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研究課題名：アスベスト曝露疾患の計算機支援画像診断の創出と臨床応用

Title:
Development of Computer-Aided Diagnosis Systems for Asbestos-Related Diseases and Its Clinical Application

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Summary

Asbestos-related diseases remains a major public health problem. Asbestos are carcinogenic to human, and may cause mesothelioma and lung cancer. Currently, about 125 million people in the world are exposed to asbestos. The World Health Organization (WHO) has estimated that more than 107,000 people die every year from asbestos-related lung cancer, mesothelioma and asbestosis resulting from the asbestos exposure. The latency period of 30-50 years between exposure and the development of clinical symptoms explains the continued rise in the numbers of asbestos-related diseases despite international recognition of the health risks. One of strategic directions towards elimination of asbestos-related diseases is to improve early diagnosis and treatment of asbestos-related diseases.

Cutting-edge medical technologies are being sought that will enable early detection and treatment of asbestos-related diseases by finding minute changes in the human lung. Advances in medical imaging technology make it possible to reveal the location of lesions at an early stage. The morphological and functional images provided by imaging technologies are becoming more complex in amount of information gained. Computer-aided diagnosis (CAD) is considered as a solution to support physicians' interpretation of the expanding amount of image information on the frontline of medical care. Development of CAD systems that encompasses detection and diagnosis would be more desirable to patients and referring physicians. The purpose of this project is to develop CAD systems for asbestos-related diseases. These systems may enable early detection and treatment for asbestos-related lung cancers, mesothelioma and asbestosis by using thin-section CT images with slice thickness of 1mm. The goal of the research and development of this project is to reach a level at which the effectiveness of CAD technologies can be reasonably proven and clinical tested for ensuring that the practical application can be carried out.

The strategic plan of our research project consists of the four key pillars. The outlines of these achievements are as follows.

(1) Constructing a database with volumetric CT images and follow-up volumetric CT images of asbestos-related diseases:

- ✓ In order to construct a large-scale database of volumetric CT images and their diagnostic results, we constructed a digital diagnostic environment system which integrated the proposed anonymization system to protect the personal information of DICOM Images. The data set of about 4700 cases were collected from four medical facilities with ethics committee approval.

(2) Development of three-dimensional image analysis of asbestos-related diseases by using volumetric CT images:

- ✓ Recent advances in the technology for multi-detector computed tomography (MDCT) have

led to an increase in the number of examinations performed for diagnosis and treatment planning. The distribution of the radiation dose to the patient can vary considerably depending on the scan parameters employed for the CT examination. We developed a core technology for analysing radiation dose and scan parameters using MDCT. In addition, we proposed a model-dependent method to determine the modulation transfer function (MTF) in the transversal plane of CT images.

- ✓ One of the most important steps of CAD is the segmentation of the lung anatomies on thoracic CT datasets. When detecting or analyzing asbestos-related lung cancer and mesothelioma, the existence of diseases often deteriorate the performance of lung structure segmentation. Especially, the segmentation process of lung lobes is influenced by diseases of parenchyma. We improved automatic segmentation method of pulmonary lobes against normal datasets and various respiratory disease datasets.

(3) Development of CAD technologies for detecting asbestos-related lung cancer and mesothelioma at early disease stage:

- ✓ We proposed a computer-aided prognosis prediction scheme that utilized quantitatively the derived image information to predict patient recurrent-free survival for asbestos-related lung cancers. We demonstrated the potential usefulness of the scheme which can provide a quantitative risk score that is strongly correlated with prognostic factors.
- ✓ In CT screening, comparative reading of present and past CT images is effective for evaluation of asbestos-related diseases. We developed a comparative reading algorithm for volumetric CT images and evaluated its performance. We also developed computerized detection schemes based on quantitative analysis of various suspected shadows including asbestos-related lung cancer, mesothelioma, and asbestosis.

(4) Development of a CAD prototype system and its clinical application:

- ✓ We implemented the GUI and integrated the detection algorithms of asbestos-related diseases as a prototype CAD system. We have been evaluating the prototype computer aided detection system.

We continuously strive to improve the performance of the developed CAD system that meet the needs of clinical practice. Our achievements encourage us to promote the research and develop the core technologies of CAD systems for early diagnosis and treatment of asbestos-related diseases.