Active Solitary Tuberculoma of the Lung: CT and Clinical Findings

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- Abstract -

To present CT and clinical features of active tuberculomas, we analyzed retrospectively CT findings of 14 tuberculomas (n=14) in 13 patients which appeared as solitary pulmonary nodules on plain radiographs and evaluated the response of tuberculomas to antituberculous chemotherapy. Nine tuberculomas (64%) were ovoid in shape and 10 (72%) showed smooth margin. Twelve (86%) tuberculomas were shown as low density lesions on unenhanced or enhanced CT scans. Calcification and cavitation were noted in three (21%) and eight (57%) tuberculomas respectively. Seven (50%) tuberculomas were accompanied by satellite nodules. Acid-fast bacilli (AFB) was positive in all tuberculomas in sputum, lavage fluid, or percutaneous transthoracic needle aspiration (PTNA). Smear and culture of lavage fluid and PTNA aspirate were superior to the detection of AFB than sputum examination. Follow-up study with antituberculous chemotherapy in 14 tuberculomas resulted in complete disappearance in three, decrease in size in seven, and no visible change in the remaining four. These observations suggest that tuberculomas are well-defined, ovoid, and low-density nodules containing calcifications and/or cavitations. Tuberculomas are relatively indolent even with threatment.

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INTRODUCTION

Tuberculoma is a tumor-like granuloma caused by the tubercle bacilli. It contains solid caseous material encapsulated by connective tissue. Tuberculoma may arise either from a primary or postprimary focus by encapsulation or from a completely blocked tuberculous cavity filled with inspissated caseous material (1, 2). Computed tomography (CT) has been regarded as a sensitive means of characterizing solitary pulmonary nodules (SPNs) and of detecting calcification with its capacity for measuring attenuation values (3-8). But there have been few reports, to our knowledge, on CT features of tuberculoma which is one of most leading causes of granulomatous nodules along with histoplasmosis and coccidioidomycosis (6). In this study, we present CT features of 14 active tuberculomas which appears as SPNs on plain radiographs and discuss their microbiological aspect and responese to antituberculous chemotherapy.
MATERIALS AND METHODS

CT scans and hospital records of 13 patients with tuberculoma as a SPN between January 1987 and December 1990 were retrospectively reviewed. Patients were 11 men and two women, ranging in age from 16 to 73 years (mean, 51 years). Seven patients had no specific complains and remaining six patients complained of mild chest pain, dry cough, fever, or hemoptysis. Antituberculous chemotherapy was not given in any patient previously.

To be included in this study, cases were required to satisfy the following criteria: (a) the lesions be defined as a SPN with distinct margins on radiographs, (b) acid-fast bacilli (AFB) be found in smear or culture of sputum, lavage fluid, or percutaneous transthoracic needle aspiration (PTNA), (C) chest CT scans be performed as an initial diagnostic work-up. We excluded the cases which showed atypical mycobacterium on microbiological study. We also excluded cases with multiple nodules in a single lung, but did not exclude the case with bilateral nodules on each lung in one patient. Total of 14 tuberculomas in 13 patients were included in this study.

Most CT scans were performed with CT-W 700 scanner (Hitachi Medical, Tokyo). Imaging parameters were 120 kVp, 300-400 mA, a 3-second scan time. Images were obtained with standard reconstruction algorithm and were photographed with both mediastinal (width, 400; level, 35) and lung (width, 1500; level, -700) window. Enhanced scans only were available in seven tuberculomas and both unenhanced and enhanced scans available in six. Unenhanced scan only was available in one tuberculoma. Enhanced scans were obtained with injection of 100 ml of 68.3% meglumine ioglicate (Rayvist R 300, Schering, Seoul, Korea), 50ml in bolus before scanning and 50ml in drip infusion during scanning. At full inspiration, contiguous scans with 5-mm collimation and at 5-mm intervals in the hilum, and with 10-mm collimation and at 10-mm intervals in other areas were done in all patients. Five tuberculomas were scanned with 5-mm collimation and nine were scanned with 10-mm collimation.

CT scans were analyzed by two radiologists with a consensus. The size, shape, and location of tuberculomas were described. The longest diameter on axial plane was measured as their size on lung window. The margin of tuberculomas was classified into four types as in the study of Siegelman et al. (4) on lung window. They are as follows; sharp and smooth (type 1), moderately smooth (type 2), some irregular undulation or slight spiculation (type 3), and grossly irregular with spiculation (type 4). Presence of calcification within tuberculomas was noted and its distribution and pattern were described as follows; central or eccentric in distribution and laminated, popcorn-shaped, or stippled in patterns. Internal characteristics of tuberculomas were recorded as either homogeneous or inhomogeneous. The density of tuberculomas was visually classified into low, intermediate, and high relative to that of surrounding musculature on enhanced and unenhanced scans. Presence or absence of satellite nodules, which were not noted with plain radiographs, was recorded especially on lung window setting. If there is recognizable enhancing wall or tumor capsule in tuberculomas, it was also described.

The frequency of positive AFB either smear or culture was studied with sputum and lavage fluid. The response of tuberculomas to antituberculous chemotherapy was noted with monthly follow-up radiographs. Initial CT findings which may predict the outcome of tuberculomas with treatment were evaluated in terms of the size, the presence or absence of calcification, cavity, and enhancing wall. Chemotherapeutic regimen with combination of four drugs
INH (isoniazid; Roche, Basal, Switzerland), ethambutol (Dow Lepetit, Milan, Italy), Pyrazinamide (Lederle, Wayne, NJ), and Rifampin (Dow Lepetit, Milan, Italy) was implemented daily for nine months. Total of 14 tuberculomas could be included in follow-up study from 6 months to 2 years.

RESULTS

CT Findings

The size of tuberculomas ranged from 1.8cm to 5.0cm (average; 3.6cm). The shape of tuberculomas was mostly ovoid (n=9, 64%) but round (n=2), rectangular (n=2), and dumbbell-shaped (n=1) tuberculomas were also noted. Eight tuberculomas (57%) were located in the apical or posterior segment of the upper lobes and superior segment of the lower lobes. The remaining tuberculomas were located in basal segments of the lower lobes (n=3), anterior segment of the upper lobes (n=2), and right middle lobe (n=1). Twelve (87%) tuberculomas were located in peripheral half of the lung and two in central half of the lung. Type 2 margin was most common and noted in eight (57%). The types of margin in decreasing order of frequency were type 3 (three, 21%), type 1 (two, 15%), and type 4 (one, 7%). Calcifications were noted in three tuberculomas (21%) and they were eccentric in distribution and stippled in pattern (Fig. 1). Internal characteristics of tuberculomas were homogeneous in 11 and heterogeneous in three. Unenhanced scans in seven tuberculomas showed low density in six and intermediate in one. The density of

Fig. 1. Tuberculoma showing internal low density and calcification on CT in a 39-year-old man. Enhanced CT scan at thoracic inlet shows a lobulated low-density nodule containing stippled and eccentric calcification (arrows). The medial lesion (white arrows) is due to lobulated nature of tuberculoma.

Fig. 2. Tuberculoma showing a peripheral air-filled cavity in a 54-year-old woman. a. Chest radiograph shows an ovoid and well-defined nodule (arrows) in left lower lung field. b. Enhanced CT scan at ventricular level shows a low-density nodule in posterior basal segment of left lower lobe. Peripherally located air-filled cavity (white arrow) is seen in the lesion.

Fig. 4. Tuberculoma showing an intermediate density in a 73-year-old man. Unenhanced CT scan at liver dome shows a slightly lobulated and iso-dense nodule in right lower lobe. Pleural tag is seen anterior to the lesion.

tuberculomas on enhanced scans in thirteen tuberculomas was low (Figs. 1-3) in 11 (85%) and intermediate (Fig. 4) in two (15%). Attenuation value could be measured in four tuberculomas at central portion on enhanced scans and ranged from 32 to 45 HU (average 40 HU). Cavity was noted in eight tuberculomas (57%). The cavities were small and located in the peripheral portion of tuberculomas (Fig. 2) in five and in the central portion (Fig. 3) in three. All cavities were filled with air (Fig. 2 & 3). Air-fluid level could not be discerned in any cavity. Satellite nodules (Fig. 3) (small nodules in the vicinity of the main lesion) were noted in 7 tuberculomas (50%). Enhancing wall in the peripheral portion of tuberculoma was noted in one (7%). Positive bronchus sign (the presence of a bronchus leading to or contained within the nodule in cross-section) was noted in only one tuberculoma (7%).

Clinical Findings

Sputum AFB was studied in all tuberculomas. Positive sputum AFB was seen in three tuberculomas in three consecutive patients (two in smear and culture and one in only culture). AFB in lavage fluid, which was studied in nine
tuberculomas, was seen in six tuberculomas (four in smear and culture and two in only culture). In two tuberculomas AFB was positive both in sputum and lavage fluid. AFB was positive only on PTNA in seven (50%) tuberculomas.

Follow-up study after antituberculous chemotherapy in 14 tuberculomas revealed complete disappearance in three on 6-12 month follow up, decrease in size in seven within 2 years, and no visible change in four up to 2 years. Any single or combinations of CT findings could not predict the response of tuberculomas to antituberculous chemotherapy. The size, cavity, calcification, and wall enhancement on CT had no significant relationship with outcome of tuberculomas after antituberculous chemotherapy.

DISCUSSION

Probably because of the lack of CT studies dealing with large series, there have been no mention on the CT attenuation value of tuberculomas. Tuberculous lymphadenitis shows low attenuation value (40-50 HU) in the inner portion of the involved lymph nodes due to a firm (caseous) material in the nodes. If the caseous material undergo liquefaction later, it may show less attenuation value on CT (9-11). We could observe low attenuation value in 12 (86%) of 14 tuberculomas.

Cavitations in tuberculomas are not uncommon. Sochocky (12) found cavitation in 10 (33%) of 30 tuberculomas on conventional tomograms. He noted that these cavities were situated either in central or peripheral portion of the tuberculomas. Mahon et al. (13) contended that the marginal slit-like cavitation was typical of tuberculomas and that it occurred in their way to maturity. Cavity was noted in eight (57%) tuberculomas on CT in our study.

The presence of satellite shadows in the vicinity of the round lesion may suggest that the lesion is tuberculous in origin (12). Satellite shadows were seen in seven (50%) of 14 tuberculomas in this study. We think these satellite shadows are due to peribronchiolar or lobular tuberculous granulomas.

We observed thin peripheral enhancing wall in one tuberculoma on postcontrast CT scans. Pratt (14) and Mahon et al. (13) suggested that there should be a layer of granulation tissue and epitheloid cells between the fibrous capsule and caseation necrosis in tuberculomas. We speculate that the enhancing wall in one tuberculoma is due to this layer of granulation tissue and epitheloid cells.

There are limitations to our study. We included active tuberculomas in this study, so most of tuberculomas are more than 2.0 cm in diameter. Therefore CT findings of this study may not necessarily apply to lesions that are inactive or less than 2.0 cm in diameter. Secondly high-resolution and reference phantom CT studies were not performed. It is likely that the incidence of calcification, cavitation, and positive bronchus sign may well have been underestimated.

Tuberculomas should be differentiated on CT from malignant nodules. Recently Swensen et al. (15), in CT evaluation of SPN, suggested that enhancement by 20 HU or more with iodinated contrast material should indicate the likelihood of malignancy. In their study, six in seven granulomas of unspecified diagnosis showed less enhancement (under 20HU) than malignant nodules. We guess malignant nodules without extensive tumor necrosis will not show such a low density as tuberculomas in our study especially on enhanced CT. Malignant nodules demonstrate spiculated margin, lobulation, and inhomogeneous density more commonly than tuberculomas. Zwirewich et al. (6), in high resolution CT-pathologic correlation, suggested that inhomogeneity in malignant nodules be mainly due to bubblelike areas of low density (due to either patent small bronchi or small, cystic spaces within neoplastic glands). In our
study, tuberculomas showed homogeneity and well-defined margin (type 1 and 2 in 72%). Air-filled cavities rather than bubblelike low density were noted within tuberculomas. Satellite nodule is also an unusual finding in the malignant nodules. Histologic-radiologic studies indicate that some calcification can be seen in up to 16% of cancers (16). Recently several papers on detection of calcification in malignant nodules with CT have been published (17-19). Mahoney et al. (19), in their CT study with 353 malignant nodules, observed 20 nodules (6%) containing calcification. Patterns of calcification were amorphous (eight nodules), punctate (10 nodules), and reticular (two nodules). Diffuse calcification were also known to occur in the malignant nodules (17, 18). Calcification was found in three (21%) of 14 active tuberculomas in our study and eccentric and stippled calcification predominated. These findings suggest that various forms of calcification can be seen also in malignant nodules and calcification do not indicate benignancy of SPN.

Tuberculomas are usually regarded as active if they show positive AFB on microbiological study. The larger the tuberculoma, the more likely it is to be active (20). In our cases, active tuberculomas ranged from 1.8cm to 5.5cm (average; 3.6 cm) in diameter. So even small tuberculomas can contain AFB in them. Bleyer et al (21) could see calcification in only one of eight active tuberculomas (positive AFB in excised specimens) with radiograph and they suggested that the presence of even small flecks of calcium seem to indicate that the process was relatively inactive. But calcification was seen in three of 14 active tuberculomas on CT in this study. This result suggests that calcification in tuberculoma on CT does not preclude the activeness of tuberculomas.

AFB was seen on smear or culture of lavage fluid in six of nine tuberculomas in which this study was done. AFB could be seen only on aspirate of PTNA in seven tuberculomas. So we think smear and culture of lavage fluid and PTNA aspirate are valuable methods in the diagnosis of active tuberculoma.

There have been no consensus on the management of tuberculomas. The majority of tuberculomas may remain stable for a long time and many of them calcify even without treatment. Grenville-Mathers (2), in a follow-up study under observation with 23 tuberculomas, found that calcification occurred in four, enlargement in five, no change in size in seven, and cavitation in seven lesions among which three showed bronchogenic spread of pulmonary tuberculosis. In our follow-up study with antituberculous chemotherapy, seven of 14 tuberculomas decreased in their size, three tuberculomas disappeared completely, and four tuberculomas did not change in their size with treatment. This result suggest that tuberculomas are relatively indolent lesions. But surgeons still recommend surgical resection if the lesions were larger than 3.0cm in diameter. In our institution, antituberculous chemotherapy is usually implemented to the patients with active tuberculomas of more than 3.0cm in diameter.

In summary, active tuberculomas are well defined, oval and low attenuation nodules, containing calcifications and/or cavitations. Calcifications in tuberculoma can’t exclude activity. Even though tuberculoma is relatively indolent lesion, chemotherapy is needed, especially in patients with large tuberculoma more than 3.0 cm in diameter with paucity of calcification, and with cavities in it.

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패의 활동성 단일 결핵종: 전산화단층촬영 소견 및 임상적 의미

순천향대학교 의과대학 방사선학과학교실, 호흡기 내과학학교실*
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단순흉부촬영상 단일 결절로 나타난 결핵종의 전산화단층촬영 소견 및 임상적 의미를 평가하기 위하여 13명의 환자에서 나타난 14개의 결핵종을 후향적으로 분석하였다. 전산화단층촬영상 9개 (64%)의 결핵종은 난형으로 나타났으며 10개 (72%)는 유연한 변연을 보였다. 12개 (86%)의 결핵종은 조영증강에 관계없이 주위 근육과 비교하여 저밀도 음영을 보였다. 결절내의 석회화와 동공 형성은 각각 3개 (21%)와 8개 (57%)의 결핵종에서 관찰되었으며 7개 (50%)의 결핵종은 원형 결절을 동반하고 있었다. 전예에서 객담검사, 세정액검사 또는 경흉부세포흡입검사로 결핵균을 발견하였다. 결핵균의 발견율은 세정액검사 및 경흉부세포흡입검사가 객담검사보다 높았다. 결핵의 화학요법을 시행한 후, 3개는 완전히 없어지고, 7개는 크기가 감소하였고, 나머지 4개는 크기의 변화가 없었다.

상기 소견으로 결핵종은 전산화단층촬영상 두터운 변연부를 갖는 난형의 저밀도 음영의 결절로 석회화와 동공 형성을 보일 수 있으며 결핵 치료에 비교적 반응이 느린 병변임을 보여준다.