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ORIGINAL ARTICLE **CME**

Endobronchial Ultrasound-guided Transbronchial Needle Aspiration in Anthracosis of Mediastinal Lymph Nodes: Correlation with Computed Tomography Findings

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ABSTRACT

Objectives: *To demonstrate the computed tomography findings of endobronchial ultrasound-guided transbronchial needle aspiration–proven hilar and mediastinal lymph node anthracosis.*

Methods: *We retrospectively studied the computed tomography (multislice computed tomography, 64 x 0.75 mm slice collimation, tube voltage 120 kV) findings in 49 patients (37 males, 12 females) with endobronchial ultrasound-guided transbronchial needle aspiration–confirmed diagnosis of 89 anthracotic lymph nodes.*

Results: *Overall, 58.4% of the cytologically proven anthracotic lymph nodes showed enlargement with a mean short axis diameter of 11.1 mm (range, 5-23 mm). The majority of the anthracotic lymph nodes were oval (86.5%), 7.9% were round, and 5.6% were polycyclic in shape. Confluence of anthracotic lymph nodes was seen in 28.1% of the lymph nodes, and patchy hyperdensities–like calcifications were observed in only 18.0%; none of the lymph nodes showed necrosis.*

Conclusion: *Lymph node anthracosis often results in enlargement of hilar and mediastinal lymph nodes.*

Key Words: *Anthracosis; Biopsy, fine-needle; Lymph nodes; Mediastinum; Tomography, X-ray computed*

中文摘要

支氣管內超聲引導下經支氣管針吸活檢矽肺縱隔淋巴結：與電腦斷層掃描表現的相關性

J Kirchner, M Broll, C Murach, P Müller, N Pomjanski, S Biesterfeld, D Liermann, R Kickuth

目的：顯示支氣管內超聲引導下經支氣管針吸活檢肺門及縱隔淋巴結證實的矽肺的電腦斷層掃描結果。

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方法：回顧研究49名（37男、12女）支氣管內超聲引導下經支氣管針吸活檢確診的矽肺患者89個淋巴結的電腦斷層掃描（多層CT，64 × 0.75 mm準直寬度，管電壓120 kV）表現。

結果：總體上，經細胞學證實的矽肺淋巴結中的58.4%平均短軸直徑擴大了11.1 mm（介乎5-23 mm）。大部分矽肺淋巴結呈橢圓形（86.5%），7.9%呈圓形，5.6%呈多環形狀。矽肺淋巴結融合佔28.1%，18.0%呈斑片狀高密度鈣化；並無淋巴結壞死。

結論：矽肺淋巴結往往會造成肺門及縱隔淋巴結腫大。

INTRODUCTION

Anthracosis (greek, Άνθρακξ read *anthrax* = coal; οσισ read *osis* = condition), also called 'black lung disease', is a chronic lung disease caused by accumulation of carbon pigment from breathing dirty air.[1] It is characterised by formation of black nodules on the bronchioles, focal emphysema, and the deposition of coal dust in lymph nodes (Figure 1).[2] Since anthracosis is a form of pneumoconiosis not only caused by the occupational exposure to coal dust (coal workers pneumoconiosis), but also by cigarette smoking and environmental pollution,[3] radiologists should be aware of mediastinal lymph node enlargement occurring in these conditions, as this fact may impact staging of malignant lung diseases per se. To our knowledge, computed tomography (CT) appearance of histologically proven lymph node anthracosis has not been substantially addressed in the literature so far.

The aim of this retrospective analysis was to demonstrate CT findings of endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA)–proven hilar and mediastinal lymph node anthracosis.

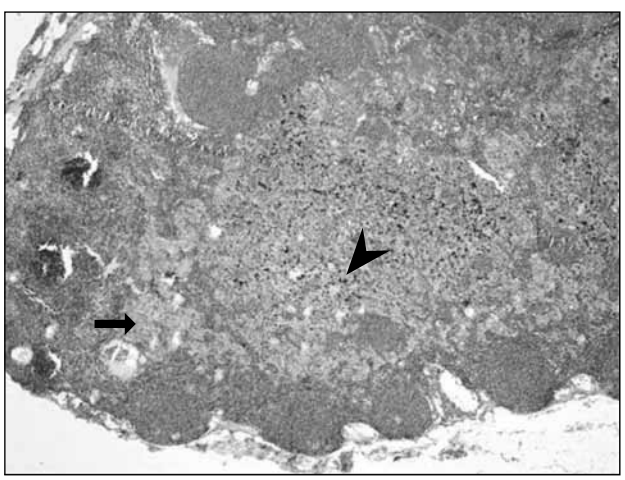

Figure 1. Histological section of a typically enlarged lymph node with sinus histiocytosis (arrow) and deposition of black anthracotic pigment in macrophages (arrowhead) [H&E; original magnification, x 4].

METHODS

We retrospectively researched the archives of our radiological and pulmonary departments to identify 49 patients (37 males, 12 females) with EBUS-TBNA–confirmed diagnosis of lymph node anthracosis between May 2009 and April 2012. Their median age was 66 years (range, 29-88 years). EBUS-TBNA revealed 89 anthracotic lymph nodes. All patients had undergone both chest X-ray and CT examinations. Abnormal findings in conventional chest X-ray (suspected pulmonary mass, lymph node enlargement, drug-refractory pneumonia) were the most common indications for performing chest CT (n=76/89, 85.4%). In addition, CT was performed for staging or restaging of tumours in 13 (14.6%) cases.

Multidetector CT (MDCT) examinations were carried out using a Siemens Somatom 64 (Siemens Medical Solutions, Forchheim, Germany) or Toshiba Aquilion 64 (Toshiba Medical Systems, Tokyo, Japan) CT system. Images were obtained at full inspiration using a 64 x 0.75 mm slice collimation with a tube voltage of 120 kV. The tube current (mA) was adjusted in relation to patient attenuation by means of the Care Dose modus (Siemens Medical Solutions) or the Sure Exposure modus (Toshiba Medical Systems). The reconstruction slice thickness was 3 to 5 mm in axial, coronal, and sagittal orientation. During MDCT, 100 to 120 ml of 300 mg or 400 mgI/l contrast medium was generally administered intravenously at a rate of 2 to 3 ml/s with a power injector followed by a normal saline 'chaser'.

Retrospective evaluation of the CT examinations was performed consensually by two board-certified radiologists (JK, RK). Mediastinal and hilar lymph node evaluation comprised measurement of diameter (short axis and long axis); lymph node enlargement was defined as showing a diameter of more than 7 to

11 mm on the short axis, depending on the regional nodal station, according to Glazer et al.[4] Enlarged lymph nodes were assessed for their density (prevalence of calcification or central low density as a sign of fatty involution), shape (oval, round, polycyclic), and contour (sharp, ill-defined). The presence of lymph node necrosis and noticeable contrast enhancement was documented. Nodal necrosis was considered present when an enlarged lymph node showed ill-defined low-attenuation areas. Noticeable lymph node enhancement was determined by nodal density of >60 HU on CT. The site of enlarged lymph nodes was documented on a standardised protocol according to the regional lymph node classification of the American Thoracic Society.[5]

EBUS-TBNA was performed with the patient under sedation or under general anaesthesia, as previously described.[6] A linear array 7.5-MHz ultrasonic bronchoscope (CP EBUS, Olympus Medical Systems, Tokyo, Japan) with a 90° angle of view was introduced orally or through an intubation tube. After ultrasound identification of a suspicious lymph node, transbronchial needle aspiration was performed using a 22G needle (model NA 201 SX 402, Olympus Medical Systems, Tokyo, Japan) under real-time ultrasound guidance. The aspirated material was prepared on glass slides, air-dried and stained.

Descriptive data were presented as medians with ranges, if appropriate; categorical data were given as counts and percentages. Statistical analysis was performed with a specialised computer algorithm (MedCalc version 6, MedCalc Software).

The study was approved by the ethics committee of our university and was HIPAA (Health Insurance Portability and Accountability Act) compliant.

RESULTS

In the 49 enrolled patients with EBUS-TBNA–proven lymph node anthracosis, chest CT revealed 443 lymph nodes of which 169 (38.1%) were enlarged (Table). Frequently enlarged lymph nodes were found in the American Thoracic Society (ATS) region 7 (n = 34); the highest percentage of lymph node enlargement was identified in region 11R (69.7%).

EBUS-TBNA revealed 89 anthracotic lymph nodes (Figure 2). The preferred localisation of transbronchial needle aspiration were: ATS region 7 (n=35/64 documented lymph nodes; 54.7%) and 10R (n=19/41; 46.3%). As a consequence, some non-enlarged lymph nodes were also aspirated in these regions. Lymph nodes in regions 2R (n=3/73; 4.1%), 2L (n=1/23; 4.3%), and 10L (n=2/33; 6.1%) were aspirated significantly less often. Despite the considerable size of enlarged lymph nodes measuring up to 26 mm in diameter, lymph nodes in region 5 were not examined.

Computed Tomographic Findings

A total of 52/89 (58.4%) cytologically proven anthracotic lymph nodes showed enlargement following the recommendations of Glazer et al.[4] The short axis of the anthracotic lymph nodes ranged from 5 to 23 mm in diameter, with a mean diameter of 11.1 mm (median, 11 mm). The long axis ranged from 6 to 33 mm, with a mean diameter of 16.5 mm (median, 16 mm). The

Table. Localisation of endobronchial ultrasound-guided transbronchial needle aspiration–confirmed anthracotic lymph nodes.

ATS region	Threshold (mm)	CT-confirmed lymph nodes, No. (%)		No. of EBUS-TBNA–confirmed anthracotic lymph nodes
		All	Enlarged lymph nodes	
2R	7	73 (16.5)	24 (32.9)	3
2L	7	23 (5.2)	6 (26.1)	1
4R	10	72 (16.3)	21 (29.2)	8
4L	10	37 (8.4)	10 (27.0)	5
5	9	45 (10.2)	12 (26.7)	0
6	8	1 (0.2)	0 (0%)	0
7	11	64 (14.4)	34 (53.1)	35
8	10	0 (0)	0 (0%)	0
10R	10	41 (9.3)	15 (36.6)	19
10L	7	33 (7.4)	13 (39.4)	2
11R	10	33 (7.4)	23 (69.7)	13
11L	10	21 (4.7)	11 (52.4)	3
Total		443	169 (38.1)	89

Abbreviations: ATS = American Thoracic Society; CT = computed tomography; EBUS-TBNA = endobronchial ultrasound-guided transbronchial needle aspiration.

majority of the lymph nodes with signs of anthracosis were oval in shape (n=77/89; 86.5%; Figure 3); 7/89 (7.9%) nodes were round, and 5/89 (5.6%) were polycyclic. Most of the anthracotic lymph nodes were well-defined with only two (2.2%) showing blurred boundaries.

Confluence of two or more anthracotic lymph nodes was seen in 25/89 (28.1%) lymph nodes; patchy hyperdensities–like calcifications were observed in 16/89 (18.0%; Figure 4). Only two of the anthracotic lymph nodes showed a central hypodensity due to fatty involution (2.2%); none showed necrosis. Contrast enhancement was documented in 5/89 (5.6%) of the anthracotic lymph nodes.

Figure 2. Cytological specimen from an endobronchial ultrasound-guided transbronchial needle aspiration with a fibrous fragment of a lymph node showing deposition of anthracotic pigment in macrophages (arrow) and the extracellular space. Erythrocytes, some inflammatory cells, and some normal epithelial cells are present at the periphery of the microphotograph (Papanicolaou staining, x 5).

Figure 3. Enlarged mediastinal lymph node (ATS region 2R) in a 73-year-old patient having colorectal cancer with some peripheral pulmonary nodules suspicious for metastases. A lymph node in ATS region 2R is well-defined and oval in shape. Endobronchial ultrasound-guided transbronchial needle aspiration revealed lymphadenopathy with deposition of anthracotic pigment (multislice computed tomography 64 x 0.75-mm slice collimation, tube voltage 120 kV, axial reconstruction).

DISCUSSION

Today, CT and positron emission tomography (PET) are the standard investigations for the assessment of hilar and mediastinal lymph nodes.[7] In general, lymph nodes with a short axis diameter of >10 mm are suspected to be malignant. Alternatively, many radiologists use a short axis diameter threshold of 10 mm for all sites with the exception of 15 mm for station 7. As normal nodes are often smaller, particularly in the upper paratracheal region, Glazer et al[4] have published specific threshold sizes for different mediastinal lymph node regions, which were used in the present study as limiting values for defining malignancy.

The finding of enlarged lymph nodes in patients with malignancy is usually interpreted as a sign of metastatic disease.[5] On the other hand, several recent studies have demonstrated that enlarged mediastinal lymph nodes are

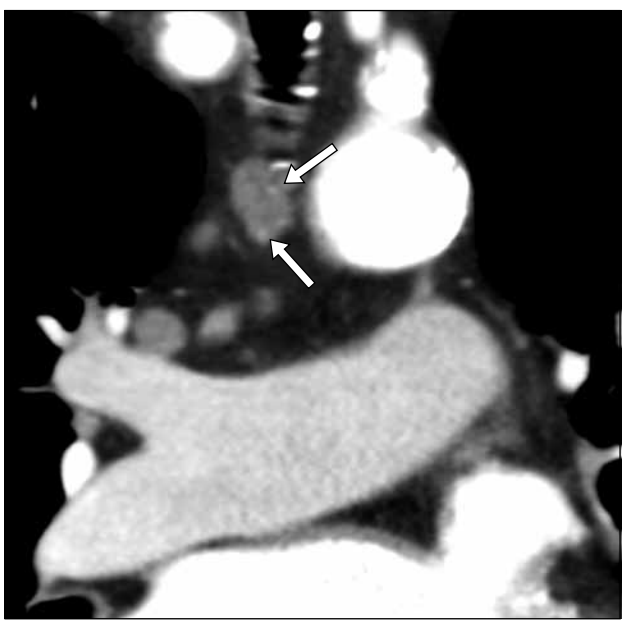

Figure 4. This is a case of an 81-year-old male with bronchial cancer. Chest computed tomography (multislice computed tomography 64 x 0.75-mm slice collimation, tube voltage 120 kV, frontal reconstruction) shows a moderately enlarged paratracheal lymph node in the ATS region 4R (11 x 18 mm) and subtle hyperdensities–like calcifications (arrows) which are polycyclic in shape.

frequently observed in a lot of benign conditions like sarcoidosis, chronic heart failure, chronic obstructive pulmonary disease, and pneumoconiosis.[8-15] Anthracosis is a form of pneumoconiosis which is caused by not only coal dust but also other environmental factors like air pollution, biomass fuels used extensively for cooking ("hut lung"), and cigarette smoke.[16-20] A recently published comparative study by our own study group in 44 heavy smokers and 44 non-smokers demonstrated that enlarged mediastinal lymph nodes may occur in a rather high percentage of heavy smokers, especially in those with severe bronchitis.[3] In that study, we found that lymph node enlargement in smokers may be caused by a deposition of anthracotic material and as a response to dust. In this context, one aim of the present comparative study between CT and EBUS-TBNA was to prove this hypothesis. To date, EBUS-TBNA is accepted as a safe and highly accurate procedure for the examination of hilar and mediastinal lymph nodes in patients with suspected lung malignancy.[7] In 2006, Herth et al[21] carried out a study in 100 patients to investigate the performance of EBUS-TBNA for staging lung cancer patients. In this study, the sensitivity and the negative predictive values for detecting malignancy were 92.3% and 96.3%, respectively. However, another comparative study, based on cytologically confirmed lymph nodes by means of EBUS-TBNA, revealed a lower sensitivity of 77% and a specificity of 55% for the CT-based diagnosis of lymph node involvement in lung cancer.[22]

Our CT findings indicate that anthracosis may often result in considerable enlargement of hilar and mediastinal lymph nodes measuring up to 23 mm in short axis diameter and 33 mm in long axis diameter. In our study, approximately 60% of all cytologically confirmed anthracotic lymph nodes were enlarged, whereas 40% were normal in size.

EBUS-TBNA revealed anthracotic lymph nodes in all ATS regions, with the exception of the regions 5, 6, and 8. Anthracotic lymph nodes were more frequently observed in regions 4R, 7, 10R, and 11R. It may be hypothesised that there is increased deposition of dust in these localisations.

Although the presence of enlarged, calcified mediastinal lymph nodes has been downright accepted as a common radiological finding in patients with coal worker's pneumoconiosis,[12-14,23] calcification as an evidence of benignity was rarely observed in our patients (18%). Egg-shell–like calcification due to the calcification of the periphery of lymph nodes, which has been reported in 56% of sandblasters suffering from silicosis,[13] was not identified in any of our patients.

The CT finding of a nodal confluence is frequently interpreted as a reliable indicator of malignancy.[24] Surprisingly, this finding was also identified in 28% of anthracotic lymph nodes in our patients. Central lucency as a sign of necrosis was not demonstrated in any of the anthracotic lymph nodes.

The results of the present study underscore the opinion that the diagnostic accuracy of the CT examination in distinguishing between malignant and benign lymph node enlargement is insufficient for making clinical decisions.[25] Unfortunately, several recent studies demonstrate that lymph node enlargement in pneumoconiosis may result in false-positive findings in 18F-fluorodeoxyglucose–PET/CT.[26-29] Since neither mediastinoscopy nor extended mediastinoscopy are able to reach all lymph node stations, the evaluation of mediastinal lymph nodes remains a challenging diagnostic problem in these patients.

There were some limitations to our study. First, the sample size was small, preventing a generalisation of our results. Second, the study design was retrospective and we did not compare the findings of anthracotic lymph nodes with a sample of other benign enlarged lymph nodes (e.g. sarcoidosis). Therefore we consider our findings preliminary.

CONCLUSION

The findings of the present study confirm our hypothesis that anthracosis may often result in enlargement of hilar and mediastinal lymph nodes. Lymph nodes may show nodal confluence, but calcification is rarely observed. These findings seem to be of utmost importance, since anthracosis can mimic other more severe illnesses presenting with mediastinal lymphadenopathy.

DECLARATION

No conflicts of interests were declared by authors.

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