Diffuse high-attenuation within mediastinal lymph nodes on non-enhanced CT scan: Usefulness in the prediction of benignancy

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Authors: Y. Kim, S. W. Lee, M. J. Choi; Seoul/KR
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Purpose

Diffuse high attenuation in lymph nodes on non-enhanced CT has been reported to be important in differentiating between benign and malignant lymph nodes, but to our knowledge, there has been no report regarding the diagnostic accuracy of diffuse high attenuation for diagnosis of benign lymph nodes.

The purpose of our study was to evaluate the usefulness of diffuse high attenuation within mediastinal lymph nodes on non-enhanced (NE) CT in predicting benignancy.

Methods and Materials

Subjects

CT scans of 74 patients who had benign or malignant mediastinal or hilar lymph nodes were enrolled in this study. A total of 32 men and 42 women were enrolled, with a mean age of 63.3 ± 12.5 years (mean ± standard deviation (SD); age range, 40-87 years). The diagnosis of malignant or benign lymph nodes was confirmed using a histopathologic examination in patients who underwent surgical resection ($n = 5$) or clinical and CT follow-up ($n = 69$) with or without treatment.

Exclusion criteria included the following: differential diagnosis between malignancy and benignancy could not be obtained with histopathologic examination or clinical and CT follow-up; and definite calcified lymph nodes containing nodular or laminated calcification or lymph nodes showing a CT number of more than 100 HU on NE imaging.

Our Institutional Review Board approved this retrospective study and waived the need for patient informed consent.

CT Examination and Nodal Assessment

All chest CT scans were obtained both before and after contrast material injection. Two chest radiologists, who were blinded to clinical, CT, and pathologic results, evaluated the three series of CT data sets to consensus. CT images were analyzed on computer monitors using PACS. NE and CE images were loaded onto the PACS monitor simultaneously, and a chest radiologist placed circular ROIs in an area as large as possible within the same lymph nodes on three series using axial CT images obtained with the standard mediastinal window settings (window level, 30 HU; window width, 400 HU). ROIs of similar sizes were placed at the same areas in the nodes on three images (Fig. 1, 2). CT numbers were measured three times, and the mean value of three measurements was used for data analysis. The net contrast enhancement of lymph
nodes was measured: net contrast enhancement = \[\text{CT number on CE images} - \text{CT number on NE images}\].

**Data Analysis and Statistics**

The CT number of lymph nodes on NE and CE images, and net contrast enhancement were compared between malignant and benign groups. Differences in CT numbers between malignant and benign node groups were analyzed using independent \(t\)-tests. Receiver Operating Characteristic (ROC) curves were calculated to evaluate the discriminatory power of CT numbers measured on NE, and CE images for diagnosis of benign or malignant lymph nodes. All statistical analyses were performed using SPSS software (IBM SPSS Statistics ver. 19.0; IBM, Inc., Amonk, NY, USA). Continuous data are presented as the mean ± SD.

**Images for this section:**

![Fig. 1: FIGURE 1. Benign reactive lymph node hyperplasia. Right lower paratracheal lymph node shows high attenuation (76 HU) on non-enhanced imaging (A) and 98 HU on contrast-enhanced imaging (B). Net contrast-enhancement was 22 HU.](image-url)
**Fig. 2:** FIGURE 2. Metastatic lymph node in a patient with lung cancer. Right interlobar lymph node shows 41 HU on non-enhanced imaging (A) and 73 HU on contrast-enhanced imaging (B). Net contrast-enhancement was 32 HU.
Results

A total of 201 lymph nodes were sampled. The mean sample number of lymph nodes per patient was 2.5 ± 1.2 for the benign group and 3.0 ± 1.7 for the malignant group. A total of 41 patients (benign reactive lymph nodes, n = 39; sarcoidosis, n = 1; tuberculous lymphadenitis, n = 1) had 101 benign lymph nodes (Fig. 1), and 33 patients (lung cancer, n = 20; metastasis, n = 13) had 100 malignant lymph nodes (Fig. 2). Patients with metastatic lymph nodes had breast cancer (n = 13), renal cell carcinoma (n = 2), colon cancer (n = 1), thymic carcinoma (n = 1), tongue cancer (n = 1), and soft plate cancer (n = 1) as a primary cancer.

Comparison of the CT Number between Malignant and Benign Lymph Nodes

Benign lymph nodes showed significantly higher CT numbers on NE images (59.4 ± 19.5 HU; range, 21-99 HU) (Fig. 3A) and CE images (86.8 ± 15.0 HU; range, 54-131 HU) than did malignant lymph nodes (NE, 40.4 ± 9.3 HU (range, 11-63 HU); CE, 77.1 ± 23.4 HU (range, 22-145 HU) (p = 0.000 and p = 0.001, respectively) (Fig. 1, 2). Malignant lymph nodes demonstrated significantly higher net contrast enhancement than did benign lymph nodes (27.3 ± 19.6 HU (benign) vs. 36.6 ± 22.3 HU (malignant); p = 0.002) (Fig. 3B).

Receiver Operating Characteristic Curve Analysis

For diagnosis of benign lymph nodes, ROC curves showed good discriminatory power in NE imaging (area under the curve (AUC), 0.80) and poor discriminatory power in CE imaging (AUC, 0.68) (Fig. 4A). The ROC curve of NE images showed sensitivity and specificity of 46% and 99% at 60 HU, respectively (Table 1). In the diagnosis of malignant lymph nodes, discriminatory power failed in all modalities (AUC: NE, 0.203; CE, 0.325) (Fig. 4B).

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**Fig. 1:** FIGURE 1. Benign reactive lymph node hyperplasia. Right lower paratracheal lymph node shows high attenuation (76 HU) on non-enhanced imaging (A) and 98 HU on contrast-enhanced imaging (B). Net contrast-enhancement was 22 HU.
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![Image](image1.png)

**Fig. 3:** FIGURE 3. Comparison of the CT number of benign and malignant lymph nodes on non-enhanced (NE) CT imaging (A) and on net-contrast enhancement (B). Benign lymph nodes shows significantly higher CT number on NE images (p = 0.000) (A), but significantly lower net contrast-enhancement (p = 0.002) (B) than malignant lymph nodes.

![Image](image2.png)

**Fig. 4:** FIGURE 4. Graphs show ROC curves for detecting benign lymph nodes (A) and malignant lymph nodes (B) with non-enhanced (NE) and contrast-enhanced (CE) CT scans. For diagnosis of benign lymph nodes, ROC curves showed good discriminatory
power in NE imaging (area under the curve (AUC), 0.80), poor discriminatory power in CE imaging (AUC, 0.68). The discriminatory power failed in all modalities (AUC: NE, 0.203; CE, 0.325) for malignant lymph nodes.

**TABLE 1. Receiver Operating Characteristics of Non-enhanced CT in the Diagnosis of Benign Lymph Nodes**

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Table 1
Conclusion

In the assessment of mediastinal lymph node with CT scan, diffuse high attenuation in lymph nodes is helpful finding for prediction of benignancy. Lymph nodes with attenuation more than 60 HU on non-enhanced images may be diagnosed as benign with a high specificity.

References


Personal Information