

**Original
Article**

Necessity of Thin Section CT in the Detection of Pulmonary Metastases: Comparison between 5 mm and 1 mm Sections of CT

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Background: The aim of this study was to evaluate the difference in the ability of 1-mm and 5-mm section Computed Tomography(CT) to detect pulmonary metastases in patients with pulmonary metastases.

Methods: We retrospectively analyzed the CT findings of 106 patients with pulmonary metastases due to malignancies treated at Toho University Omori Medical Center between 2013 and 2020.

Results: Cases with only one nodule evaluated by 5-mm section CT had significantly lower discordance with 1-mm section CT than cases with two or more nodules detected by a 5 mm section ($p = 0.0161$). After reference to a 1 mm section, cases with only one nodule reevaluated by 5-mm section CT had significantly lower discordance than cases with two or more nodules reevaluated using 5-mm section CT. In cases with only one nodule, reevaluation using a 5 mm section was consistent with evaluation using a 1 mm section. However, this was not observed in cases with two or more nodules, with a significant difference between one nodule and two or more nodules.

Conclusions: If there are two or more nodules observed in 5-mm section CT it may be necessary to reevaluate using 1-mm section CT to determine the exact number of pulmonary metastases.

Keywords: pulmonary metastases, CT, thin section

Introduction

In patients with pulmonary metastases from a variety of primary tumors it is necessary to completely resect

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these metastases for long-term survival.¹⁾ However, only a few patients are suitable candidates for surgery²⁾ and preoperatively it is necessary to carry out appropriate evaluation of the pulmonary metastases.²⁾

To ensure complete resection of pulmonary metastases it is necessary to determine whether or not these can be resected.²⁾ Although Computed Tomography(CT) is an important imaging tool to evaluate the resectability of pulmonary metastases,²⁾ the inaccuracy of conventional CT makes it difficult to use low invasive video-assisted thoracic surgery (VATS).¹⁾ The parameters of the CT are an important factor for the detection of pulmonary metastases with a small diameter.³⁾

The aim of this study was to evaluate differences between 1-mm and 5-mm section CT to detect pulmonary metastases.

Patients and Methods

This study was approved by the Ethics committee of Toho University Omori Medical Center (M19108). We retrospectively analyzed the CT findings and clinical features of 106 patients with resected pulmonary metastases treated at Toho University Omori Medical Center between 2013 and 2020. Of the 106 patients with surgical resection, 98 patients had curative resection and 8 had surgical resection for definitive diagnoses. This study included patients with multiple resections. We counted patients with two resections at different periods as two cases although we did patients with simultaneous resections for multiple nodules as one case.

This study examined the number of metastatic lung nodules detected on 5-mm and 1-mm section CT (**Fig. 1**). On the axial plane, the findings of 5-mm section CT were reviewed based on the findings of 1-mm section CT. The following data were retrieved from the patients' medical records: gender, age, and primary tumor.

Chest CT was performed using a 64-row multidetector scanner. Axial images in lung window (window level -600 HU, window width 1600 HU) were reconstructed with 5-mm slices pitch without overlap from

both lungs and with 1-mm slices pitch without overlap from one lung or both lungs.

Statistical Analysis

The chi-square test was used to assess differences in the CT findings.

Results

Table 1 summarizes the characteristics of the patients. There were no significant differences between the presence of one and two or more nodules in the primary sites (**Table 2**).

The results of 73 cases with one nodule detected by 5-mm section CT were not consistent with those obtained by 1-mm section CT (**Tables 3 and 4**). There was a significantly greater difference between the findings of the 5-mm and 1-mm section in cases with two or more nodules compared to cases with one nodule (**Table 4**, $p = 0.0161$).

When 5-mm section CT was reviewed based on the findings of 1-mm section CT there was a significant difference between the review and original images with two or more nodules (**Table 4**, $p = 0.0161$).

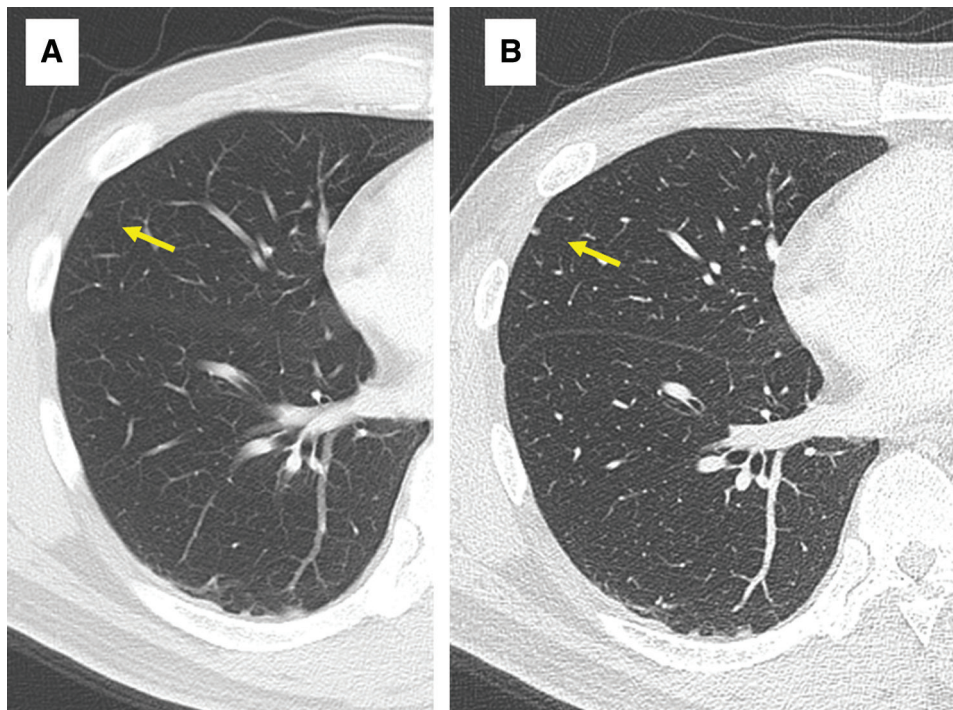


Fig. 1 The findings of 5-mm section CT (**A**) and 1-mm-section CT (**B**). Although the 5 mm section revealed an unclear shadow of a pulmonary metastasis, the 1 mm section could clearly identify this lesion.

Table 1 Characteristics of the patients with pulmonary metastases

| Clinical factor | Total |
|---------------------|-------|
| Patient number | 106 |
| Age (range) | 43–86 |
| Mean | 66 |
| Gender | |
| Male:female | 64:42 |
| Primary site | |
| Colon | 49 |
| Rectum | 29 |
| Kidney | 6 |
| Mamma | 5 |
| Uterus | 3 |
| Lung | 2 |
| Sarcoma | 2 |
| Esophagus | 1 |
| Larynx | 1 |
| Mediastinum | 1 |
| Parotid gland | 1 |
| Pharynx | 1 |
| Stomach | 1 |
| Submandibular gland | 1 |
| Tongue | 1 |
| Urinary bladder | 1 |
| Other | 1 |

Table 2 Site of primary tumor, grouped according to the number of nodules observed by 5 mm CT

| Number of metastasis in 5 mm section | Number of metastasis in 5 mm section | | p-value |
|--------------------------------------|--------------------------------------|-----------|---------|
| | 1 | 2 or more | |
| Colon | 30 | 19 | 0.8658 |
| Rectum | 17 | 12 | |
| Kidney | 3 | 3 | |
| Mamma | 2 | 3 | |
| Other | 11 | 6 | |

Comparison of the findings of 5-mm section CT based on those of 1-mm section CT showed a significant difference in cases with two or more nodules, whereas there was complete concordance in cases with only one nodule (Table 4, p = 0.0005).

Discussion

When making a decision to carry out a metastasectomy for a pulmonary metastasis, it is very important to determine whether the lesions are resectable.¹⁾

Complete resection of pulmonary metastases is necessary for long-term survival in patients with pulmonary metastases.²⁾ In turn, a curative resection of pulmonary metastases relies on accurate diagnosis of metastatic lung nodules.³⁾

Table 3 Concordance between CT 5 mm and thin (1 mm) sections for detecting pulmonary metastases

| Case number | 5 mm section | Thin section (1 mm) | 5 mm reviewed |
|-------------|--------------|---------------------|---------------|
| 63 | 1 | 1 | 1 |
| 6 | 1 | 2 | 2 |
| 1 | 1 | 3 | 2 |
| 2 | 1 | 3 | 3 |
| 1 | 1 | 5 | 3 |
| 14 | 2 | 2 | 2 |
| 3 | 2 | 3 | 3 |
| 1 | 2 | 4 | 4 |
| 2 | 2 | 8 | 7 |
| 6 | 3 | 3 | 3 |
| 2 | 3 | 4 | 4 |
| 1 | 4 | 4 | 4 |
| 1 | 6 | 10 | 9 |
| 1 | 7 | 12 | 8 |
| 1 | 11 | 13 | 12 |
| 1 | 11 | 14 | 14 |

Table 4 Comparison among 5mm, 5mm reviewed, and 1mm section

| Number of metastasis in 5 mm section | Concordance with thin section | Discordance with thin section | p-value |
|---|-------------------------------|-------------------------------|---------|
| Comparison of 5 mm and 1 mm sections | | | |
| 1 | 63 | 10 | 0.0161 |
| 2 or more | 21 | 12 | |
| Review of comparison of original and review 5 mm sections | | | |
| 1 | 63 | 10 | 0.0161 |
| 2 or more | 21 | 12 | |
| Comparison of 5 mm review and 1 mm sections | | | |
| 1 | 63 | 0 | 0.0005 |
| 2 or more | 35 | 8 | |

However, previous studies have reported negative results regarding conventional CT.³⁾ Diederich et al. demonstrated that surgical exploration was necessary to detect pulmonary nodules smaller than 6 mm or pleural lesions, with the sensitivity of helical CT being better than that of conventional CT in patients with pulmonary nodules.⁴⁾ Parsons et al. reported that metastases detected by intraoperative lung palpation were not seen on preoperative helical CT in 27 of 59 (46%) cases reviewed by a radiologist and 27 of 58 (47%) cases reviewed by a second radiologist.⁵⁾ Another study in 152 patients with an open metastasectomy showed that 30 had non-imaged malignant nodules that could be palpated and therefore required removal.⁶⁾ Chung et al. reported that additional metastatic tumors could be identified at open thoracotomy in 32 of 120 (26.7%) patients with pulmonary colorectal metastases.⁷⁾ In that report, a low sensitivity for detecting pulmonary metastatic nodules indicated that in

spite of advances in CT, it is necessary to palpate the lung to ensure complete resection of detectable lesions.⁸⁾

Over time there have been improvements in CT⁹⁾ and now 1-mm section CT is able to detect all pulmonary metastatic nodules that intraoperative palpation is able to identify.²⁾ It may also be possible to adapt VATS for complete resection of pulmonary metastatic nodules. Therefore, we planned this study to determine the usefulness of 1-mm section CT for the detection of metastatic lung nodules.

Our results showed that 1-mm section CT makes it possible to detect more pulmonary metastases. This result was quite predictable; however, we revealed that reevaluation of 5-mm section CT and careful examination of these sections are useful for detecting one pulmonary metastatic nodule although in cases with two or more nodules 5-mm section CT might not detect all pulmonary metastatic nodules. We recommend that 1-mm section CT should be used for the detection of pulmonary metastatic nodules in cases which are suspected to have two or more nodules. In this regard, Chung et al. reported that although CT had high sensitivity to detect a unilateral solitary nodule, it had low sensitivity to detect bilateral multiple nodules.⁷⁾ These results are consistent with the findings of our study.

How many of the pulmonary metastases are considered applicable for operative indication? There is no consensus as to the number of resectable metastases and all of the tumor must be completely resectable with adequate remaining pulmonary reserve on curative resection.¹⁾ One-millimeter section CT may affect indications for metastasectomy because 1-mm section CT may detect non-malignant pulmonary nodules and we may overlook cases that would have been eligible for curative resection. Therefore, we should assess not only the number of nodules but also the imaging and clinical features of the nodules and decide the diagnosis of metastases and indications for metastasectomy.^{1,10)}

There were several limitations in this study. First, the study was a retrospective design. Second, the study included several types of malignancy, rather than a single type. Third, we could not evaluate the usefulness of sagittal or coronal view because we did not take sagittal or coronal view of 5-mm section CT. Notwithstanding these limitations, we report the significant findings of this study.

Conclusions

The use of 5-mm section CT for evaluation of the number of pulmonary metastases should be evaluated

carefully. We recommend that 1-mm section CT should be used to evaluate pulmonary metastases. This is especially relevant if two or more nodules are identified by 5-mm section CT, and in these cases it is necessary to reevaluate the number of pulmonary metastases using 1-mm section CT in order to determine the exact number of lesions.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Toho University Omori Medical Center (M19108). This study was conducted using patient data from 2013 to 2020. Because the study was a retrospective design we used the existing information of all patients that did not require permission to access. We also used individual data without obtaining individual consent from all patients according to the Ethical Guidelines for Medical and Health Research Involving Human Subjects of the Ministry of Health, Labour and Welfare in Japan (<https://www.mhlw.go.jp/file/06-Seisakujouhou-10600000-Daijinkanboukouseikagakuka/0000080278.pdf>).

The presented study design was accepted by the ethics committee on the condition that a document that declared an opt-out policy by which any potential patient and/or their relatives could refuse enrollment in the study would be uploaded on the Web page of the Toho University Omori Medical Center.

Author Contributions

YA, TS, SK, HO, AS, and AI were involved in the conception and design of the study. AI wrote the manuscript. YA, TS, SK, HO, and AS collected the data. All authors read and approved the final manuscript.

Disclosure Statement

We have no conflicts of interest to declare for this study.

References

- 1) Erhunmwunsee L, Tong BC. Preoperative evaluation and indications for pulmonary metastasectomy. *Thorac Surg Clin* 2016; **26**: 7–12.
- 2) Kang MC, Kang CH, Lee HJ, et al. Accuracy of 16-channel multi-detector row chest computed tomography with thin sections in the detection of metastatic pulmonary nodules. *Eur J Cardiothorac Surg* 2008; **33**: 473–9.

- 3) Margaritora S, Porziella V, D'Andrilli A, et al. Pulmonary metastases: can accurate radiological evaluation avoid thoracotomic approach? *Eur J Cardiothorac Surg* 2002; **21**: 1111–14.
- 4) Diederich S, Semik M, Lentschig MG, et al. Helical CT of pulmonary nodules in patients with extrathoracic malignancy: CT-surgical correlation. *AJR Am J Roentgenol* 1999; **172**: 353–60.
- 5) Parsons AM, Ennis EK, Yankaskas BC, et al. Helical computed tomography inaccuracy in the detection of pulmonary metastases: can it be improved? *Ann Thorac Surg* 2007; **84**: 1830–6.
- 6) Cerfolio RJ, Bryant AS, McCarty TP, et al. A prospective study to determine the incidence of non-imaged malignant pulmonary nodules in patients who undergo metastasectomy by thoracotomy with lung palpation. *Ann Thorac Surg* 2011; **91**: 1696–700; discussion 1700–1.
- 7) Chung CC, Hsieh CC, Lee HC, et al. Accuracy of helical computed tomography in the detection of pulmonary colorectal metastases. *J Thorac Cardiovasc Surg* 2011; **141**: 1207–12.
- 8) Parsons AM, Detterbeck FC, Parker LA. Accuracy of helical CT in the detection of pulmonary metastases: is intraoperative palpation still necessary? *Ann Thorac Surg* 2004; **78**: 1910–6; discussion 1916–8.
- 9) Wormanns D, Ludwig K, Beyer F, et al. Detection of pulmonary nodules at multirow-detector CT: effectiveness of double reading to improve sensitivity at standard-dose and low-dose chest CT. *Eur Radiol* 2005; **15**: 14–22.
- 10) Loverdos K, Fotiadis A, Kontogianni C, et al. Lung nodules: a comprehensive review on current approach and management. *Ann Thorac Med* 2019; **14**: 226–38.