研究成果の刊行に関する一覧表

書籍：なし

雑誌：

学会発表：

1．溶接工肺のCT所見：珪肺との比較、髙橋雅士（友仁山崎病院 放）、新田哲久（滋賀医大 放）、岸本卓巳（岡山労災病院 呼内）、大塚義紀（北海道中央労災病院 呼内）、芦澤和人（長崎大学 臨床腫瘍学）、第316回公益社団法人日本医学放射線学会関西地方会、平成29年６月３日、ホテルエルセラーン大阪

2．CT Findings of Malignant Pleural Mesothelioma and Correlation with the Survival Period. Kato Katsuya, Genba Kenichi, Ashizawa Kazuto, Kishimoto Takumi, Fujimoto Nobukazu, Aoe Keisuke, Takeshima Yukio, Inai Kouki. World Congress Thoracic Imaging Boston（WCTI2017）. MA, USA. 2017/ 06/ 18

3．胸部３次元CT画像を用いたじん肺の粒状影の空間分布パターン解析、日野公貴、鈴木秀宣、河田佳樹、仁木　登（徳島大）、加藤勝也（川崎医科大）、岸本卓巳（岡山労災病院）、芦澤和人（長崎大）、電子情報通信学会　医用画像研究会、平成29年７月６－７日、東北大学　片平桜ホール

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Quantitative assessment for pneumoconiosis severity diagnosis using 3D CT images

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ABSTRACT

Pneumoconiosis is an occupational respiratory illness that occur by inhaling dust to the lungs. 240,000 participants are screened for diagnosis of pneumoconiosis every year in Japan. Radiograph is used for staging of severity rate in pneumoconiosis worldwide. CT imaging is useful for the differentiation of requirements for industrial accident approval because it can detect small lesions in comparison with radiograph. In this paper, we extracted lung nodules from 3D pneumoconiosis CT images by two manual processes and automatic process, and created a database of pneumoconiosis CT images. We used the database to analyze, compare, and evaluate visual diagnostic results of radiographs and quantitative assessment (number, size and volume) of lung nodules. This method was applied to twenty pneumoconiosis patients. Initial results showed that the proposed method can assess severity rate in pneumoconiosis quantitatively. This study demonstrates effectiveness on diagnosis and prognosis of pneumoconiosis in CT screening.

Keywords: pneumoconiosis, computed tomography, computer aided diagnosis

1. INTRODUCTION

Pneumoconiosis is an occupational respiratory illness that occur by inhaling dust to the lungs. 240,000 participants are screened for diagnosis of pneumoconiosis every year in Japan. Radiograph is used for staging of severity rate in pneumoconiosis worldwide. The International Labor Office (ILO) provides a staging of pneumoconiosis using radiographs [1]. Its advantages are relatively low cost, low radiation dose, and wide availability. However, the chest radiograph is relatively insensitive for detecting early stage pneumoconiosis [2]. Chest CT scans are more sensitive than routine radiographs in detecting pneumoconiosis. However, the utility of CT as a screening modality is still a question of debate [3]. The reason is that CT scans are not recommended for routine surveillance due to the increased radiation exposure and the lack of scoring scheme [4]. Since 1992, several classification or coding systems for evaluating pneumoconiosis in CT studies have been reported [5]. We have analyzed the relationship between the size and frequency of lung nodules so as to quantify the severity rate of pneumoconiosis so far [6]. We extracted lung nodules from 3D pneumoconiosis CT images by two manual processes and automatic process, and created a database of pneumoconiosis CT images. We used this database to analyze, compare, and evaluate visual diagnostic results of radiographs and quantitative assessment (number, size and volume) of lung nodules. This method was applied to twenty pneumoconiosis patients. The results showed that the proposed method can assess severity rate in pneumoconiosis quantitatively. This study demonstrates effectiveness on diagnosis and prognosis of pneumoconiosis in CT screening.

2. MATERIALS AND METHODS

2.1 Materials

This study was approved by institutional review board in Nagasaki University. The scanning was carried out with 120 kV, 240mA, 1mm slice thickness, 512x512 matrix, pixel size of 0.625mm or 0.781mm, 1mm reconstruction interval, and

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FC13-H or FC52 convolution kernel. Private information that was contained in DICOM header information is replaced by a DICOM anonymization system [7].
Pneumoconiosis was classified into 12 stages based on a guideline defined by ILO: 0/-, 0/0, 0/1, 1/0, 1/1, 1/2, 2/1, 2/2, 2/3, 3/2, 3/3, 3/+. The total number of patients is twenty: stage 0/1 is five, stage 1/0 is five, stage 1/1 is five, and stage 2/2 is five. The stages were certified by consensual decision of physicians.

2.2 Methods

2.2.1 Manual extraction of lung nodules
Extraction of pulmonary nodules was set under the conditions of window level - 500 and window width 1500 and extracted using an axial plane. Extraction procedure was achieved in the order of right lung apex part, right lung bottom part, left lung apex part and left lung bottom part. This procedure was repeated many times. Micro nodules was extracted twice by one person. The period between the first time and the second time was more than 6 months or one week.

2.2.2 Detection of lung nodules
Our group has developed computer aided detection (CADe) and computer aided diagnosis (CADx) systems for lung cancer CT screening [8][9]. This CADe has detection functions for multi diseases; lung nodules, pleural diseases, emphysema, and osteoporosis [10][11][12]. In early stage of pneumoconiosis, a lot of small nodules are occurred, so this CADe is set so that nodules from 1 mm to 3 mm can be detected. The CADe detection result on the first and second logical sums are superimposed and newly reviewed, and if a nodule is detected, it is added to the database.

2.2.3 Quantitative assessment of pneumoconiosis
Severity rate in pneumoconiosis was assessed by number, size and volume of lung nodules. Assuming that nodules have spherical shape, nodule size is defined by a diameter that is computed from nodule volume. The number of nodules was counted by three dimensional labeling method.

2.2.4 Comparison and evaluation of the first and second manual extraction
To assess the inter-observer variability in the manual detection process, we computed precision, recall, and *F* scores based on the first and the second manual extractions. Additionally, the coincidence rates by size of the lung nodules were evaluated.

2.2.5 Comparison and evaluation between visual diagnostic results of radiographs and quantitative assessment results of CT images
Compared with the diagnosis obtained physicians' visual assessments based on radiographs, we investigated whether the quantitative assessments based on 3D CT images can improve the classification of severity rate of pneumoconiosis.

3. RESULTS

Fig.1 shows three dimensional distributions of lung nodules that extracted by this method. In Fig.1 (a), (b), (c), (d), (e) are stage 0/1, (f), (g), (h), (i), (j) are stage 1/0, (k), (l), (m), (n), (o) are stage 1/1, and (p), (q), (r), (s), (t) is stage 2/2. Several cases are found which do not coincide with diagnostic results mainly in cases of low severity rate. Table 1 shows evaluation results of the coincidence rates by sizes of lung nodules from first and second extraction results. For small nodules from 2mm to 4mm in diameter, the coincidence rate was low, and the coincidence rate was high for nodules with 4mm or more. This showed a similar tendency in other cases. Fig.2 shows the relationship between the number and volume of lung nodules in each case. It is suggested that it may not be accurately in the disease type classification using radiographs. Fig.3 shows the results of calculating the average number and standard deviation of lung nodules for each type classification of radiographs and CT images. Classification of CT images was classified according to the number of nodules. Table 2 shows the results of comparisons with radiographs and CT classification. Mann-Whitney U test was performed for each type, and comparison was performed at a signification level of 0.0083 (0.05 / 6) by the Bonferroni correction. As a result, there was no significant differences in classification of radiographs, but significant differences were found in classification using CT images. By quantitative assessment using CT images, there is a possibility that the severity rate of pneumoconiosis can be accurately classified.

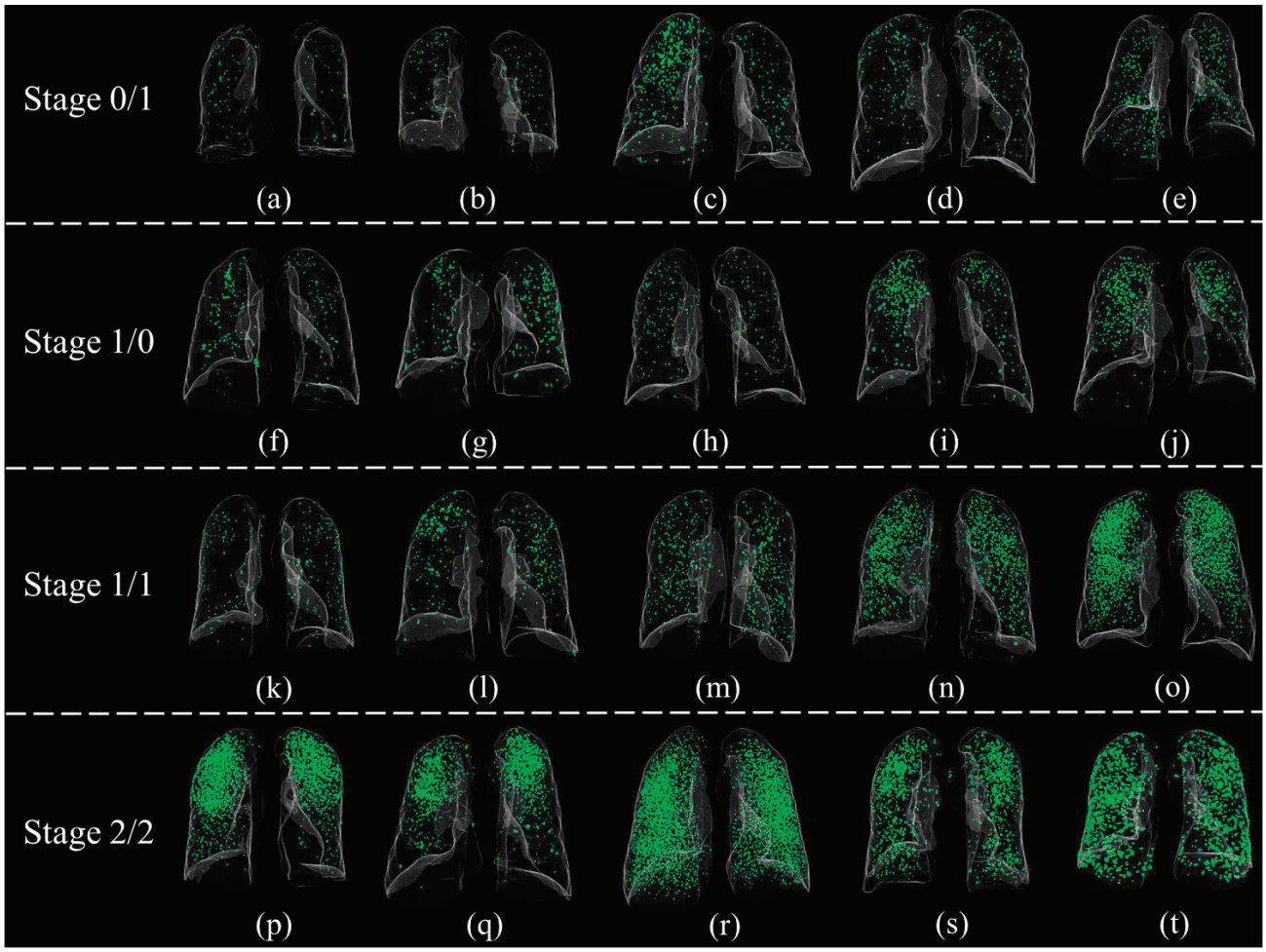


Fig.1 Three dimensional distribution of extracted lung nodules.

Table 1: Coincidence rate by size of lung nodules of first and second times (case 1/0(g)).

diameter[mm]	The number of lung nodules			Coincidence rate	
	Final	First	Second	First	Second
0<d<1	0				
1≤d<2	1	0	1		
2≤d<3	75	51	68	0.654	0.872
3≤d<4	124	118	121	0.944	0.968
4≤d<5	42	42	42	1	1
5≤d<6	6	6	6	1	1
6≤d<7	4	4	4	1	1
7≤d<8	1	1	1	1	1
8≤d<9	1	1	1	1	1
9≤d<10	0				

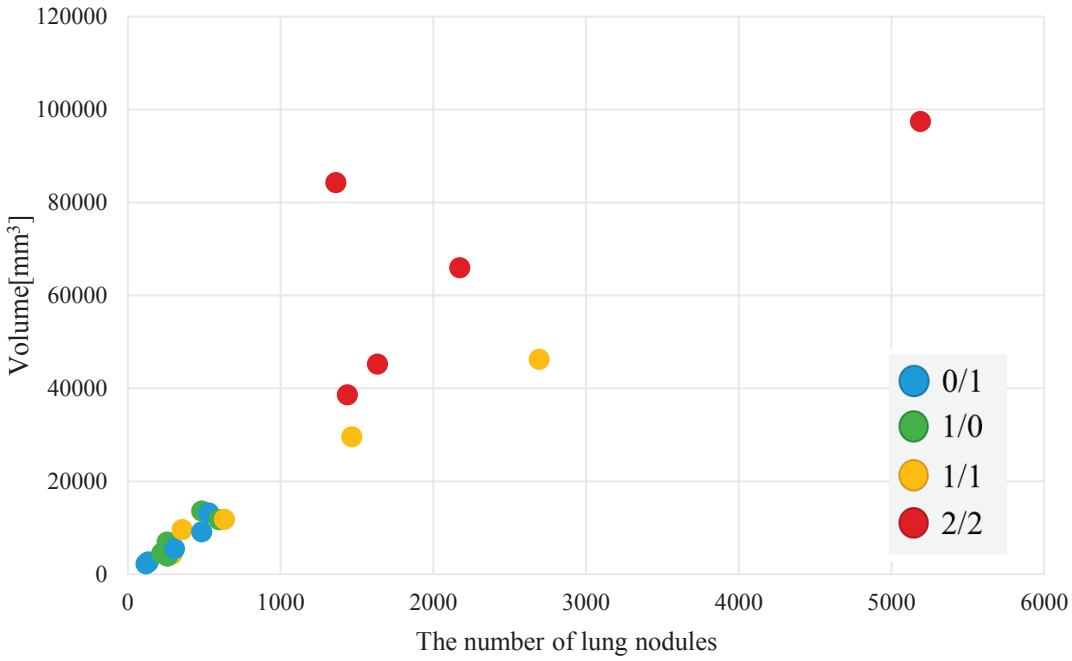
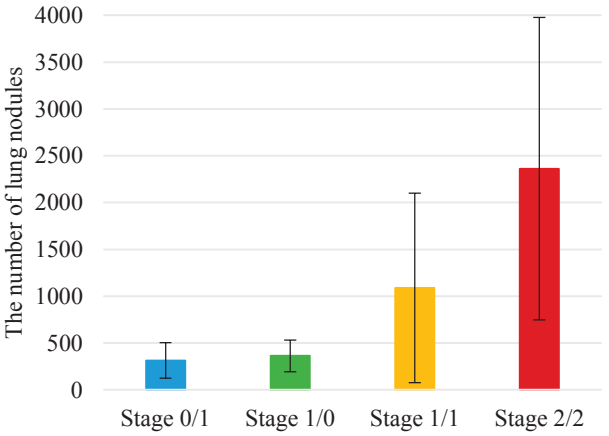
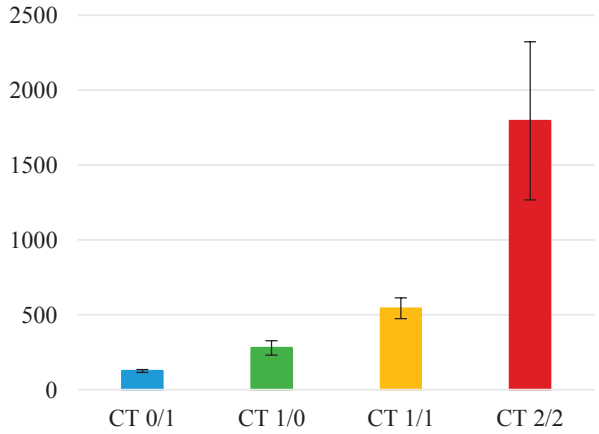


Fig.2 Relationship between the number of lung nodules and volume



(a) Average number and standard deviation of lung nodules in disease type classification using radiographs



(b) Average number and standard deviation of lung nodules in disease type classification using CT images

Fig 3. The evaluation results of the disease type classification using the radiographs and the disease type classification using the CT images

Table 2: Comparison disease type classification with radiographs and CT

(a) Classification of radiographs

Radiographs	
Disease type classification	p-value
Stage 0/1-1/0	0.7540
Stage 0/1-1/1	0.1171
Stage 0/1-2/2	0.0090
Stage 1/0-1/1	0.0758
Stage 1/0-2/2	0.0090
Stage 1/1-2/2	0.1745

(b) Classification of CT images

CT images		
Disease type classification	p-value	
CT 0/1-1/0	2.26E-19	*
CT 0/1-1/1	1.59E-17	*
CT 0/1-2/2	2.26E-19	*
CT 1/0-1/1	0.0062	*
CT 1/0-2/2	0.0040	*
CT 1/1-2/2	0.0062	*

*: $p < 0.0083$ (0.05 / 6)

4. CONCLUSIONS

We extracted lung nodules from 3D pneumoconiosis CT images by two manual processes and automatic process. We used this database to analyze, compare, and evaluate visual diagnostic results of radiographs and quantitative assessment (number, size and volume) of lung nodules. By presenting the results of quantitative assessment using CT, it becomes possible to more accurately classify severity of pneumoconiosis, and high diagnostic accuracy can be expected.

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