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Tuberculous-destroyed lung: cardiovascular CT findings and prognostic imaging factors

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ABSTRACT

The purpose of this study was to evaluate cardiovascular computed tomography (CT) findings in tuberculous-destroyed lung (TDL) and to correlate these imaging features with survival. CT was assessed for the diameter of the pulmonary artery (dPA) and ascending aorta, the diameters of ventricles, ventricular septal bowing (VSB), extent of TDL, or hypertrophied bronchial artery and others. Seventy-three percent of the TDL patients had a dPA greater than 29 mm. The right ventricle (RV)/left ventricle (LV) ratio in 70% of the patients was greater than 1.0, and VSB was observed in 18%. The RV/LV ratio was the only independent risk factor for poor survival in statistical analysis.

1. Introduction

Although the absolute number of tuberculosis (TB) cases has been falling globally since 2006, TB remains a challenging problem because the incidence of this disseminated disease is increasing in some areas, including developing countries [1].

If TB is diagnosed early and appropriate treatment is administered, the patient will eventually be cured. However, drug-resistant TB and the increasing number of AIDS patients have resulted in an increased incidence of destroyed lung due to TB [2,3]. Moreover, current prolonged life expectancy and the increased use of drugs that suppress cellular immunity may further increase the incidence of tuberculous-destroyed lung (TDL) and its complications [4].

Although a series of clinical factors related to prognosis of TDL patients were evaluated [5,6], there have been only few reports of prognostic factor associated with cardiovascular system in TDL. Moreover, to our knowledge, there has been no report about computed tomography (CT) findings of cardiovascular system focusing on imaging prognostic factor in these patients. The aim of this study was to evaluate cardiovascular findings by chest CT in TDL patients and to identify the prognostic imaging factors that contribute to mortality.

2. Materials and methods

2.1. Patients

The institutional review board approved this retrospective study. From December 2004 to March 2012, we reviewed medical records and radiological reports in patients with positive diagnosis code for TDL in our institute. The designation of TDL was based on the following: a clear history of past TB; supported by radiologic findings of destroyed lung parenchyma and lung volume loss with secondary cicatrical changes, all of which were verified via simple chest radiographs and CT scans [6]. A total of 210 patients with TDL were identified. Among these 210 patients, we excluded the 117 patients who had no contrast-enhanced chest CT scan and/or who had co-existing pulmonary or cardiovascular disease. Finally, 93 who had contrast-enhanced chest CT scans (male:female ratio, 62:31; mean age, 63 years; age range, 33–88 years) were included in our study.

2.2. Image acquisition

Chest CT scans were performed using a 16- (n=25) and 64- (n=68) channel Multidetector CT (MDCT) scanner (Sensation; Siemens Medical Solutions, Erlangen, Germany). The parameters for the 16-channel MDCT imaging were 120 kVp, 80–100 mAs, 3–5-mm thickness, and a 1.5-mm collimation. Contrast-enhanced chest CT scans were obtained after injection of 30 g of iodinated contrast agent (100-ml iopromide, Ultravist 300) at a rate of 2.3 ml/s with the use of a power injector (OP100, Medrad, Pittsburgh, PA, USA). The parameters for the 64-channel MDCT imaging were 120 kVp, 80–100 mAs, 3-mm thickness, and 1.2-mm collimation. Contrast-enhanced chest CT scans were obtained after injection of 30 g of iodinated contrast agent

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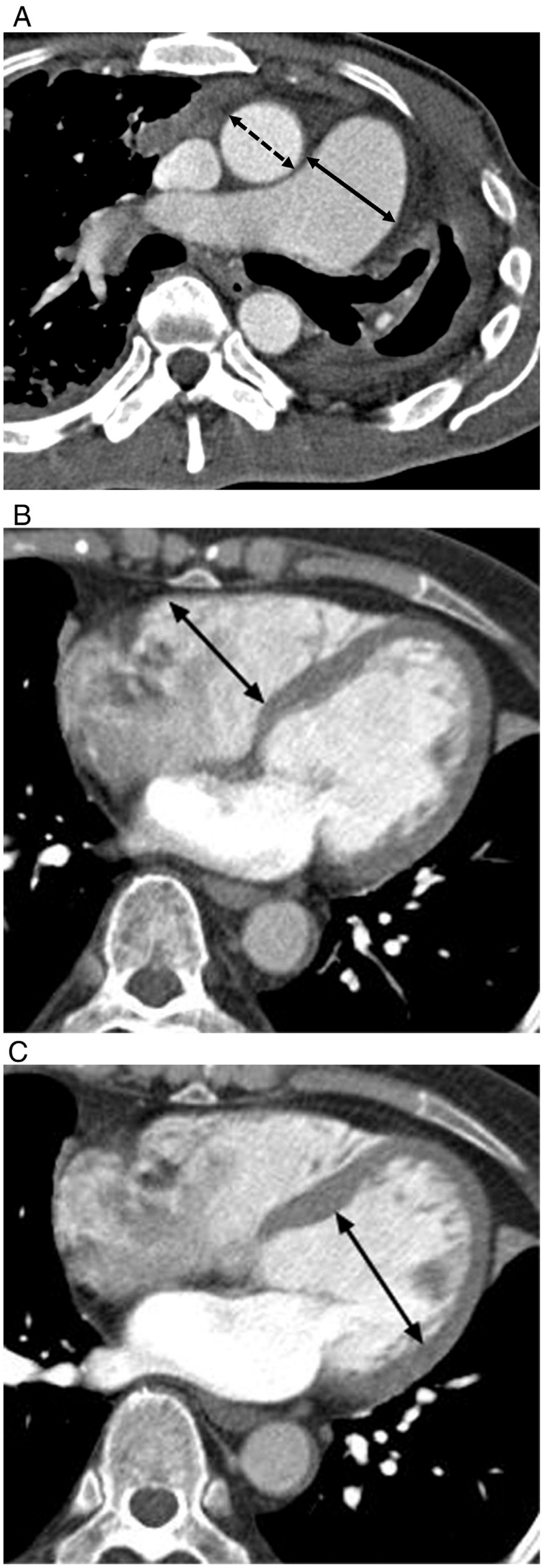

(100 ml iopromide, Ultravist 300) at a rate of 2.3 ml/s using a power injector (Stellant, Medrad, Pittsburgh, PA, USA). The scan data were displayed directly on monitors (two monitors, 512 × 512 image matrices, 12-bit viewable gray scale) of a picture archiving and communication system (Starpacs, Infinitt, Seoul, Korea).

2.3. Image interpretation

The areas of destroyed lung were assessed visually by two chest radiologists (S.W.L. and S.S.S.; 1 and 10 years of field experience, respectively) who were unaware of the clinical characteristics and prognosis of the patients, except their history of TB infection. To briefly present the degree of destruction, we used the simplified destroyed lung scoring system (DLS) [7]. A total of six lobes in both lungs (the lingular segment was considered a separate lobe) were assessed for the presence of lung lesions on chest CT scans; the presence of volume-decreased, calcified, bronchiectatic, emphysematous, and cicatrical lesions with or without centrilobular nodules were confirmed as TDL lesions. Bronchiectasis, emphysema, and centrilobular nodules, which were separately located without evidence of other cicatrical tuberculous lesion, were excluded. The score was graded according to the number of lobes showing destroyed lung; a score of 1 was assigned if 1–2 lobes were involved; 2 if 3–4 lobes showed destroyed lung lesions; and 3 when the destroyed lung lesions involved 5–6 lobes in both lungs.

The diameter of the pulmonary artery (dPA) was measured at the widest point of the main pulmonary artery on transverse sections at the level of bifurcation using electronic calipers. The widest short axis of the diameter of the ascending aorta (dAA) was measured on the same level of the CT section (Fig. 1A). The right ventricle (RV) diameter was measured from the inner wall to the inner wall at the widest point in the chamber, which was typically in the basal third of the RV (Fig. 1B). The left ventricle (LV) diameter was measured on the transverse image that showed the mitral valve at its widest point of the LV (Fig. 1C) [8,9]. The dPA/dAA and the RV/LV diameter ratio were calculated, and the presence of ventricular septal bowing (VSB) was evaluated [9,10]. The dPA and dPA/dAA ratio were correlated (Pearson correlation) with the result of the echocardiography including the right ventricular systolic pressure (RVSP) ($n=40$). Chest CT was also assessed for the presence of pulmonary thromboembolism (PTE), pericardial effusion, and bronchial artery hypertrophy (BAH).

The relationship between CT signs and prognosis (survival) was assessed. Survival was calculated with the Kaplan–Meier method, and hazard ratios were calculated with the Cox proportional-hazards model. The planned Cox proportional-hazard model was used to identify factors associated with an increased risk of death. Factors associated with mortality with P value of less than .20 in the univariate analysis were entered in the multivariate model, and nonsignificant factors were removed by means of a backward-selection procedure. For the secondary analyses, we compared rates of survival with the use of the log-rank test. P value of less than .05 was considered to indicate statistical significance.

3. Results

3.1. Clinical findings

Among 93 patients, 86 patients presented in a stable state (84 with a history of anti-TB medication and 2 without); seven patients still

Fig. 1. Measurement of cardiovascular findings on CT. (A) The dPA of 42 mm (continuous arrow) and dAA of 28 mm (dashed arrow) in a 52-year-old male suffering TDL with DLS score 3; (B) transverse contrast-enhanced chest CT scan in a 73-year-old male taken at the widest point of the tricuspid valve. The diameter of RV is measured (arrow) at this level from inner wall to inner wall. (C) The diameter of LV is measured (arrow) at the level at which the mitral valve is widest.