of the superior mesenteric artery (Meyers MA et al., 2010).

2.11.2 .2 Inferior Phrenic Nodal Pathways

Tumors involving the esophagogastric junction or the gastric cardia may invade the diaphragm as they penetrate beyond its wall. The lymphatic drainage of the peritoneal surface of the diaphragm is via the nodes along the inferior phrenic artery and veins that course along the left crus of the diaphragm toward the celiac axis or the left renal vein (Meyers MA et al., 2010).

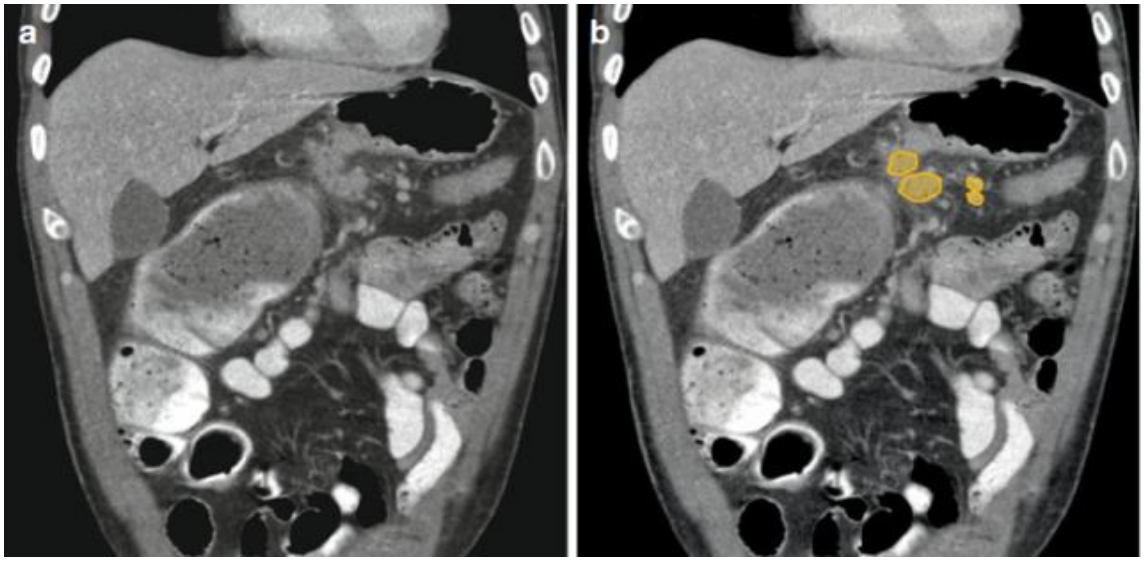

figure 2.22 (a , b) Coronal reformatted CT image in a patient with stomach cancer shows prominent gastrocolic ligament lymph nodes (*orange*)

A CT scan of the abdomen and pelvis is the most widely recommended method for preoperative staging of gastric cancer (Coburn NG 2009).The accuracy of MRI is considered to be inferior to CT for examining LN involvement, but may be more accurate than CT for non-nodal metastatic disease (Dicken BJ et al., 2005) .Further diagnostic imaging via 18 F- fluorodeoxy- D-glucose (FDG) PET is not a replacement for CT in gastric cancer cases, but can complement CT for staging and prognostic information (Coburn NG 2009).

2.12.3 Small Intestine

The three most common malignant tumors of the small intestine are lymphoma, adenocarcinoma, and carcinoid tumor. The path of regional nodal metastasis follows the vessels of the involved segment to the root of the superior mesenteric artery (SMA) (see figure 2.23) near the head of the pancreas and to the extra peritoneum (Meyers MA et al., 2010).

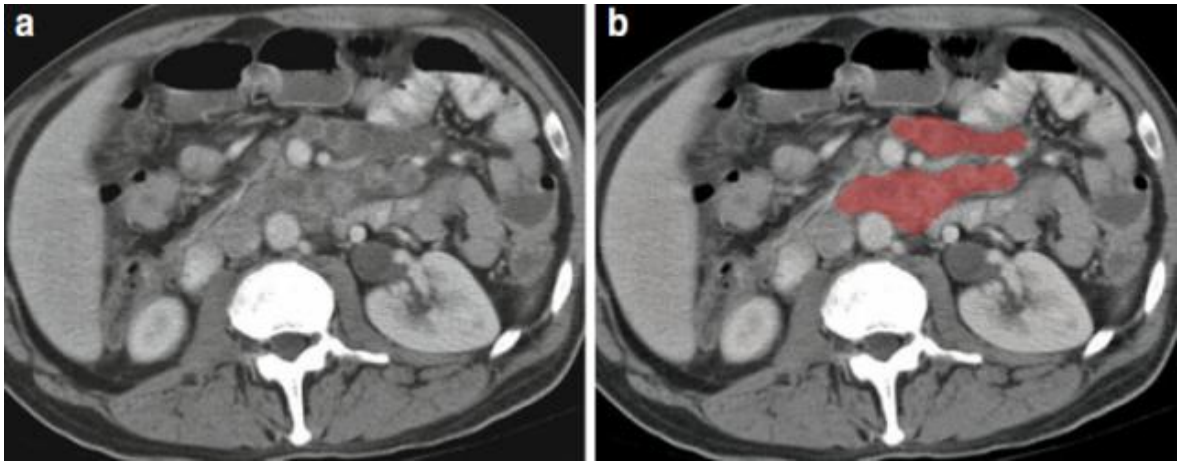

figure 2.23 *:(**a , b) Axial CT image in a patient with lymphoma shows enlarged, clustered mesenteric root lymph nodes*** (*red*)

2.12.4 Appendix

Similar to the small intestine, carcinoid tumor, noncarcinoid epithelial tumor, and lymphoma are the three most common tumors of the appendix. Lymph node metastasis is rare in the tumors of the appendix. Generally, nodal metastasis follows the ileocolic vessels along the root of the mesentery to the origin of the SMA and the paraaortic region (Meyers MA et al., 2010).

2.12.5 Colorectal

Colorectal adenocarcinoma is the third most common cancer and the third most common cause of cancer deaths (Morón FE et al., 2007). Lymph node metastasis is one of the most important prognostic factors in the TNM classification defining the number of positive nodes in stepwise incremental groups that correlates with poorer outcome (see figure 2.24) (Meyers MA et al., 2010). Accurate identification of abnormal lymph nodes is important as it aids in preoperative planning of the extent of surgery. Patients with T1–T2 rectal tumors can be treated with resection alone. If there are nodal metastases (or if the tumor is T3), neoadjuvant treatment is required. It also helps in identifying regions of

possible recurrence in treated cases, in the clinical setting of increasing carcinoembryonic antigen levels (Taylor FGM et al.,2008) .

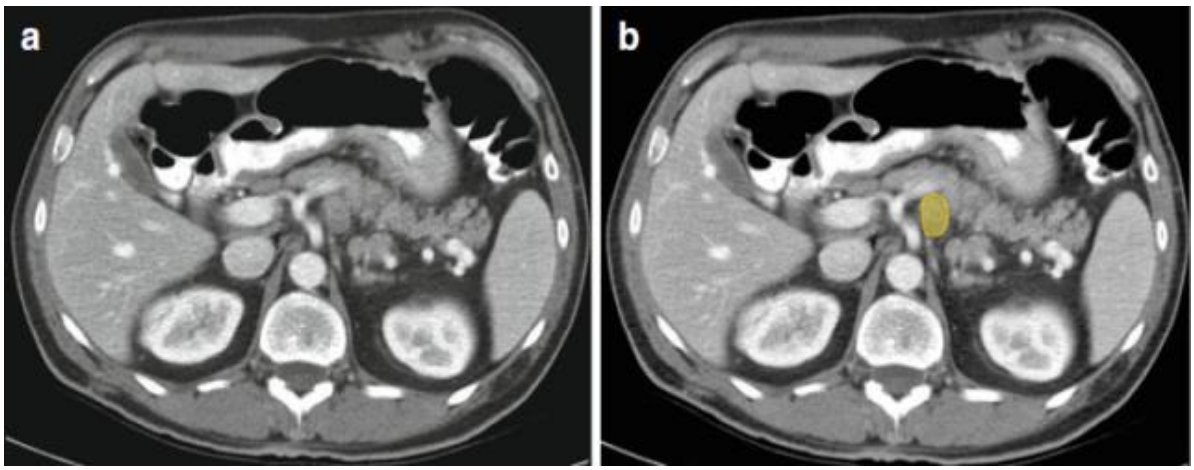

figure 2.24 *:(**a , b) Axial CT image in a patient with primary colon cancer shows an enlarged celiac lymph node*** (*yellow*)

Table 2.4 lists regional lymph nodes for colorectal cancer. Lymph from the wall of the large intestine and rectum drains into the lymph nodes accompanying the arteries and veins of the corresponding colon and rectum (Granfield CA et al.,1992). The nodes can be classified according to the location as follows (see figure 2.25).

Table 2.4 :Regional lymph nodes for colorectal cancer (Morón FE et al., 2007).

Pericolic/perirectal
Ileocolic
Right colic
Middle colic
Left colic
Inferior mesenteric artery
Superior rectal (hemorrhoidal)

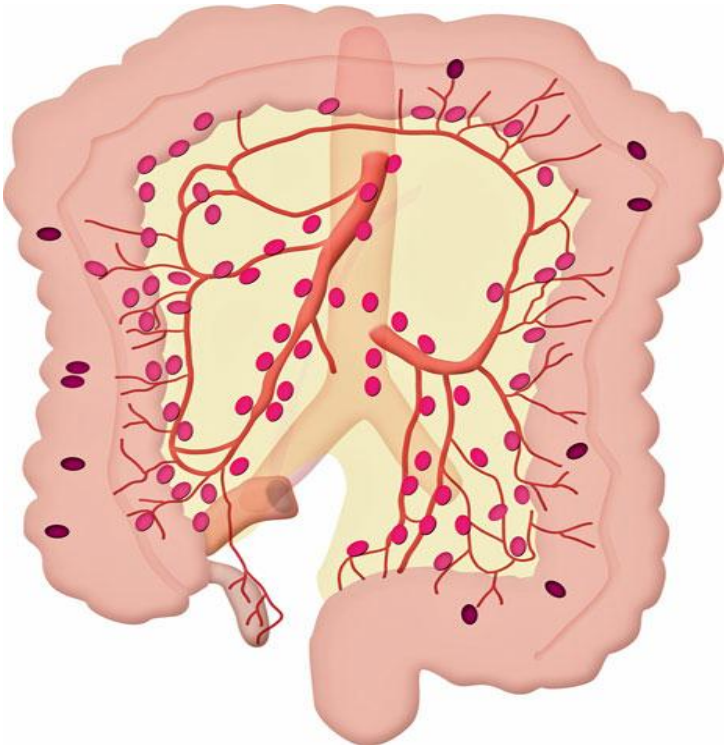

figure 2.25*:*Lymphatic drainage pathways for the colon

• The epicolic nodes accompanying the vasa recta outside the wall.

• The paracolic nodes along the marginal vessels.

• The intermediate mesocolic nodes along the ileocolic, right colic, middle colic, left ascending and descending colic, left colic, and sigmoidal arteries.

• The principal nodes at the gastrocolic trunk, the origin of the middle colic artery, and the origin of the inferior mesenteric artery.

2.12.6 Caecum and ascending colon

The lymphatic drainage is via the epicolic nodesand the paracolic nodes, which are seen in proximity with the marginal vessels along the mesocolic side of the colon. From the paracolic nodes , lymphatic drainage follows the vessels in the ileocolic and right colic mesentery, where the intermediate nodal group is located and drains into the principal nodes at the root of the SMA.

2.12.7 Transverse colon

The lymphatic drainage is from the epicolic nodes and the paracolic nodes (along the marginal vessels) to the intermediate nodal group situated along the middle colic vessels and then into the principal node at the root of the SMA.

2.12.8 Left side of colon and upper rectum

The lymphatic drainage is from the epicolic and the paracolic (along the marginal vessels) group to the intermediate mesocolic nodes including the left colic nodes, and then to the principal inferior mesenteric artery (IMA) nodes.

2.12.9 Lower rectum

There are two different lymphatic pathways: one is along the superior hemorrhoidal vessels toward the mesorectum and mesocolon; the other is the lateral route, along the middle and inferior hemorrhoidal vessels toward the hypogastric and obturator nodes, and then to the paraaortic nodes size, whereas tumor deposits are smaller.

2.13 Retroperitoneal Lymph Nodes

2.13 .1 Renal, Upper Urothelial, and Adrenal Malignancies

Lymphatics draining the kidney are derived from three plexuses: one beneath the renal capsule, the second around the renal tubules, and the third in the perirenal fat. These plexuses drain into lymphatic trunks that run from the renal hilum along the renal vein to the paraaortic nodes, which then drain into the cisterna chyli and predominantly the left supraclavicular nodes via the thoracic duct. The lymphatic drainage for the proximal ureters is to the paraaortic nodes in the region of the renal vessels and gonadal artery. The middle ureteral lymphatics drain to the common iliac nodes and the lower ureteral lymphatics to the external and internal iliac nodes. All the iliac nodes drain to the paraaortic nodes, cisterna chyli, and predominantly the left supraclavicular nodes via the

thoracic duct. The adrenal lymphatics drain to the paraaortic nodes (Meyers MA et al., 2010).

2.14 Lymphatic Spread of Malignancies

2.14.1 Renal Tumor

Renal tumors account for 3 % of all cancer cases and deaths (American Cancer Society. 2011) ; the majority of these are renal cell carcinomas. Lymph node status is a strong prognostic indicator in patients with kidney cancer (Karakiewicz PI et al., 2006) with 5-year disease-specific survival for patients with node-positive disease reported between 21 % and 38 % (Capitanio U et al., 2009).

Lymphatic spread of renal cell carcinomas (RCC) is initially to regional lymph nodes. These include nodes along the renal arteries from the renal hilum to the paraaortic nodes at this level (see figure 2.26). Ten to fifteen percent of patients have regional nodal involvement without distant spread. Lymphatic spread may continue above or below the level of the renal hilum, with subsequent spread to the cisterna chyli and to the left supraclavicular nodes via the thoracic duct. Occasionally, there is spread from these nodes to the mediastinum and pulmonary hilar nodes (Meyers MA et al., 2010).

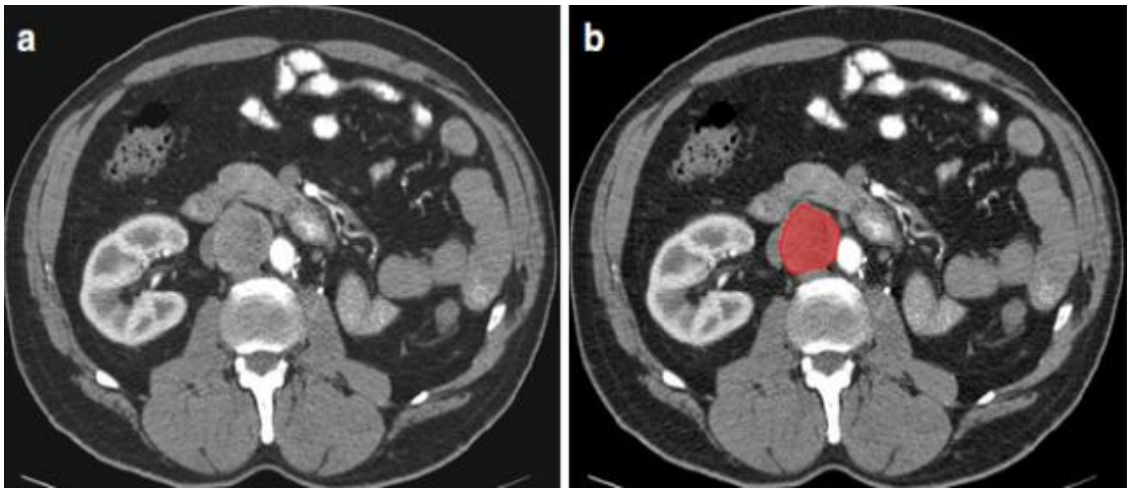

figure 2.26 :(a , b) Axial CT image in a patient with left nephrectomy for renal cell cancer shows enlarged aortocaval (*red*) ***lymph node with biopsy-proven recurrent RCC.***

Diagnosis of pathologic lymph nodes is problematic, as approximately 50 % of enlarged regional nodes are hyperplastic (Israel GM et al., 2003) Criteria currently used for suspect nodes are those 1 cm or more in short axis and loss of oval shape and fatty hilus. Clustering of three or more nodes in the regional area is also suggestive of metastatic spread.

2.14.2 Adrenal Tumors

Primary malignant tumors of the adrenal gland arise from the cortex as adrenocortical carcinomas or from the medulla as pheochromocytomas or in the spectrum of the neuroblastoma ganglioneuroma complex. Most of these tumors spread by lymphatic spread to the para-aortic lymph nodes (Meyers MA et al., 2010).

2.14.3 Pancreatic Cancer

Pancreatic cancer is the second most common gastrointestinal malignancy and is the fifth leading cause of cancer-related death. The majority of cases are ductal adenocarcinomas (exocrine ductal epithelium, 95 % of cases). Up to two thirds may be located in the head of the pancreas. Lymph node metastases are common in pancreatic and duodenal cancer and they carry a poor prognosis (Takahashi T et al., 1997).

2.15 Criteria for Diagnosing Abnormal Lymph Nodes

2.15.1 Size

Multiple studies have been performed to decide the cut-off size for distinguishing normal from abnormal nodes. Due to varied results, there is lack of consensus for the size criteria. In addition, the size criteria vary for different tumors. Generally, nodes larger than 10 mm in short-axis diameter are considered enlarged for the iliac nodes and 15 mm for inguinal nodes.

2.15.2 Shape and Margin

Ovoid lymph nodes with a fatty central hilum favor a benign etiology. Nodes with a higher short-axis to long-axis ratio (i.e. , rounded nodes) are more likely to be malignant (Granfield CA et al.,1992).It has also been shown that nodes with an irregular margin are more likely to be metastatic (Gest TPP1994) .

2.15.3 Internal Architecture

the presence of central low density on computed tomography (CT), suggestive of necrosis is also seen in metastases. Mucinous primary tumors can be associated with subtle calcification within metastatic lymph nodes.

2.16 Imaging-based Criteria for Identifying Nodal Metastases

2.16.1 Lymph Node Size

The ability to distinguish between malignant and benign change in lymph nodes by using morphologic imaging techniques is reliant on nodal size criteria. The criterion that is generally accepted is a maximum short-axis diameter of more than 10 mm (Roy C, et al., 1997). However, size-based nodal assessment has several limitations. Findings of lymph node involvement in malignancy are often inaccurate because a substantial proportion of nodes that harbor metastases from abdomen cancers are not enlarged to a size considered to exclude normalcy. Furthermore, the size of a node does not allow differentiation between nodal metastasis and nodal hyperplasia. The sensitivity of CT imaging for the detection of nodal metastases on the basis of node size ranges from 24% to 78%. The results of many studies have shown that the use of a node size smaller than 10 mm as the criterion for identifying nodal metastases from abdominal malignancies resulted in a reduction in the false-negative rate; however, this benefit was offset by diminished specificity (Stomper PC, et al., 1987).

Another limitation of using node size to identify metastatic disease is the variability of the size criterion according to the location of the node and the primary tumor. On the basis of their experience with MR imaging, (Grubnic S, et al., 2002).

advocated that lymph nodes with a maximum short-axis diameter of more than 5 mm in the retroperitoneum and 6 mm in the pelvis be considered abnormal. (Vinnicombe,et al.,1995) proposed that the upper limit of the maximum short-axis diameter for normal lymph nodes in patients with pelvic tumors be 9 mm for the common iliac region, 10 mm for the external iliac region, and 7 mm for the internal iliac region. (Koh DM , et al., 2006).

2.16.2 Shape and Contour of Nodes.

Most benign nodes are ovoid, whereas malignant nodes tend to have a rounded shape. However, the use of combined criteria of size and shape did not improve the accuracy of radiologic assessment of urogenital pelvic cancers beyond that achieved with size as the single criterion (Bellin MF, et al., 2003). Another useful sign of nodal involvement might be an irregular node border, which occurs in some cases because of extracapsular extension of metastatic disease (figure 2.27). However, this sign is rarely observed in small nodal metastases.

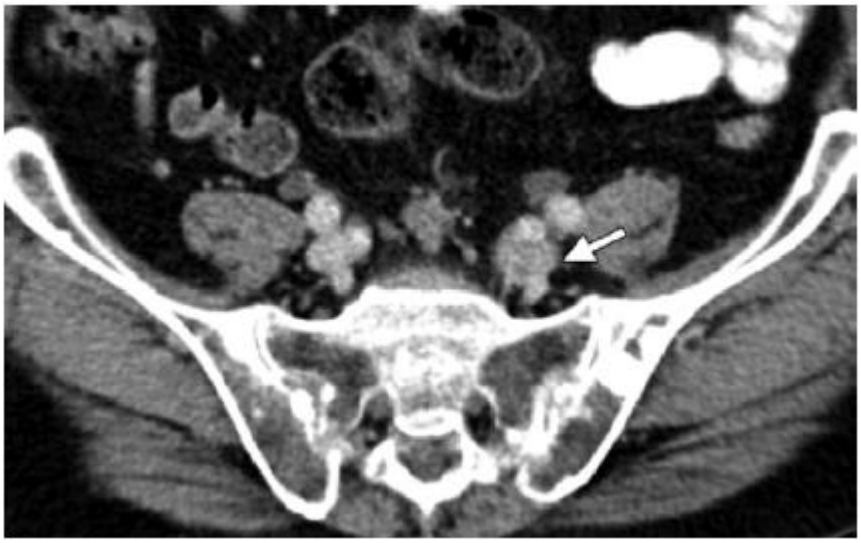

figure 2.27*:*Axial contrast-enhanced CT image shows an enlarged inguinal node (arrow) with a maximum short-axis diameter of 14 mm. The node has irregular borders and demonstrates inhomogeneous enhancement, characteristics that are strongly suggestive of metastasis. (Blanca Pano et al., 2011)

2.16.3 Nodal Location

The location of a node should be considered to determine whether it lies along a specific lymphatic drainage pathway. Nodes that are located along the pathway of lymphatic drainage from a primary tumor and that are borderline in size or recently increased in size have a higher probability of metastatic infiltration and should be evaluated more carefully than other nodes.(Blanca Pano et al., 2011).

2.16.4 Number of Nodes

The presence of a group of normal-appearing nodes may be suggestive of malignancy, as was found in a study of non- Hodgkin lymphoma. However, the specificity of this sign is low, particularly in the pelvis, where nodal asymmetry is common and may lead to false-positive findings (Koh DM et al., 2006).

2.16.5 Internal Nodal Architecture.

Internal architectural features such as calcifications and accumulations of fat or fluid, which are well depicted with anatomic imaging techniques of MDCT, may be helpful for identifying nodal metastases. The CT number (HU) of an involved node may resemble that of a primary malignancy; this finding is suggestive of nodal involvement.(Blanca Pano et al., 2011).

Nodal calcifications may be observed in the presence of metastases from different organs in the abdomen e.g. bladder cancer (TCC). However, calcifications also may be seen in nodes affected by benign inflammatory disease such as tuberculosis or by posttherapeutic changes such as occur after treatment for seminoma (figure 2.28). It is important to remember that nodal calcifications are not a reliable sign of either malignancy or benignity.(Blanca Pano et al., 2011).

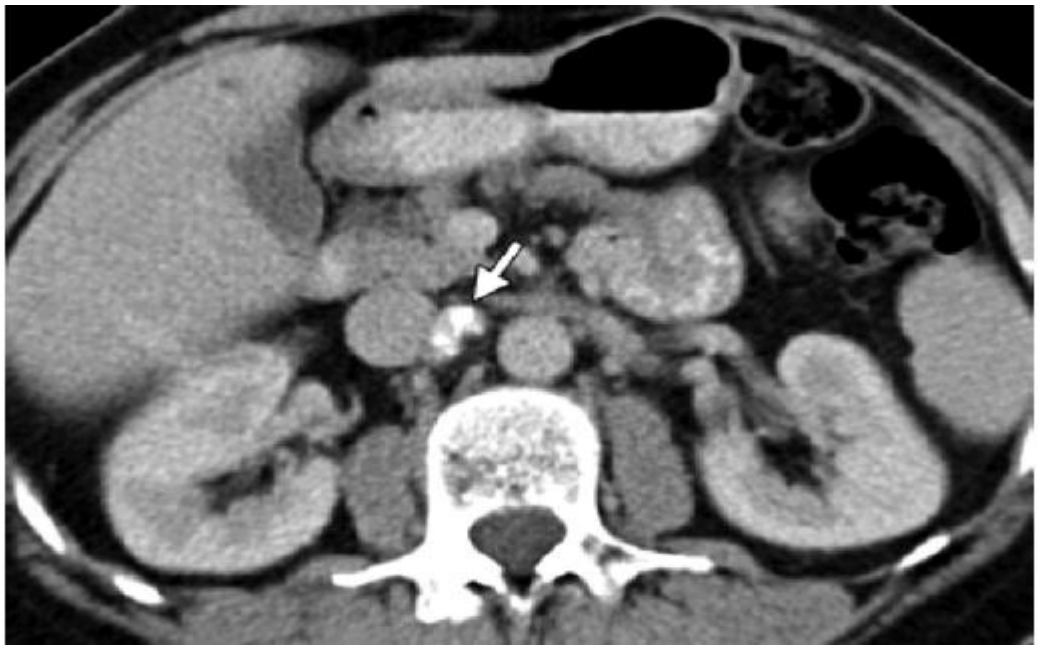

figure 2.28*:*Axial contrast-enhanced CT image obtained in a patient who had undergone treatment for a seminomatous tumor of the right testis shows an enlarged, calcified aortocaval node (arrow) with a diameter of 15 mm in its greatest dimension, Nodal calcification in this case is nonspecific*.*(Blanca Pano et al., 2011).

Some metastatic nodes, have an internal cystic appearance due to central areas of necrosis that have low attenuation at CT. Large metastatic nodes also frequently appear heterogeneous, with a low-density component (perhaps due to necrosis) at their centers. However, the appearance of a central area of lower density within a lymph node is not pathognomonic of malignant infiltration and may be observed also in the presence of tuberculosis and various fungal infections (Huppert BJ et al., 2003) (figure 2.29).

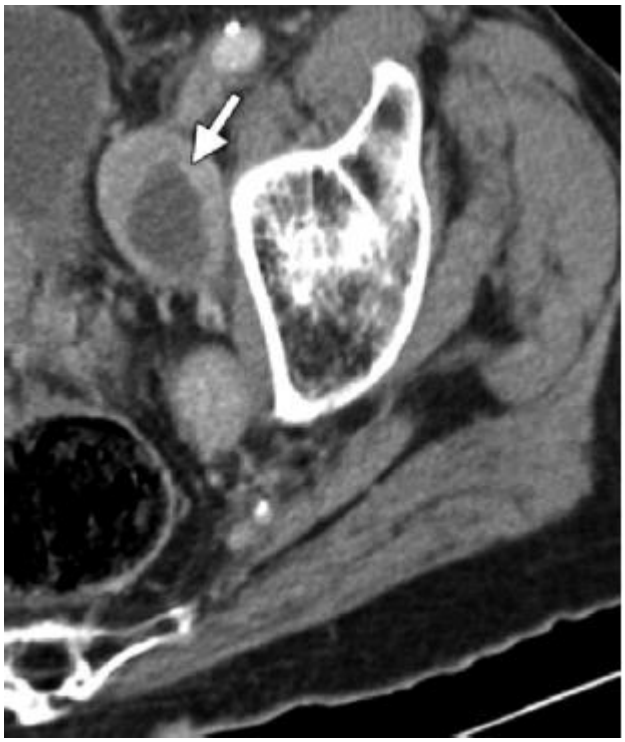

figure2.29*:*Magnified axial contrast-enhanced CT image shows an enlarged external iliac node (arrow) with a central region of low attenuation, an appearance produced in this case by tuberculosis and not pathognomonic of malignant infiltration. (Huppert BJ et al., 2003)

Lymph nodes frequently enhance after the administration of a contrast agent. Homogeneous enhancement of a node may result from both benign and malignant conditions. However, inhomogeneous enhancement of an enlarged node should arouse the suspicion that malig-nant infiltration may be present (Husband JE et al., 2002).

Metastatic nodes may demonstrate contrast enhancement similar to that of the primary tumor, a finding that represents malignant infiltration with the same grade and aggressiveness. (Noworolski SM et al.,2003)

recently reported that it is possible to discriminate between benign change and malignancy on the basis of semiquantitative or quantitative analysis of the rate of nodal contrast enhancement at both CT imaging. However, the use of this approach is still confined to the research setting. Accumulated fat within a node is more likely to represent benign change than malignancy.

2.16.6 Other Indicators.

Various characteristics of a primary tumor, such as its anatomic location, stage, grade, histologic makeup, and biologic behavior, affect both the frequency of occurrence and the individual characteristics of nodal metastases.

2.17 Imaging Evaluation of abdominal LNs by MDCT

Anatomic imaging techniques are the techniques most widely used for the staging of nodal disease in patients with abdomen and pelvic malignancies. Multidetectors CT imaging enable direct visualization of lymph nodes, allowing evaluation of those that are related to the primary tumor. The most common sign of nodal involvement in malignancy is the enlargement of lymph nodes. However, normal-sized or minimally enlarged lymph nodes also may represent metastases, and other signs, such as the shape or location of nodes, should be considered. The combined use of these morphologic criteria could help improve the detection of nodal metastases at multidetectors CT imaging.(Blanca Pano et al., 2011).

Multidetectors CT is the modality most often used for the initial staging of urogenital malignancies because of its high spatial resolution and capability for acquisition of a large image dataset within a brief time. Multiplanar reconstruction of the near-isotropic multidetectors CT image datasets provides three-dimensional views of nodal shape and allows accurate nodal measurement and accurate calculation of the ratio of the

longitudinal nodal diameter to the transverse diameter. Moreover, the high spatial resolution provided by multidetectors CT is beneficial for illustrating the relations between lymph nodes and vessels. MR imaging provides excellent soft-tissue contrast and is therefore helpful for the staging of tumors in sites such as the bladder and prostate, where the regional lymph nodes are those within the pelvis.(Blanca Pano et al., 2011).

2.18 Previous studies:

With the advent of multi-detector computed tomography, routine assessment of abdominal lymph nodes is now possible. For the first time, normal abdominal lymph nodes may be reliably identified non invasively. Because of the increasing volume of cross-sectional imaging examinations being performed, lymph nodes in the abdomen are being detected with increasing size frequency. This is often an unsuspected finding. Although the detected lymph nodes may be normal, there is a large number of disease processes that may lead to abdominal lymph nodes enlargement. The most common causes of abdominal lymph nodes enlargement. are neoplastic, inflammatory, and infectious processes. Many of these causes may also result in lymph nodes enlargement. elsewhere in the body. It is important to recognize abdominal lymph nodes enlargement. in patients with a history of a primary carcinoma because the enlarged lymph nodes affects the staging of the disease, which in turn will affect further management. In addition, abdominal lymph nodes enlargement. may be the only indicator of an underlying inflammatory or infectious process causing abdominal pain. The distribution of the lymph nodes may indicate the exact nature of the underlying disease process, and the correct treatment may then be instituted. Besides neoplastic, inflammatory, and infectious processes,

many other disease processes may occasionally result in abdominal lymph nodes enlargement. (Brian C. et al., 2005).

Intensive studies in the field of abdominal lymph nodes enlargement were conducted in the world. All These studies are considered similar to the current study, but they are partial in assessment of enlarged lymph nodes in the abdomen, because they are based on the study of one organ in the abdominal, While the current study involve all organs of the abdomen, and these similar studies have reached conclusions can be summarized as follows.

Evaluation of lymph nodes with RECIST this study assumed that Lymph nodes are common sites of metastatic disease in many solid tumors. Unlike most metastases, lymph nodes are normal anatomic structures and as such, normal lymph nodes will have a measurable size. Additionally, the imaging literature recommends that lymph nodes be measured in the short axis, since the short axis measurement is a more reproducible measurement and predictive of malignancy. Therefore, the RECIST committee recommends that lymph nodes be measured in their short axis and proposes measurement values and rules for categorizing lymph nodes as normal or pathologic; either target or non-target lesions. Data for the RECIST warehouse are presented to demonstrate the potential change in response assessment following these rules. These standardized lymph node guidelines are designed to be easy to implement, focus target lesion measurements on lesions that are likely to be metastatic and prevent false progressions due to minimal change in size.. (L.H. Schwartz. et al., 2008).

Mesenteric Lymph Nodes Seen at Imaging: Causes and Significance ,this study assumed that With use of multidetectors CT, lymph nodes are frequently identified in the mesentery. These may be a normal finding. Mesenteric lymphadenopathy has a myriad of causes. These most commonly include tumor, inflammation, and infection, but there is a wide differential diagnosis. The appearance, distribution, and enhancement pattern of the lymph nodes may give an indication of the underlying pathologic condition. (Brian C. et al., 2005).

Inflammation and Tumor Microenvironment in Lymph Node Metastasis, this study assumed that In nearly all human cancers, the presence of lymph node (LN) metastasis increases clinical staging and portends worse prognosis (compared to patients without LN metastasis). Herein, principally reviewing experimental and clinical data related to malignant melanoma, we discuss diverse factors that are mechanistically involved in LN metastasis. We highlight recent data that link tumor microenvironment, including inflammation (at the cellular and cytokine levels) and tumor-induced lymphangiogenesis, with nodal metastasis. Many of the newly identified genes that appear to influence LN metastasis facilitate general motility, chemotactic, or invasive properties that also increase the ability of cancer cells to disseminate and survive at distant organ sites. These new biomarkers will help predict clinical outcome and point to novel future therapies in metastatic melanoma as well as other cancers. (Xuesong Wu et al., 2011).

Mesenteric Lymph Nodes: Detection and Significance on MDCT, this study assumed that the 120 patients with otherwise normal CT scans, 47 had mesenteric lymph nodes greater than 3 mm. Of these 47 patients, 22 (47%) had five or more lymph nodes detected. Twenty-five (53%) of the 47 patients had four or fewer nodes. The mean size of the largest nodes was 4.8 mm (range, 3–9 mm), and the mean size of the

nodes found per patient was 3.6 mm (range, 3–6 mm). These nodes were identified only at the mesenteric root in 32 patients (68%), only in the mesenteric periphery in eight patients (17%), and only in the right lower quadrant in five patients (11%). Nodes were identified in more than one location in two patients (4%) , so that Incidental finding of mesenteric lymph nodes is common, reflecting more widespread use of thin-collimation MDCT and PACS workstations. In general, these nodes are small, measuring less than 5 mm. Such nodes when found in an otherwise healthy population are clinically insignificant and require no further imaging(Brian C. et al., 2004).

Pericolic Mesenteric Lymph Nodes: An Aid in Distinguishing Diverticulitis from Cancer of the Colon, this study assumed that Lymph nodes were seen in 22 (71 %) of 3 1 cases of colonic cancer and in four (15%) of 27 cases of diverticulitis. The lymph nodes were 0.5-2.5 cm in short-axis diameter. We saw no difference in node size for patients with colonic cancer versus patients with diverticulitis. The nodes were most commonly located along the blood vessels in the mesenteric fat. Statistical analysis showed a significant difference ($p < .001$) in the frequency but not in the size of nodes between the two groups of patients. The detection of nodes resulted in a diagnostic sensitivity and specificity for colonic cancer of 71% and 85%, respectively. Pericolic lymph nodes are seen much more frequently in patients with colonic cancer than in patients with diverticulitis. The detection of Pericolic lymph nodes in patients suspected of having diverticulitis should raise the suspicion of underlying colonic cancer that should, in turn, prompt additional evaluation. (Chintapalli. et al., 1997).

Tuberculosis Versus Lymphomas in the Abdominal Lymph Nodes, this study assumed Disseminated and non-disseminated tuberculosis involved predominantly lesser omental, mesenteric, anterior

pararenal, and upper paraaortic lymph nodes. Lower paraaortic lymph nodes were involved more often in Hodgkin's disease (15 patients [94%]), non-Hodgkin's lymphoma (24 patients [89%]), and disseminated tuberculosis (five patients [100%]) than in non-disseminated tuberculosis (one patient [5%]). Mesenteric lymph nodes were involved more often in disseminated tuberculosis (four patients [80%]) and non-disseminated tuberculosis (I I patients [52%]) than in Hodgkin's disease (one patient [6%]) ($p < .01$). Anatomic distribution was not different between disseminated tuberculosis and non- Hodgkin's lymphoma. Tuberculous lymphadenopathy commonly showed peripheral enhancement, frequently with a multilocular appearance, whereas lymphomatous adenopathy characteristically showed homogeneous attenuation (14 patients [87.5%] with Hodgkin's disease and 19 patients [70%] with non-Hodgkin's lymphoma [$p < .01$]). And Our findings indicate that the anatomic distribution and specific enhancement patterns of lymphadenopathy seen on contrast-enhanced CT can be useful in differentiating between tuberculosis and untreated lymphomas of the abdominal lymph nodes.(Yang. et al., 1999).

CHAPTER THREE

3. Materials and methods:

3.1 Materials:

3.1.1 Population of the study:

The study population was composed a group of 150 different patients , Their ages from 30 up to 106 years with different gender presenting to the Asser central Hospital in Abha - KSA , they complaining from different abdominal lesions during the period from August 2013 to August 2015.

3.1.2 Study sample:

The sample size consisted of 150 patients.

3.1.3 Inclusion criteria

patient (30 -106) years

3.1.4 Ethical considerations:

Special consideration was given to the right of the confidentiality and anonymity for all participants. Anonymity was achieved by using number for each participant to provide link between the collected information and the participants. Justice and human dignity was considered by teaching the selected participant equally when offering them an opportunity to participate in the research. Permission for conducting the study was obtained from head of the radiology department at Aseer central hospital.

3.1.5 Data analysis:

Data were presented as mean ± SD in a form of comparison tables. Statistical analysis was performed using the standard Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 16 .ANOVA and person correlation, Independent t-test were used . p-value was calculated for each individual data. Correlation is significant at the $p<0.00$

3.2 Methods:

3.2.1 Scanning protocol:

Patient preparation: All patients had a low-residue diet, ample fluids, laxative on the day prior to the examination, and they fasted for 4-6 hours before the examination. Patients were given water as a neutral oral contrast agent so that the degree and pattern of the bowel enhancement can be well analyzed. On arrival at the medical imaging department in Asser Central Hospital (ACH) . Firstly Patients drunk 600 ml of a mixture of diluted sodium amido-trizoate and meglumine amido-trizoate (Gastrografin 15mL) ,370 mg I/mL diluted with water ,Then 10 minutes later Patients drunk 600 ml of a mixture of diluted (Gastrografin 15mL) ,370 mg I/mL diluted with water, except in case of bowel ischemia we give patient only water . 2hrs later patients entering the scanning room.

3.2.2 Image acquisition and parameters:

All patients were scanned using a 64-MDCT scanner (Philips Medical systems (Cleveland), INC. brilliance 64 computed tomography x-ray Model Number 728231y). The examinations were performed in supine position. The abdomen was routinely imaged from the diaphragm to the symphysis pubis during a single breath-hold.

The scan parameters were as follows : One mm collimation, 64x0.75mm detector configuration, 600 millisecond gantry rotation ,

8mm/s table feed accounting for a pitch of 0.8, 120kVp, 180 effective mAs and 6 seconds total scan time.

3.2.3 Steps of MDCT:

Intra venous contrast enhancement was used in all patients. Two-phase CT or three phases according to the clinical diagnosis (arterial , delayed phase and triple phase) was performed . A 18-gauge cannula was inserted into an arm vein and a 1.5ml/Kg of iodinated contrast material (Omnipaque 350mg) was injected at a rate of 3-4 mL/sec using an automated power injector. The delay between the start of the IV contrast injection and the start of the scanning was 35-40 seconds to achieve the arterial phase, and 5-10 minutes for the delayed phase .In triple phase we introduce 200 Ml normal saline mixture with 15ml of Gastrografin 370 mg I/mL rectally

3.2.4 Image analysis:

The thin slices were sent to the workstation (Carestream Health ,Inc., 2008.OS, Win XP7, PACS sys Cs version 110- ach. Med -im) which is diagnostic viewing and processing workstation , where 3D volume-rendering (3DVR), multiplanar reformatted (MPR), maximum-intensity-projection (MIP) and MDCT angiography displays. All the abdominal abnormalities included pattern of intestinal wall enhancement, length of the loop involvement, degree of wall thickening, types of thickness , site of the affection , lymph nodes involvement and abdominal inflammatory process were reported.

The criteria to evaluate the abnormal abdominal lesions on contrast-enhanced MDCT were as follow:

• Classification of lesion according to the site of the abdomen (the 9 region of the abdomen).

• Classification of lesion according to the type , such as inflammatory , Benign tumors and malignancy

• Full CT scan reports of diagnosis (CDs and medical reports)

3.2.5 Data collection:

The data was collected by master data sheets using the variables of age, height, gender, weight, BMI . The name of affected part, include : site, size of the lesion , CT-number of the affected part (mean) and diagnosis .The lymph node, include: the name ,affected or not ,enlargement (short axis measurement),CT-number (mean) , effective on the other organ (metastasis) or not.

CHAPTER FOUR

4. Results:

Table 4.1: Mean , median And Standard Deviation (SD) Minimum And Maximum Values Of The Age, weight, BMI and dimension For The study Group.

	Age	WEIGHT	BMI	Dimension short axis
Mean	52.0467	66.3867	23.2519	14.0758
Median	49.5000	65.0000	22.4100	13.5500
Std. Deviation	18.25558	8.93360	2.97314	4.08924
Minimum	28.00	53.00	18.38	6.00
Maximum	106.00	100.00	35.80	28.00

Table 4.2 :frequency and percentage age group.

Age	Frequency	Percent (%)
<30	12	8.0
31-40	38	25.3
41-50	31	20.7
51-60	21	14.0
61-70	21	14.0
70+	27	18.0
Total	150	100 %

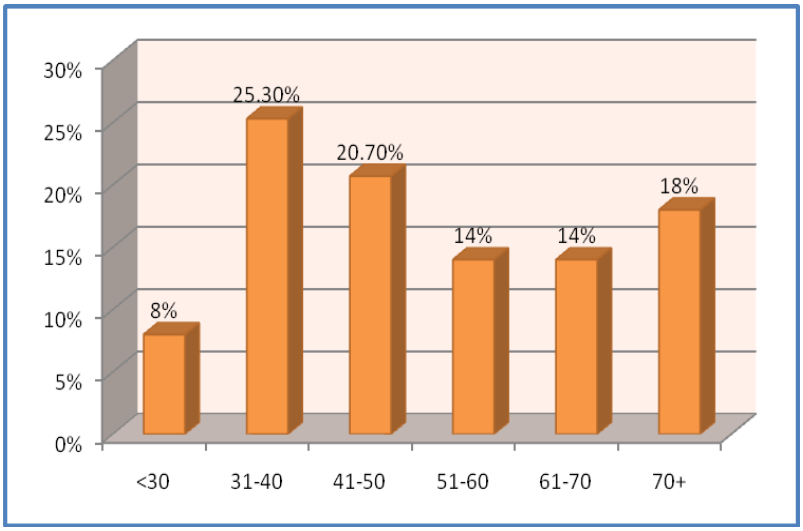

Figure 4.1 frequency and percentage age group.

Table 4.3 : frequency and percentage of the gender .

Gender	Frequency	Percent (%)
Male	78	52.0
Female	72	48.0
Total	150	100 %

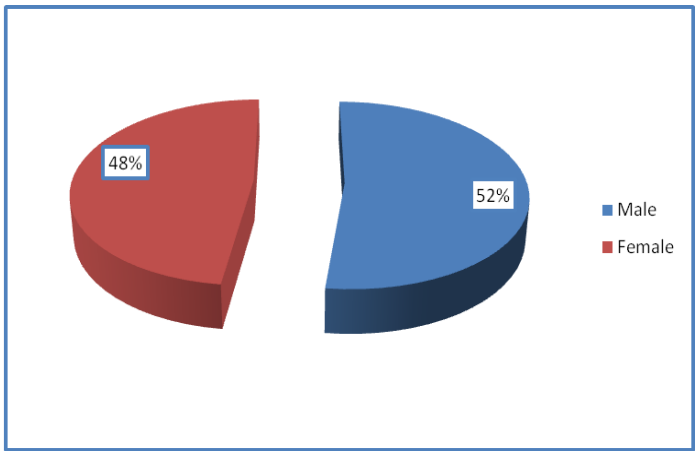

Figure 4.2: frequency and percentage of the gender.

Table 4.4 Distribution of lymph nodes according to the abdominal regions (1,2,3,..9).

Regions	Frequency	Percent (%)
1	14	9.3
1,2,3,4&	1	.7
1,2&3	19	12.7
1,2&4	1	.7
1,2&5	1	.7
1&2	7	4.7
1&4	1	.7
2	13	8.7
2&3	8	5.3
2&4	1	.7
2&5	6	4.0
3	4	2.7
3&6	1	.7
4	6	4.0
4&6	1	.7
4&7	1	.7
5	3	2.0
5&6	1	.7
7	30	20.0
7&8	2	1.3
7&9	1	.7
8	24	16.0
8&9	1	.7
9	3	2.0
Total	150	100 %

Table 4.5 : frequency and percentage of the gender of affected and non-affected abdominal lymph node .

AFFECTED / NOT	Frequency	Percent (%)
Yes	132	88.0
No	18	12.0
Total	150	100.0

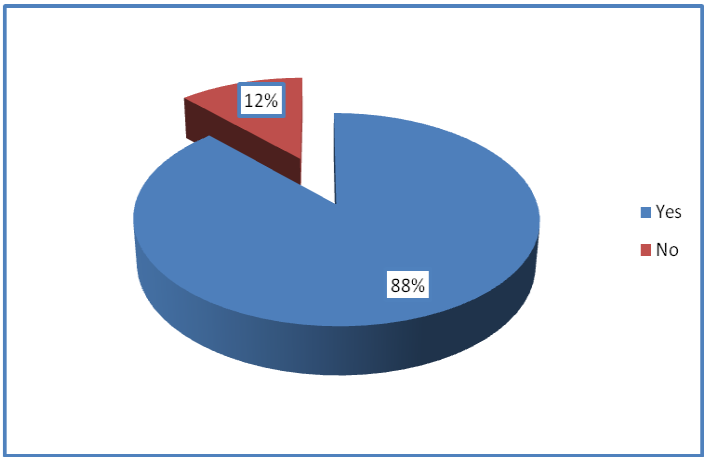

Figure 4.3: frequency and percentage of the gender of affected and non-affected abdominal lymph node.

Table 4.6 : frequency and percentage of the enlarged and non-enlarged abdominal lymph node .

ENLARGEMENT	Frequency	Percent (%)
Yes	132	88.0
No	18	12.0
Total	150	100.0

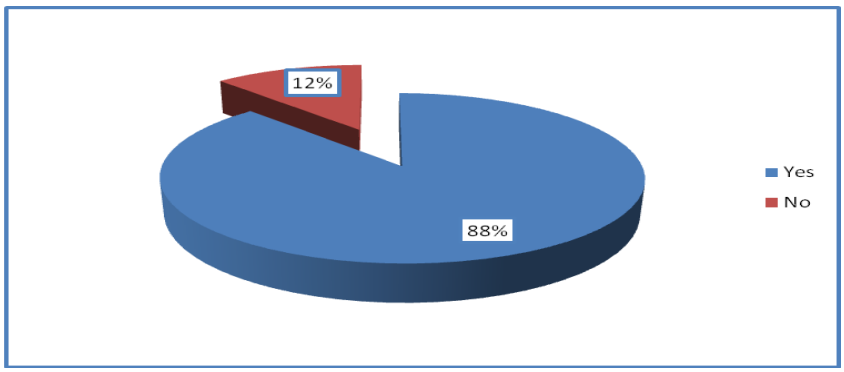

Figure 4.4: frequency and percentage of the enlarged and non-enlarged abdominal lymph node .

Table 4.7 : The lymph node size, frequency and percentages

lymph node size	Frequency	Percentages (%)
<6mm	36	24.0
6-10 mm	22	14.7
10.1-15 mm	52	34.7
15.1-20 mm	32	21.3
20.1-25 mm	6	4.0
>25 mm	2	1.3
Total	150	100%

Table 4.8 : Computerized tomography final diagnoses frequency and percentages

Diagnosis/CT findings	Frequency	Percentages (%)
Adrenal Mass	2	1.3
Ampular Mass	1	0.7
Appendicitis	20	13.3
Ca Stomach	5	3.3
Common bile duct Mass	2	1.3
Cholangiocarcinomsa	4	2.7
Cholecystitis	9	6.0
Colitis	19	12.7
Crohn's Disease	5	3.3
Diverticulitis	4	2.7
Gastritis	4	2.6
Gall bladder Carcinoma	2	1.3
Hepato cellular carcinoma	26	17.4
Hepatitis	1	0.7
Lymphoma	1	0.7
Ovarian Carcinoma	2	1.3
Pancreatic Tumor	8	5.3
Pancreatitis	9	6.0
Pelvic Mass	1	0.7
Prostatic Cancer	4	2.7
Pyelonephritis	3	2.0
Renal cell carcinoma	2	1.3
Splenomegaly	1	0.7
Transitional cell carcinoma /Ureter	2	1.3
Colon Tumor	13	8.7
Total	150	100.0

Table 4.9 : Lymph nodes Location, frequency and percentages

Lymph nodes Location	Frequency	Percentages (%)
Common iliac	1	0.7
Gastro duodenal ligament LNs	1	0.7
Inguinal	5	3.3
Internal iliac	2	1.4
Mesenteric	62	41.3
Para aortic	43	28.7
Paracaval	1	0.7
Periaortic	1	0.7
Pericolic	4	2.7
Periportal	1	0.7
Perirectal	1	0.7
Porta hepatis	9	6.0
Spleen	1	0.7
Not detected	18	12.0
Total	150	100.0

Table 4.10 : Frequency of Distribution of lymph nodes Sites in different Abdominal Regions

	Abdominal Region (Site)	Frequency
SITE* (1-9)	**1**	14
	1,2,3,4,5	1
	1,2,3	19
	1,2,4	1
	1,2,5	1
	1,2	7
	1,4	1
	2	13
	2,3	8
	2,4	1
	2,5	6
	3	4
	3,6	1
	4	6
	4,6	1
	4,7	1
	5	3
	5,6	1
	7	30
	7,8	2
	7,9	1
	8	24
	8,9	1
	9	3
Total		150

***Site stands for abdominal Regions**

1:RUQ,2:epigastric,3:LUQ,4:RT hypoconderium,5:umbilical,6LT hypoconderium,7:RT Iliac,8:hypogastric,9:LT Iliac region.

Table 4.11 : Cross tabulation between the Distribution of lymph nodes Locations in different Abdominal Regions and CT findings

CT Findings/Diagnosis and Lymph Node Location Cross tabulation																
CT Findings/Diagnosis	**Lymph Node Location***															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Adrenal Mass	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2
Ampular Mass	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Appendicitis	0	0	0	2	0	4	5	8	0	0	1	0	0	0	0	20
Ca Stomach	0	0	0	1	0	2	0	2	0	0	0	0	0	0	0	5
CBD Mass	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
Cholangocarcinomsa	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	4
Cholecystitis	0	0	0	0	0	2	3	1	1	0	0	0	0	2	0	9
Colitis	0	0	0	0	0	13	1	3	0	0	2	0	0	0	0	19
Crohn's Disease	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	5
Diverticulitis	0	0	0	0	0	2	1	0	0	0	1	0	0	0	0	4
Gastritis	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4
GB Carcinoma	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2
Hcc	0	0	0	0	0	9	4	8	0	0	0	1	0	3	1	26
Hepatitis	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Lymphoma	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Ovarian Carcinoma	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2
Pancreatic Tumor	0	0	0	0	0	4	0	4	0	0	0	0	0	0	0	8
Pancreatitis	0	0	0	0	0	2	1	6	0	0	0	0	0	0	0	9
Pelvic Mass	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Prostatic Cancer	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	4
Pyelonephritis	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	3
Rcc	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Splenomegaly	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Tcc/ureter	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Colon Tumor	0	0	0	0	1	8	0	2	0	1	0	0	1	0	0	13
Total	1	1	1	5	1	62	18	43	1	1	4	1	1	9	1	150
	P-value= 0.000 Correlation is significant at p≤0.05															

***Lymph Node Locations:-**

1:Common iliac, 2:Gastroduodenal ligament LNs, 3:Iliac 4: Inguinal, 5:Internal iliac, 6:Mesenteric ,7:None, 8:Para aortic, 9:Paracaval 10:Periaortic,11: Pericolic ,12:Periportal,13: Perirectal ,14:Porta hepatis ,15:Spleen

Table 4.12 : Descriptive Statistics With ANOVA Test Shows Different Abdominal lesions And CT Findings(Mean Values ± Std. Deviation, Minimum and Maximum Values Measured In mm)

Diagnosis (CT outcome)	Number of Patients	Lymph Nodes Measurements			
	N	Mean/mm	Std. Deviation	Minimum	Maximum
Hcc	22	50.53	7.96	40.90	64.00
Pancreatic Tumor	8	14.67	3.69	8.50	18.30
Pancreatitis	9	16.90	4.61	10.00	23.40
Appendicitis	15	12.30	2.79	7.60	19.00
Colitis	17	25.70	5.35	19.10	31.90
Pyelonephritis	3	37.70	0.35	37.70	37.70
Rcc	2	14.00	5.09	10.40	17.60
TCC/Ureter	2	10.30	1.97	8.90	11.70
GB Carcinoma	1	6.00	0.10	6.00	6.00
Cholecystitis	6	11.65	3.30	8.40	16.40
Crohn's Disease	5	12.74	1.43	10.80	14.20
Ovarian Carcinoma	2	10.65	1.90	9.30	12.00
Pelvic Mass	1	14.60	0.01	14.60	14.60
Cholangiocarcinoms a	4	16.70	5.17	12.60	24.00
Splenomegaly	1	10.50	0.00	10.50	10.50
Colon Tumor	11	30.76	6.39	24.40	44.00
Ca Stomach	5	14.64	3.74	10.80	20.00
Diverticulitis	2	10.90	3.53	8.40	13.40
Prostatic Cancer	3	16.10	9.13	8.00	26.00
CBD Mass	2	16.05	1.34	15.10	17.00
Adrenal Mass	2	17.85	5.86	13.70	22.00
Gastritis	4	29.65	6.85	24.80	34.50
Hepatitis	1	-	-	-	-
Lymphoma	1	14.00	0.25	14.00	14.00
Ampular Mass	1	8.00	0.02	8.00	8.00
Total	132	14.07	4.08	6.00	28.00
	18 cases were of undetected/measured lymph nodes				
P-value = 0.176 Correlation is significant at p≤0.05					

CHAPTER FIVE

5.1 Discussion

A total of 150 MDCT scans were reviewed. Lymph nodes < 6 mm in the short axis diameter were identified in 36 patients (24%). Those patients, had lymph nodes identified at different regions of the abdomen and detected at more than one site with different CT outcomes.

Given that radiologists and technologists now see these nodes so frequently, we must first explain the reason that we see them and then discuss whether these nodes are normal or abnormal. The most obvious reason that we see these nodes in clinical practice is the use of MDCT scanners. The thin collimation possible with MDCT allows improved spatial resolution for detecting and discriminating between small objects. Therefore, the small lymph nodes and other structures within the abdomen and pelvis will be seen. But our study did not consider lymph size <6mm.Faster scanning times and bolus administration of IV contrast allowing easier detection of lymph nodes.

Most reports defining the size criteria for normal lymph nodes were written before MDCT (Kiyono et al., 1988).More recent reports using MDCT have described the presence of lymph nodes within the mesentery seen with inflammatory and malignant processes The size of these nodes has been reported to range from 5 to 20 mm.(Rao PM et al., 1997).

This study the lymph nodes were measured in short axis in mm it was found that it has range from ≤6mm to ≥25mm(table4-4).the importance of detection lymph nodes , is to ensure that these nodes are not the earliest manifestation of lymphoma or metastatic disease from an occult primary neoplasm or other clinical findings.

Recent report (Lucey BC et al., 1997). has shown that mesenteric lymph nodes with a mean maximum short-axis dimension of 4.6 mm may be seen in the normal mesentery at CT. it is important not to misdiagnose these nodes as the early manifestation of a lympho-proliferative disorder. Enlarged lymph nodes in the mesentery, however, may have many causes, including tumors and inflammations. In addition, it is important to remember that the size of the nodes alone does not always reflect disease,(Lucey et al., 2005).Tumors involving lymph nodes as small as 5 mm in the short-axis diameter have been detected on MDCT in patients with proven malignancy. This is alarming, given that many studies defining the size criteria for normal abdominal lymph nodes have suggested that normal nodes may be as large as 9 mm in the upper and 11 mm in the lower paraaortic regions (Dorfman RE et al., 1991).

The imaging literature recommends that lymph nodes should be measured in the short axis, since the short axis measurement is a more reproducible measurement and predictive of malignancy. (Orringer MB et al., 1985). Another cause of considering the lymph node short axis size is that Lymph nodes in the preoperative setting for many tumors based upon size measurements. However, there has been relatively little uniformity in the manner in which the lymph nodes were measured in many of these studies. It has been shown that short axis measurement of lymph nodes was the most reliable parameter of nodal size, because it is less dependent on the spatial orientation of the lymph node relative to the CT scan (Schwartza et al., 2009) . These justify our selection of short axis as measured dimensions used in our study. Our study used the short axis measurements, and found the maximum frequency of measured values were found in 52 (34.7%) out of150 patient with the size 10.1-15 mm.

Pathologic analysis of enlarged lymph nodes is performed to assess the outcome of patients. Colitis lymph node is one that measures (25.7mm), Gastritis (29.65mm) Colon tumor (30.76mm), Pyelonephritis (37.7mm) and HCC (50.53mm) these were presented in (table 4-8),
Common iliac, Gastro duodenal ligament LNs , Paracaval, Periaortic, Periportal ,Perirectal, were less frequent locations of enlarged lymph nodes where the Mesenteric Para aortic region were more affected with enlarged nodes, this was presented in (table 4-9).

The presence and location of lymph nodes have a significant influence on management of a patient as well as a patient's prognosis therefore the location of lymph nodes were also be evaluated .It was found that the RT Iliac, and hypo gastric region are the most affected locations (table4-10) .

The first part of our study dealt with the questions: how are the sizes of lymph nodes distributed, which lymph nodes are affected, do the size distributions between node positive and -negative cases differ, and what are the roles of small lymph nodes (<6mm) and large lymph nodes? The second part investigated a hypothesized association between lymph node size and outcome.

The size criteria are mainly used for determining the probability of malignancy within a lymph node, Most of the lymph nodes detected were found in the groups between 10.1mm to 15 mm and 15.1mm to 20 mm. The size distribution differs only slightly between node-positive and -negative cases. Only the proportion of lymph nodes of maximum short axis 64mm is significantly larger in cases of cancer (HCC) and colon tumor 44mm. (table4-12). (Cserni et al., 2002) as well as (Mo¨ et al., 1999) found significant larger mean lymph node diameters in node-positive colorectal cancer. In our study, lymph nodes of all sizes were detected ranged from<6mm up to25mm This stands with the data of

(Cserni et al., 2002) who mentioned The likelihood of detecting a metastasis clearly increases with increasing lymph node size.

Radiological lymph node staging is mainly based on the detection of large lymph nodes and this finding is of clinical importance. Our data suggest that the lymph node size is of analytical significance. The fact that the examined lymph nodes are associated with positive results in cancer and inflammatory cases (table4-12) might be due an enhanced immunological response with enlargement of lymph nodes, as this part of our study is limited by a rather small study size.

Lymph Node Sites were: Common iliac, Gastroduodenal ligament LNs, Iliac, Inguinal, Internal iliac, Mesenteric, Para aortic, Paracaval Periaortic, Pericolic , Periportal, Perirectal , Porta hepatis ,and Spleen with the highest distribution in mesenteric and para aortic (table4-9 and 4-11) represent the correlation between the site/location of LNs and CT outcomes. Unlike most other sites of lymph nodes presence occur normally in the body and will have a normal size, our study showed that 18 out of 150 of the cases have nodal size of 6mm or less.

To characterize the size of lymph nodes, Schnyder and Gamsu studied healthy patients from Switzerland and found that normal nodes detected in the pretracheal, retrocaval space showed a mean longest diameter of 5.5 ± 2.8 mm (Schnyder et al., 1981). and the normal lymph nodes were less than 11 mm. our results were in line with these findings.

According to a land mark paper, (Glazer GM et al., 1985). suggested using 1 cm as the upper limits of normal for lymph nodes in the short axis. Values above this should be considered enlarged and potentially malignant (Glazer GM et al., 1985).Since an accurate, reproducible measurement of lymph nodes is critical in assessing response to therapy, we have granted the short axis measurement of

lymph nodes as it was applied in previous studies (Eisenhauer et al., 2009).

The comparison between multiple studies is difficult because of the different size criteria utilized, for abnormal nodes the different type of measurements performed, and most importantly different patient populations(Schwartza et al., 2009). As our population is Asian it may differs accordingly and can justify our findings.

It was mentioned and recognized that not all lymph nodes have the same size throughout the body (Dorfman et al., 2009). For instance, axillary and inguinal lymph nodes may be larger than hilar or retroperitoneal lymph nodes and still be non-malignant. Even within the abdomen, normal lymph node size will vary. For instance, a normal size short axis lymph node measurement for the retrocaval space is 6mm and 8mm in the porta-caval and gastro-hepatic space, and 11mm for the lower para-aortic region.

This study showed that the size of six or less are found in patients with different outcomes either inflammatory or malignancies at different stages and at different abdominal site/quadrants. Our results showed that size stratification situated upon different abdominal region with higher frequencies were found at the right iliac and hypogastric areas as seen in (table4-10) and would be difficult to serially follow and potentially provide discordant findings. However the enlarged lymph nodes location was significantly correlated with the final CT outcome as seen in the cross tabulated results mentioned in (table 4-11)

Colonic carcinoma is one of the most common causes of enlarged lymph nodes in the pericolic region and the visualization of lymph nodes in this region in patients with colonic carcinoma strongly suggests nodal metastasis (Schwartza et al., 2009). However, the criteria used in calling lymph nodes abnormal or suggestive of metastasis

vary (Freeny PC et al., 1986). used a size of I.5 cm or a cluster of three nodes of smaller diameter as criteria for abnormality .The latter study showed increased sensitivity for nodal disease using a node size of I cm as abnormal. In contrast, although large abdominal lymph nodes have been reported in nonmalignant conditions (Li DKB et al., 1981).

CT studies found abdominal lymphadenopathy due to benign causes as well as Crohn's disease enlarged lymph nodes was also be seen. In two recent studies,(Rao et al., 1997). reported the presence of lymph nodes in cases of diverticulitis, colitis, appendicitis .Similar results were found in our study as 62 of the cases have enlargement of the mesenteric lymph nodes diagnosed to have appendicitis, colitis, HCC, colon cancer and 48 of the sample have enlarged lymph nodes at the para aortic (table 4-11).

statistically There is significant relationship at $p<0.05$ between the location of lymph nodes and the outcome in patients with different inflammatory and cancer cases.

Although the detection of positive lymph node has an impact on the patient's prognosis and, therefore is most important because it changes the treatment.(Bruno et al.,2012). Therefore, we investigated the size and location of the largest lymph node in each node-positive case.

One study have mentioned that lymph nodes to be considered pathologically enlarged and measurable, must be at least 15mm in short axis when assessed by CT scan (CT scan slice thickness recommended to be not greater than 5 mm). Lymph nodes that are at least 10mm but less than 15mm in short axis may be pathologic and can be considered non-measurable/non-target lesions (that are not measured). At baseline and in follow-up, only the short axis will be measured and followed. They

recognize that micro metastases may still be present in small nodes, and large nodes may only contain inflammation (Schwartza et al., 2009).

This study analysis shows that most of the largest lymph nodes affected are 65mm in diameter. Therefore, they should be easy to detect during pathological analysis. Our study showed that 18 positive cases have nodes less than 6mm. Patients with CT findings of inflammation visualization of mesenteric lymph nodes should raise the suspicion of an underlying malignancy and initiate further investigation.

5.2 Conclusion:

This study performed in Saudi Arabia at Asser Central Hospital-KSA ; is considered as an attempt for assessment of abdominal lymph nodes enlargement by using multidetectors computed tomography (MDCT) for patients aged between 30 to 75 years old. For all the cases studied in the Aseer central hospital, the lymph node enlargement values obtained are found to be within the standard reference for lymph nodes size .The data obtained may add to the available information in international records for general use. The guidance on where efforts on Regular detection need to be discover the dangerous diseases in the early stages even easier for treatment and avoid it is difficulty to treat and directed to fulfill the requirements of the optimization process and serve as a reference for future researches in lymphadenopathy of ages more than 30 years old**.**

In summary, the purpose of the measured lymph node was to address the value of the short axis measurement of lymph nodes .The goal of the criteria was to create an ordinary that is biologically meaningful thus far simple to use and systematize in both oncology and radiology practices. Finally, by adopting these methods of characterizations for lymph nodes, their use in response assessment is better aligned with clinical radiology practice.

5.3 Recommendation:

☞MDCT with 3D imaging is an important diagnostic tool for suspected malignant lesions, benign tumor or inflammatory processes which affect any abdominal organ. It is also important in the detection of the affected lymph nodes and extension into nearby organs and distant metastases.

☞MDCT imaging for abdomen has an excellent sensitivity and specificity for detection of abdominal lymph nodes enlargement.

☞MDCT provides certain suggestive signs that may be helpful in distinguishing the underlying aetiological cause of abdominal lymph nodes enlargement.

☞By granted the short axis measurement for lymph nodes using MDCT, their use in response assessment will be better associated with clinical radiology practice.

☞The findings of this study indicate that specific anatomical distribution and enhancement patterns of lymph node enlargement shown on contrast-enhanced MDCT can be useful in differentiating between tumor and inflammatory process.

☞statistically there is No significant relation between the lymph nodes enlargement and CT findings.

☞A high index of suspicion and a recognition of the MDCT imaging findings can lead to an early diagnosis and reduction in the long-term morbidity and mortality.

☞This study needs further studies with bigger sample size that may explain more precise assessment of affected abdominal lymph nodes the measurement of LNs Size is better to be done with high resolution MDCT (64 and 128 rows) because it gives accurate measurements.

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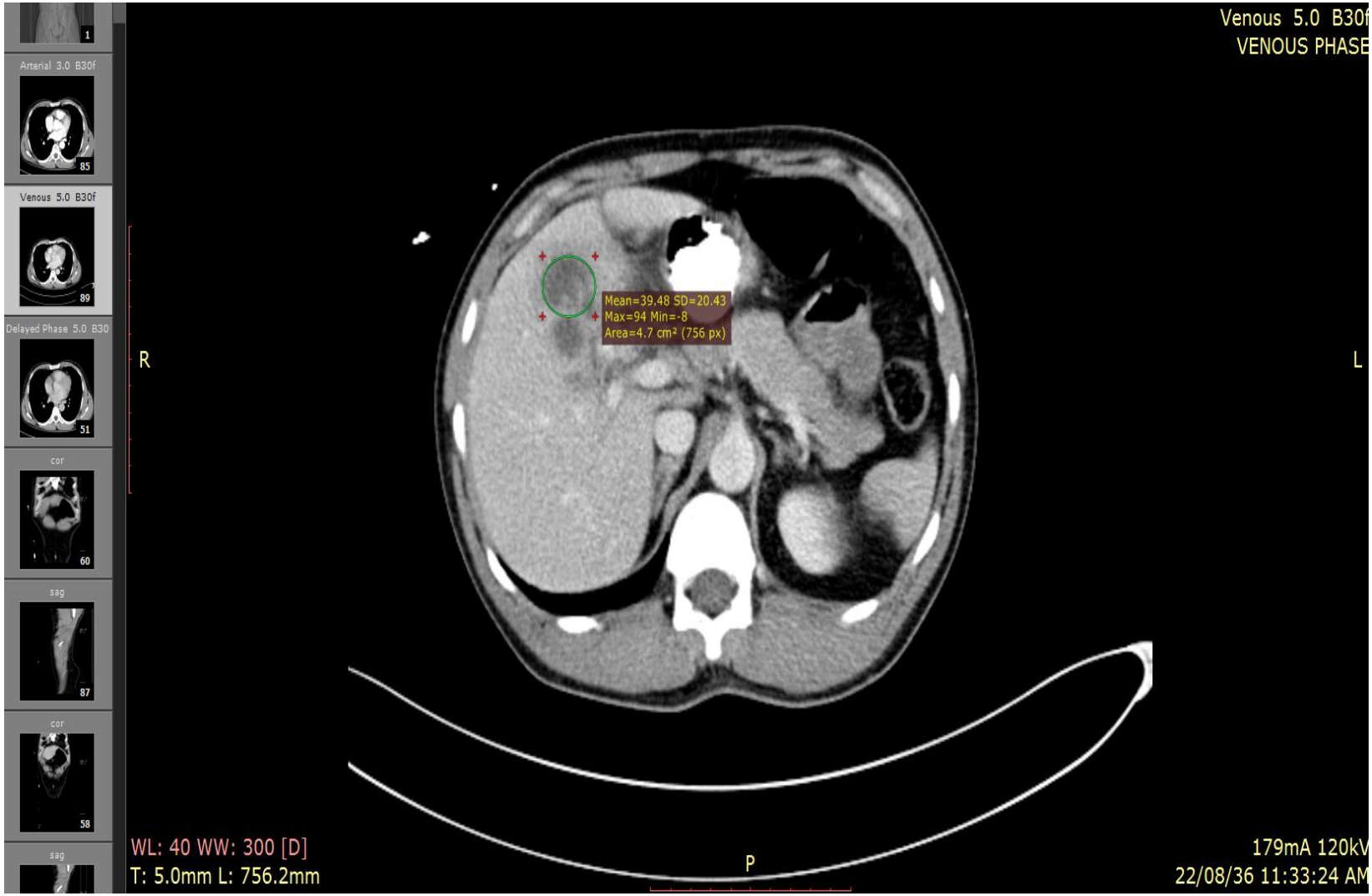
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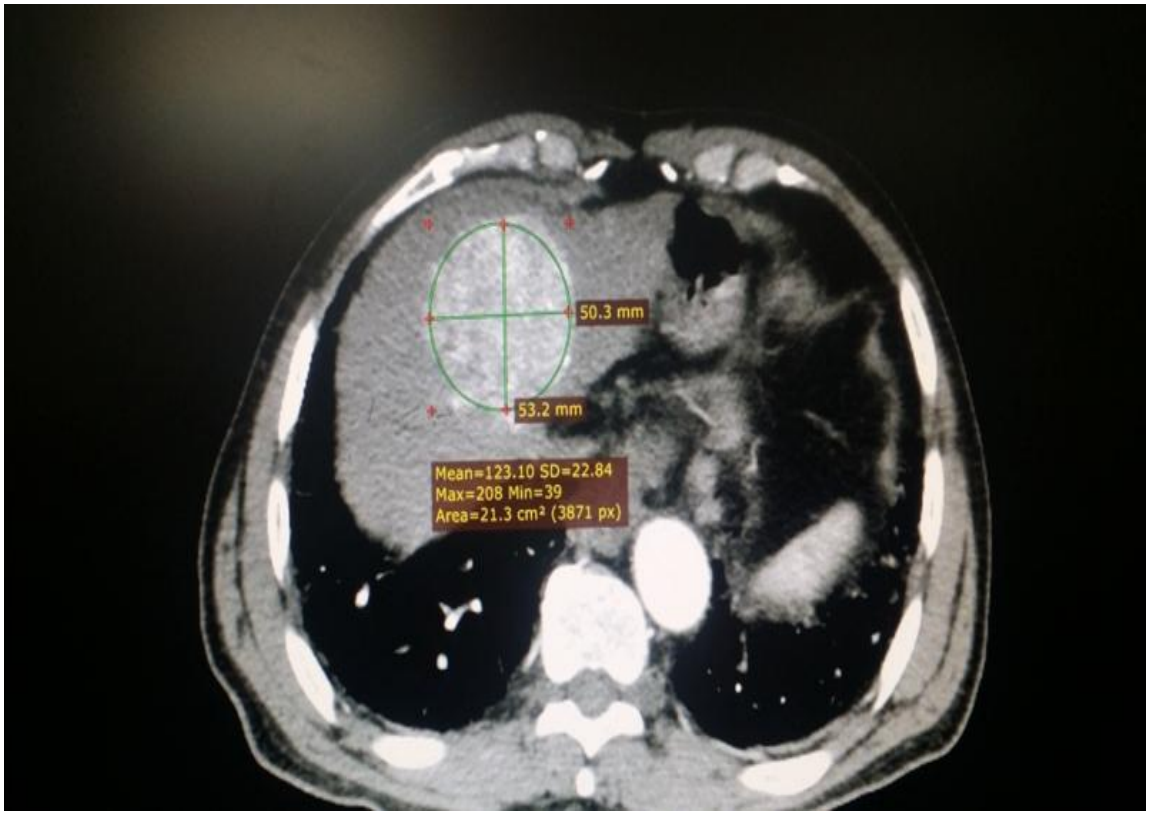
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Max=208 Min=39
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ACCEPTANCE OF MANUSCRIPT

21 ST JANUARY 2016

Dr. Mohammed Idriss Amer,
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Saudi Arabia.

Dr. Caroline Edward Ayad,
College of Medical Radiological Science,
Sudan University of Science and Technology,
Khartoum,
Sudan.

RE: GARJMMS-16-002

Dear Dr. Caroline Edward Ayad,

After a careful and thorough perusal of your manuscript, I am pleased to inform you that reviewers have recommended your manuscript "**Abdominal Lymph Nodes: Detection and Significances on Computerized Tomography**" and it has been accepted for publication in the Global Advanced Research Journal of Medicine and Medical Science (GARJMMS) ISSN: 2315-5159. It is an excellent paper and we have made only few minor corrections. It will be published in the January 2016 issue of the journal.

Thanks for publishing with us.

Best Regards,

Cooper Okubor

Editorial officer,
Global Advanced Research Journal of Medicine and Medical Science (GARJMMS) ISSN: 2315 5159.
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