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Full Length Research Paper

Abdominal Lymph Nodes: Detection and Significances on Computerized Tomography

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With the introduction of multidetector computed tomography (MDCT), evaluation of lymph nodes is now possible. The objectives of our study dealt with firstly: how are the sizes of lymph nodes distributed, which lymph nodes are affected, do the size distributions between cases differ. Secondly investigated a hypothesized association between lymph node size and outcome. 150 CT scans were reviewed for patients in whom the MDCT scan revealed abdominal abnormality. Patients with a documented history of cancer or any illness known to cause lymphadenopathy were included. 78(52%) were males and 72(48%) were females ranging in age from ≤30to ≥70 years, with a mean age of 52.05±18.26years. In accordance with our departmental protocol for imaging the abdominal cases, the patients were administered the oral and intravenous contrast material. The lymph node size was evaluated and measured in the short-axis diameter in (mm). We recorded the lymph nodes locations distribution as well as sites (the abdominal quadrant from 1-9) and correlated with the nodal size. The study showed that the most common causes of abdomen lymphadenopathy are neoplastic, inflammatory, and infectious processes. The size of the enlarged lymph nodes ranged between ≥6mm and ≥25mmwith no significant relation was detected with the CT outcomes. Lymph node sites were: common iliac, gastro duodenal ligament lymph nodes, 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 regions. The distribution of the lymph nodes indicates the exact nature of the underlying disease process and CT outcomes significantly at p<0.000. By granted the short axis measurement for lymph nodes using MDCT, their use in response assessment will be better associated with clinical radiology practice

Keyword: lymph nodes, computerized tomography, lymph node metastasis; inflammation

INTRODUCTION

With the introduction of computerized tomography, the prospect to represent the lymph nodes routinely using a noninvasive imaging technique is now possible. As imaging techniques improved, it was possible to visualize not only enlarged lymph nodes but also normal nodes, which began a debate over defining the size criteria for

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normal lymph nodes. Many published studies described the normal size of detectable mediastinal lymph nodes (Kiyono et al., 1988; Glazer et al., 1985; Quint et al., 1986). Others reported the normal sizes of lymph nodes found in the upper abdomen and retroperitoneum (Magnusson , 1983; Dorfman et al., 1991; Callen et al., 1977; Lee et al., 1978) using computerized tomography. Few has been published describing the size criteria of normal mesenteric lymph nodes. 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 mesentery as well as common iliac, inguinal, para aortic, paracaval, periaortic, pericolic, periportal, perirecta, porta hepatis that were clearly identifiable. To our knowledge, no data were defining the size of lymph nodes measured by MDCT and comparing the enlarged lymph with the associated CT diagnosis. In clinical practice, the radiologist must decide if these nodes, which often measure only a few millimeters in diameter, are of any clinical significance. In addition, it is important to remember that the size of the nodes alone does not always reflect disease, and the number and distribution of lymph nodes is also important (Brian, 2005). We decided to determine the frequency with which lymph nodes are identified on MDCT, at the intraabdominal disease in a group of patients with known malignancy, infection and inflammatory conditions.

The raised questions of our study dealt with: 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 and large lymph nodes. The second part investigated a hypothesized association between lymph node size and outcome.

MATERIALS AND METHODS

We reviewed the CT scans of 150 consecutive patients who presented to our CT department over a 12 month period in whom an MDCT scan revealed abdominal abnormality. Approval was obtained from our department. Patients with a documented history of cancer or any illness known to cause lymphadenopathy were included. As a result, MDCT scans of normal patients were excluded. 150 patients were our study population: 78(52%) were men and 72(48%) were women ranging in age from ≤30to ≥70 years, with a mean age of 52.05±18.26years.

All CT examinations were performed using Philips Medical Systems (Cleveland), Inc. Brilliance 64 Computed Tomography X-Ray Model Number 728231 and Siemens Medical Solutions, Computed Tomography Siemens str. 1, D-91301 Forchheim, Germany, Head quarters: Berlin And Munich Siemens Ag, Wittels basher Platz 2, D-80333 Munich, Germany.

In accordance with our departmental protocol for imaging the abdominal cases, the patients were administered the oral and intravenous contrast material. One radiologist reviewed all CT scans. The size was evaluated and measured in the short-axis diameter. We recorded the size of the lymph nodes and noted their location as being one of nine sites (the abdominal quadrant from 1-9). In cases in which lymph nodes were detected in more than one location, their presence was documented in all detectable locations. This division of locations was subjectively selected, If multiple nodes were detected at one location, the mean short-axis measurement of the lymph nodes was also obtained and recorded. All measurements were recorded in a computer database.

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.

RESULTS

Table 1. 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 2. 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 3. Lymph nodes Location, frequency and percentages

Lymph nodes Location	Frequency	Percentages (%)
Common iliac	1	0.7
Gastro duodenal ligament Lymph Nodes	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. 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 quadrants** 1:RUQ,2:epigastric,3:LUQ,4:RT hypoconderium,5:umbilical,6LT hypoconderium,7:RT Iliac,8:hypogastric,9:LT Iliac region.

Table 5. 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
Common bile duct Mass	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
Cholangiocarcinomsa	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
Gall bladder Carcinoma	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2
Hepatocelluler Carcinoma (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
Renal Cell Carcinoma (Rcc)	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Transitional cell carcinoma /Ureter	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 6. Descriptive Statistics With ANOVA Test Shows The Distribution Of Lymph Nodes Measured In Short Axis In Different Abdominal Regions 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
Hepatocelluer Carcinoma	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
Renal cell carcinoma	2	14.00	5.09	10.40	17.60
Transitional Cell Carcinoma/Ureter	2	10.30	1.97	8.90	11.70
Gall Bladder 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
Cholangiocarcinomsa	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
Common bile duct 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

DISCUSSION

A total of 150 MDCT scans were reviewed. Lymph nodes less than 6 mm in the short axis diameter were identified in 36 patients (24%). Those patients, had lymph nodes identified at different quadrant of the abdomen and detected at more than one site with different CT outcomes. We explain that the obvious reason that we are able to characterize 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 were seen. But our study did not consider lymph size less than6mm.Faster scanning times and bolus administration of IV contrast as well, allowing easier detection of lymph nodes.

Most reports defining the size criteria for normal lymph nodes were written before MDCT (Glazer et al., 1985; Kiyono et al., 1988; Quint et al., 1986). 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 et al., 1997; Seo et al., 2003; Macari et al., 2002).

In our study the lymph nodes were measured in short axis in mm it was found that it has range from ≤6mm to ≥25mm(table1).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 et al., 2005) 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). In our study 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 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, 1985; Matsuoka et al., 2007). 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 2).

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 3). 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 in our study. It was found that the RT Iliac, and hypo gastric region are the most affected locations (table 4) .

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 10.1-15 mm and 15.1-20 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. (table 6).

Cserni et al (Cserni, 2002) as well as Mo¨nig et al (Mo¨nig 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. (Cserni, 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 (table 6) 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 lymph nodes, 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 (table 3 and 5) reflect the correlation between the site/location 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 and Gamsu, 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 et al. (Glazer 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 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 (Freeny et al., 1986).

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., 1991). 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 (Dorfman et al., 1991).

Our study showed that the size of six (mm) 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 ilac and hypo gastric areas as seen in (table 4) 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 5).

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 et al., 1986; Balthazar et al., 1988; Scharling et al., 1996). Freeny et al. (Freeny 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 and Rennie CS, 1981; Deutch et al., 1987; Jones et al., 1984; Warshauer et al., 1995).

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, (Seo et al., 2003; 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 5).

We have found a statistically 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/nontarget 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).

Our 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.

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.

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