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Letter to the Editor

Use of 3D-CT airway analysis software to assess a patient with severe persistent bronchial asthma treated with bronchial thermoplasty

Dear Editor,

Bronchial thermoplasty is a bronchoscopy technique to heat the airway smooth muscle by controlled thermal energy. Many studies have found that it helps improve symptoms in patients with severe asthma (1–3). Few reports, however, have addressed the question of what changes occur in the bronchial lumina and walls after thermoplasty. We used three-dimensional (3D) airway analysis software to analyze the changes in the bronchial lumina and walls before thermoplasty and after the first and third sessions.

Case report

A 69-year-old woman was undergoing treatment for severe persistent asthma with steroid inhalation and long-acting β_2 agonist inhalation, and she had also taken omalizumab at age 63 years. Since her condition was poorly controlled, she was admitted for bronchial thermoplasty. On examination before the first session of bronchial thermoplasty, resting SpO_2 was 98%, and respiratory sounds were normal. Blood tests showed an elevated IgE level at 378 U/ml, but the WBC count was 6560/ μl with 3.8% eosinophils.

Assessments including respiratory function tests and computed tomography (CT) were performed after the first and third bronchial thermoplasty sessions. The thermoplasty tests were performed with the approval of the Ethics Committee of our hospital. An Olympus P240 bronchofiberscope (Olympus, Tokyo, Japan) was used with an Alair Bronchial Thermoplasty System (Boston Scientific Corporation) as the high-frequency energization system, CT was carried out with a Toshiba Aquilion, and AZE Virtual Place software was used for 3D airway analysis.

It was twenty-one days between the first thermoplasty and second. And forty-three days between second and third. Because after second thermoplasty, she was slight tiredness and require rest. She recovered gradually several weeks.

The first thermoplasty session consisted of 72 activations in the right inferior lobe (Fig. 1C), the second session consisted of 48 activations in the left inferior lobe, and the third session consisted of 82 activations in the left upper lobe, the lingular segment, and the right upper lobe. Respiratory function tests showed that forced expiratory volume in 1 s ($\text{FEV}_{1.0}$) improved from 0.96 L (51.3%) before treatment to 1.27 L (67.9%) after the first session and 1.28 L (68.4%) after the third session.

The second CT scan was performed fifteen days after first thermoplasty. The third was twenty-six days after third thermoplasty. Because operating thermoplasty immediately, cause inflammation at bronchial and we don't perform accurate analysis.

CT also showed dilation of the bronchial lumina (Fig. 1A, B, D and E). Three-dimensional airway analysis of right eight bronchus was performed, and the inner luminal area of the airway (Ai, in %, calculated as luminal area/tracheal area) and the airway wall thickness of the airway (WT, in %, calculated as tracheal wall/(tracheal wall + luminal radius)) at the orifice of the lower lobe, the orifice of bronchus 8, the orifice of 8a, and the orifice of 8ai were measured.

The results of this 3D airway analysis (Fig. 2) showed that Ai at the orifice of the inferior lobe was 28.6% before treatment, 33.9% after the first session, and 33.2% after the third session, and the equivalent values for WT at this point were 46.2%, 41.4%, and 42.2%, respectively. At the orifice of bronchus 8, Ai was 20.0%, 26.2%, and 28.1%, and WT was 54.6%, 48.4%, and 46.5%, respectively. At the orifice of 8a, Ai was 19%, 25.2%, and 29.4%, and WT was 55.7%, 48.9%, and 44.7%, respectively. At the orifice of 8ai, Ai was 21.6%, 22.2%, and 28.4%, and WT was 52.7%, 52.2%, and 45.3%, respectively. Dilation of the bronchial lumen and decreased bronchial wall thickness were evident at measured range.

Discussion

Three-dimensional airway analysis software has been widely used in studies of chronic obstructive pulmonary disease (COPD), but to the best of our knowledge, this is the first time that this 3D airway analysis software has been used to study the airways of a patient who has undergone bronchial thermoplasty.

In the RISA study, patients with severe asthma were followed for 1 year, and improvements in the Asthma Quality of Life Questionnaire (AQLQ) score and $\text{preFEV}_{1.0}$ were observed.¹ In the AIR2 study, patients were followed for 5 years, and AQLQ scores improved relative to those of a control group. The proportion of patients whose symptoms were severely aggravated declined to 44%, and emergency outpatient visits also decreased to 78%.²

However, the mechanism whereby bronchial thermoplasty exerts its effect has yet to be identified. Brown *et al.* carried out bronchial thermoplasty in dogs' airways and found that the airway wall (smooth muscle) diminished and the airway diameter was dilated compared with a control group.³ Miller *et al.* carried out bronchial thermoplasty in lung lobes prior to their resection in eight lung cancer patients, and they found that airway smooth muscle thickness was reduced by approximately

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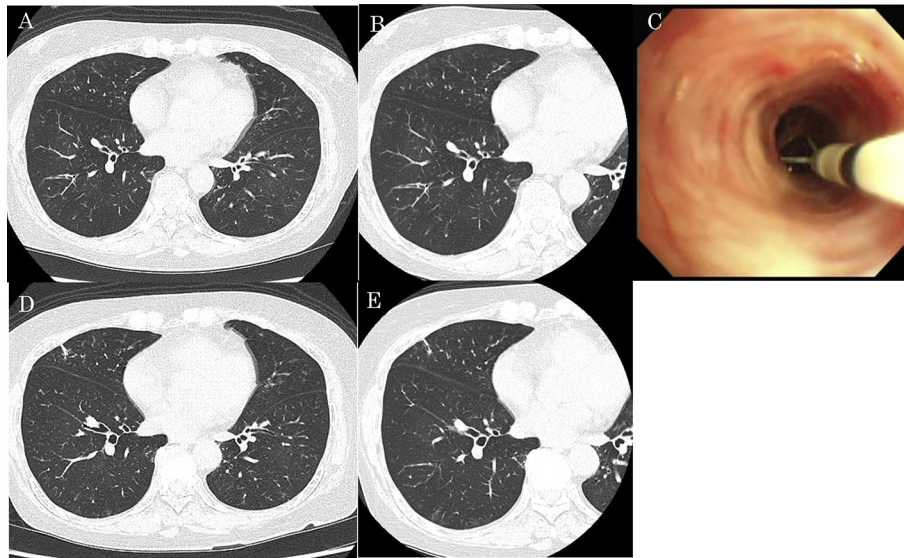


Fig. 1. CT before bronchial thermoplasty (A), HRCT (B). Bronchial thermoplasty treatment in the right lower airway. The electrodes are in close contact with the airway wall (C). CT after bronchial thermoplasty (D), HRCT (E) judge an extension of the bronchial lumen.

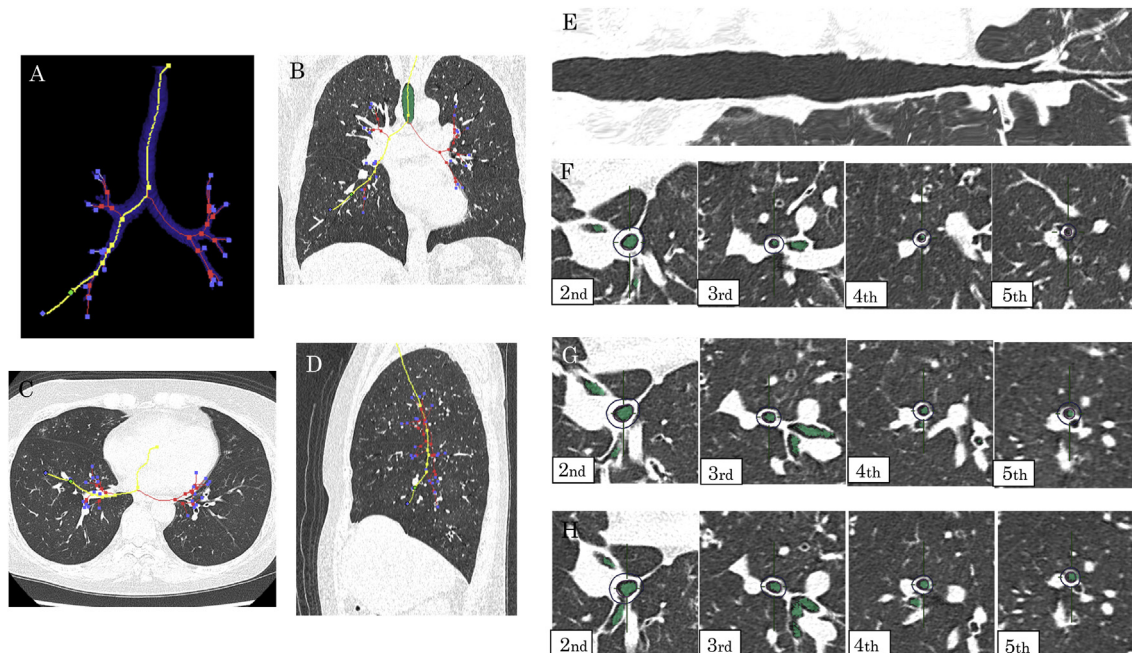


Fig. 2. Bronchial construction (A). Axial, sagittal, and coronal slices (B–D). Yellow lines indicate the same airway in both A–C and D. A image of the selected airway (B8) from the right lower lobe (E). Short-axis images obtained from the curved MPR image are precisely perpendicular to the long axis of the airway. Bronchial lumen and airway wall thickness from second bronchi to five bronchi before thermoplasty (F: the upper row). After first thermoplasty (G: the middle row). After third thermoplasty (H: the lower row).

50%.⁴ That study, however, was designed to show that the procedure could be safely used in humans rather than dogs, rather than to evaluate the airway diameter.

Kirby *et al.* used optical coherence tomography of the inside of the airways to carry out a 2-year follow-up of 2 patients who had undergone bronchial thermoplasty. Although the airway wall thickness decreased in 1 patient, it increased in the other.⁵

Three-dimensional airway analysis software has been used for airway analysis in COPD patients.^{6,7} Hasegawa *et al.* carried out CT scans and 3D airway analysis of COPD patients a week before and after the administration of anticholinergic drugs, and they found that Ai increased by approximately 40% (8). Right eight

bronchus is also reportedly the bronchus for which the airway diameter can be measured with the greatest accuracy (9), and we therefore measured this bronchus in the present study. This case right eight bronchus was 18 activations (the center of 8 at 3 activations, 8a side at 6 and 8b at 9). Dilation of the bronchial lumen and decreased bronchial wall thickness were evident at measured range: the orifice of bronchus 8, the orifice of 8a, and the orifice of 8ai.

There were certain limitations in the present case. The first was that the patient had been taking high-dose steroids before treatment for thermoplasty, and their effect may have contributed to the results. Another point is that our investigation was carried

out less than 3 months after thermoplasty was performed. It is possible that further changes to the bronchial lumen and airway wall thickness may occur over the long term, and continued follow-up is required.

Conclusions

We used bronchial thermoplasty to treat a patient with persistent asthma. Dilation of the bronchial lumen and decreased bronchial wall thickness were evident after thermoplasty.

Conflict of interest

The authors have no conflict of interest to declare.

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