Introduction

Lung cancer is one of the most common neoplasms worldwide, accounting for more than 10% of all malignant tumors, but the long-term survival rate remains low. In Japan, lung cancer is also the leading cause of cancer-related death in male individuals and the second leading cause of cancer-related death in female individuals; deaths due to lung cancer are estimated to have affected more than 77,000 people in 2016 (National Cancer Center Japan Report 2016: http://ganjoho.jp/reg_stat/statistics/stat/summary.html). Chest radiographic screening is a commonly used conventional method for the detection of lung and mediastinal tumors. However, majority of the lung cancer detected by chest radiography are those that have already progressed to the advanced stage. Recent studies have shown that low-dose spiral computed tomography (LDCT) is effective for the early stage detection of lung cancer. On the other hand, usability of early stage detection of mediastinal tumors on chest LDCT is still obscure because of the rarity of these tumors. The purpose of this study was to reappraise and to clarify the usefulness of LDCT in the early detection of lung and mediastinal tumors.

Materials and Methods

Subjects

Among more than 300,000 people who underwent medical check-ups consecutively for 6 years (from April 1, 2010 to March 31, 2016) at our institution (Healthcare Center, Shinjuku-oiwake Clinic and Ladies, Seikokai), 2,395 people who also underwent LDCT were enrolled in this study. The presence of lung and mediastinal tumors was investigated in these individuals.

Results

Ten cases of lung and mediastinal tumors were detected on LDCT. Seven of these 10 cases were detected on LDCT only, and no abnormal opacity was observed on chest radiography. Five cases were finally diagnosed as malignant (4 lung cancer and 1 mediastinal sarcoma). Among the 5 malignant cases, 4 were also detected on LDCT only, and were successfully resected, and no tumor recurrence has been observed.

Conclusion

These results suggest that screening with LDCT is more useful than screening with radiography. LDCT contributes to the early detection of lung and mediastinal tumors.

Key words

Computed tomography, radiography, lung cancer, mediastinal tumor
In total, the present study consisted of 2,395 individuals, including 1,794 males (aged 14–75 years, mean 48.7 years) and 601 females (aged 24–74 years, mean 48.1 years). The presence of lung and mediastinal tumors was investigated in these populations. This study was conducted in accordance with the ethical principles, and each participant was fully respected and security of personal information was provided to participant. The study protocol was approved by the Seikokai Group Ethics Committee.

Methods

CT measurement was performed using a 4-row helical CT (ROBUSTO; Hitachi, Tokyo) with a condition of 50 mA at 120 KV and no use of contrast medium, and 5 mm-axial images were evaluated. A chest radiography and LDCT interpretation was made by radiologists and pulmonologists with at least double-checking or triple-checking where appropriate. In cases that needed further examination, patients were referred to special hospitals and a final diagnosis was made by the chest surgical specialists.

Results

Among 2,395 individuals, 10 cases of thoracic tumors were found, including 5 lung tumors and 5 mediastinal tumors (Table 1). Seven of these 10 cases were detected using LDCT only (case No. 1, 2, 3, 6, 7, 8, and 10), and no abnormal opacities were observed on chest radiography (i.e. Figs. 1AB and 2AB). Among the 3 remaining cases detected using chest radiography, 2 cases needed careful interpretation to find a tumorous shadow (i.e. Fig. 3AB). Five cases were finally diagnosed as malignant including 4 lung cancer cases (case No. 1, 2, 3, and 4) and 1 case of mediastinal sarcoma (case No. 6). Among the 5 malignant cases, 4 were successfully resected (case No. 1, 2, 3, and 6), and to date, no tumor recurrence has been observed. All resected malignant tumor cases were detected using LDCT within the early stage, and thoracoscopic surgery for the tumor resection could be performed. The remaining case (case No. 4), which was detected on both chest radiography and LDCT, had already progressed to advanced disease, and systemic chemotherapy was performed for treatment. This case was diagnosed as small cell lung cancer. All malignant patients were over the age of 50 years, and 4 patients were current smokers. In this study, we also detected 3 other benign mediastinal tumors by LDCT, which led to surgical treatment (case No. 7, 8, and 10). No tumor recurrence has also been observed in these patients to date.

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**Table 1 Characteristics of thoracic tumor cases**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age(year)</th>
<th>Sex</th>
<th>Tumor Location</th>
<th>Diagnosis</th>
<th>Detection</th>
<th>Smoking</th>
<th>Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>58</td>
<td>M</td>
<td>Lung (right lower lobe)</td>
<td>NSCLC (stage I)</td>
<td>LDCT</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>55</td>
<td>M</td>
<td>Lung (right middle lobe)</td>
<td>NSCLC (stage I)</td>
<td>LDCT</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>64</td>
<td>M</td>
<td>Lung (left upper lobe)</td>
<td>NSCLC (stage I)</td>
<td>LDCT</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td>67</td>
<td>M</td>
<td>Lung (left main bronchus)</td>
<td>SCLC (ED)</td>
<td>LDCT + radiography</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>42</td>
<td>M</td>
<td>Lung (right middle lobe)</td>
<td>Hamartoma</td>
<td>LDCT + radiography</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>63</td>
<td>M</td>
<td>Mediastinum (anterior)</td>
<td>Liposarcoma</td>
<td>LDCT</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>7</td>
<td>51</td>
<td>M</td>
<td>Mediastinum (anterior)</td>
<td>Thymoma</td>
<td>LDCT</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>8</td>
<td>40</td>
<td>F</td>
<td>Mediastinum (anterior)</td>
<td>Teratoma</td>
<td>LDCT</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>27</td>
<td>M</td>
<td>Mediastinum (posterior)</td>
<td>Neurofibroma</td>
<td>LDCT + radiography</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>56</td>
<td>M</td>
<td>Mediastinum (middle)</td>
<td>Bronchogenic cyst</td>
<td>LDCT</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

LDCT: low-dose spiral computed tomography

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Fig. 1A  Chest radiograph of case No. 1. There was no obvious abnormal shadow.

Fig. 1B  Chest LDCT of case No. 1. There was a ground-glass opacity on a right lower lobe segment 9. This case was finally diagnosed as a lung cancer.
Discussion

Lung cancer is an aggressive and heterogeneous disease\(^4\)\(^{\text{-}}\)\(^{11}\), and is still the leading cause of cancer-related death in both the United States\(^2\) and Japan, despite a lower incidence of lung cancer compared to gastric and colon cancer (National Cancer Center Japan Report 2016: http://ganjoho.jp/reg_stat/statistics/stat/summary.html). One feature of lung cancer is that the majority of patients have evidence of spread at the time of presentation. Early stage detection is infrequent and usually serendipitous in outpatients. Recently, several studies showed that screening using LDCT contributed to the early stage detection\(^1\)\(^{\text{-}}\)\(^{20}\) and saved lives\(^3\)\(^{\text{-}}\)\(^{21}\) from lung cancer when compared with screening using chest radiographs. Therefore, early stage detection of lung cancer in health check-ups within the no symptom period is important and may reduce cancer related deaths. In our present study, we detected 3 lung cancers using LDCT (case No. 1, 2, and 3), and could perform thoracoscopic resection within the early stage. These 3 patients are still alive and disease free after operation more than 30 months to date. Unfortunately, we could not detect the remaining lung cancer case (case No. 4) at an early stage despite screening with LDCT by every year. This case was of a small cell lung cancer, which is one of the most rapidly progressing cancers in humans. On the other hand, all patients with lung cancer (case No. 1, 2, 3, and 4) were current smokers and were male individuals over the age of 50 years. In total, 802 men were included in this generation (>50 years), and 265 of 802 were current smokers. We could detect lung cancer cases in this population at a high rate (1.5%; 4/265). For this reason, we encourage CT examinations in health check-ups for male individuals over the age of 50 years who have smoking habit.

In this study, we also detected 5 cases of mediastinal tumors by LDCT and chest radiography, and of these, 4 cases were detected using only LDCT. Case No. 9 could also be detected using chest radiography; however, careful interpretation was needed to find this shadow as shown Fig. 3A. LDCT could detect these tumors easily compared to chest radiography as shown Fig. 3B.
It is noteworthy that we could detect a mediastinal liposarcoma, which is known as a disease with a poor prognosis\textsuperscript{22} at the early stage and this led to surgical resection. On the contrary, chest radiography did not contribute to the early detection of malignant tumors in the present study despite resectability being the important prognostic factor in thoracic malignancies\textsuperscript{23-26}. It is known that mediastinal tumors occur less frequently than lung tumors, and more than 80% of these tumors are benign histologic types\textsuperscript{25, 27}. However, in our knowledge, the epidemiological studies of mediastinal tumors in health check-up have seldom reported and precise incidence of this tumor is still obscure. In this study, we could detect 5 mediastinal tumors in 2,395 individuals (0.21\%) by using LDCT, and this was approximately the same frequency as that of lung tumors. We consider that more mediastinal tumors might potentially exist but are presently not detected because of their anatomical location and silent clinical course compared with lung tumors, although further studies are needed to confirm our results.

There are some problems associated with CT screening including false positive scans of benign nodules, exposure to radiation, and the expensive cost. In this study, we excluded individuals who were followed-up periodically owing to a small nodular or infiltrative shadow; however, numerous individuals still need to be followed-up every year. CT imaging also involves more radiation exposure than chest radiography. The average dose for a standard CT scan of the chest is approximately 7 mSv, which results in high exposure to radiation\textsuperscript{29}. Whereas, the average dose for LDCT imaging is approximately 1.5 mSv and this is rather less than the exposure to the upper gastrointestinal series\textsuperscript{29} and is approximately half of the natural ambient exposure of approximately 3 mSv per year\textsuperscript{29, 30}. Regarding the cost, LDCT is almost equal to Barium fluoroscopy in health check-up centers in Japan (10,000–15,000 JPY). Barium fluoroscopy is usually performed as a routine examination in health check-ups or Ningen Dock for patients over the age of approximately 40 years; however, CT examination is usually optional in health check-ups. We consider that LDCT takes less time and is less uncomfortable than Barium fluoroscopy; therefore, we recommend using LDCT examinations as well as Barium fluoroscopy at least for male individuals over the age of 50 years who have a smoking habit.

In this study, we could also detect other lung inflammatory diseases such as lung tuberculosis and cryptococcus disease using LDCT only (data not shown). We could refer these cases to the specialists within the phase of no abnormal shadow in chest radiography, and this led to early treatment by antibiotics. In addition, we often detect slight interstitial change of pulmonary fibrosis and incipient low attenuation area of chronic obstructive pulmonary disease (COPD) using LDCT within the phase of no symptom (data not shown). Recently, there have been a considerable number of people detected to have chronic lung diseases\textsuperscript{32}, and above all, COPD is the leading cause of morbidity and mortality in several countries\textsuperscript{32, 33}. Prevalence of COPD is estimated to be more than 5 million people in Japan\textsuperscript{41}, and numerous studies have been conducted\textsuperscript{15,37}. However, COPD is not well recognized in our country despite of these situations. We consider that LDCT contributed to the early detection of not only the thoracic tumors but also various lung diseases like COPD as mentioned above.

In summary, we could detect 7 lung and mediastinal tumor cases by LDCT only, including 4 malignant tumors, and this led to surgical resection at an early stage. We suggest including LDCT examination in health check-ups, especially for male individuals over the age of 50 years. While it may be argued that the CT examination of thoracic tumors in health check-up is not sufficiently established to allow a valuable method especially mediastinal tumors, we submit that our current data is sufficiently compelling to elicit further analysis by investigators with access to similar research. As such, the present study may shed some light on the path by which further insight into these intriguing thoracic tumors might be gained.

The preliminary data of this study about mediastinal tumors was presented at the 15th World Congress on Lung Cancer (WCLC) in Sydney and the 18th Congress of the Asian Pacific Society of Respirology (APSR) in Yokohama. The preliminary data of this study about lung cancer was presented at the 25th and 26th Annual Meetings of the International Health Evaluation and Promotion Association (IHEPA) in Taipei and Tokyo, respectively.

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The authors state that they have no Conflict of Interest (COI).

REFERENCES


