Ciliated muconodular papillary tumor with a growing cavity shadow that mimicked colorectal metastasis to the lung: a case report

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Abstract
Background: Ciliated muconodular papillary tumor (CMPT) is a rare papillary nodule tumor with benign and malignant characteristics that occurs in the peripheral lung.

Case presentation: A 70-year-old woman who underwent right hemicolectomy for colorectal cancer (CRC; pT3N0M0, p-stage II) 2 years prior, presented with a sub-centimeter growing cavity shadow on chest computed tomography (CT), which was suspected to be a CRC metastasis. Because positron emission tomography CT suggested there was no other site suspicious of recurrence, thoracoscopic resection with preoperative pleural dye marking was planned to remove the small lesion, which seemed to be hardly palpable on CT. Immediately after pleural dye marking adjacent to the lesion using cone beam CT in the hybrid operating room, thoracoscopic wedge resection was performed and the tumor was finally diagnosed as CMPT, characterized by the papillary growth of mucus-producing cells in the alveoli.

Conclusion: We resected the non-palpable small lung lesions following preoperative marking using cone-beam CT in the hybrid operating room. This case highlights a rare cavitary CT image of a CMPT mimicking a metastatic lung tumor from colorectal cancer.

Keyword: Ciliated muconodular papillary tumor, Cavity shadow, Metastatic lung tumor, Non-palpable tumor

Background
Ciliated muconodular papillary tumor (CMPT) is a rare peripheral lung tumor, characterized by the papillary growth of ciliated columnar, mucous, and basal cells. Our case was unusual because a growing cavitary lesion detected by computed tomography (CT) initially led us to suspect a colorectal cancer (CRC) metastasis.

Case presentation
A 70-year-old woman with a 45-year smoking history, who had undergone colectomy for CRC (pT3N0M0, p-stage II) 2 years prior, presented with a CT nodule shadow in her right lower pulmonary lobe that had grown from 0.2 cm at her right hemicolectomy (Fig. 1a) to 0.3 cm at 12 months, and to 0.5 cm at 14 months postoperatively (Fig. 1b). The serum levels of tumor markers were within their normal ranges; CEA, 2.9 ng/mL; CA19-9, 6.8 U/mL; CA125, 4.0 U/mL. Because this growing cavitary lesion with a slightly irregular wall thickness suggested CRC metastasis, a thoracoscopic resection was performed.

As the lesion was barely palpable, preoperative marking was required. Although the dye material was radiolucent, the tip of the catheter used for dye marking was radiopaque. After confirming the positional relationship between the tumor and the tip of the catheter by using cone beam CT in the hybrid operating room, dye marking with indigo-carmine dye (0.3 mL) by bronchoscopy...
was performed at a point around 5 mm cranial to the tumor. Preoperative marking took 6 min with two CT inspections (Fig. 2a, b). Intraoperatively, the tumor had no gross pleural changes, but because it was slightly palpable at 5 mm caudal from the dyed site, we performed a wedge resection (Fig. 2c). Intraoperative frozen sections revealed fibrotic tissues with no apparent malignant cells, which did not match the CRC tissue. Permanent sections showed proliferating papillary cells with cilia adjacent to the bronchi and mucous glands around the cystic wall; the alveolar structure was intact and was composed of normal epithelial cells, with no atypical cells (Fig. 3a, b). Immunohistochemically, the lesion was positive for cytokeratin-7 (CK7), focal positive for thyroid transcription factor-1 (TTF-1), and negative for cytokeratin-20 (CK20) and caudal type homeobox-2 (CDX2), which ruled out CRC metastasis (Fig. 3c, d). We therefore diagnosed the tumor as CMPT. The patient has remained recurrence-free for 7 months.

Discussion

Since CMPT was first reported in 2002 by Ishikawa et al., only 60 cases have been reported and it has not been categorized by the World Health Organization [1, 2] (Table 1). CMPT reportedly occurs more frequently in women (males:females, 1:1.2), and has no correlation with smoking history. Although it usually presents as a peripheral nodule with ground glass opacity (GGO) on
CT (median size, 10 mm; range, 4–45 mm), only 13% of reported cases show central cavitation on CT, and a recent case series (n = 16) to assess thin-section CT features of CMPT showed no cases of cavity formation [3].

Our case presenting with a growing cavity shadow was radiographically suspected to be CRC metastasis, because necrotic components, known as dirty necrosis, which suggest a colorectal origin, were considered to be drained through the airway [4]. However, the specimen was CK7+/TTF1+/CDX2−/CK20−, which indicated that it was not a metastasis. CMPT typically shows distinct papillary growth of a mixture of ciliated columnar, mucous, and basal cells, often with central mucin accumulation, focal fibrosis, and a disrupted alveolar framework, which correlates with cavitation on CT. Because differential diagnosis of CMPT includes adenocarcinoma with cilia formation, mucinous adenocarcinoma, mucoepidermoid carcinoma, peribronchiolar metaplasia, and glandular papilloma, intraoperative diagnosis of these lesions from a small specimen can be challenging. To our knowledge, only two CMPT cases have been diagnosed intraoperatively, both of which by facilities that had previously diagnosed CMPT [5]. Histopathologically, our CMPT was diagnosed as a benign lesion; however, some reports suggest it to be a precursor of adenocarcinoma because they had confirmed BRAF, EGFR, and ALK mutations, which occur early in lung adenocarcinogenesis. In our case, BRAF immunostaining was positive for only cilia cell, and the tumor itself was not stained (Fig. 3e); however, other studies reported that epithelial cells and cytoplasm had been stained [6, 7]. Because CMPT is rare and lacks accumulated studies, whether these molecular findings support CMPT being an adenocarcinoma precursor remains unclear.

Regarding optimal resection, in a thoracoscopic setting without any preoperative marking, accurate localization of the 6-mm tumor located apart from the pleura seemed to be difficult [8, 9]. Generally, preoperative marking methods for small lesions include CT-guided marking and bronchoscopic marking. However, CT-guided marking with hook wires can cause pneumothorax, bleeding, and potentially fatal air embolism in about 1.3% of cases [10]. On the other hand, bronchoscopic marking has a lower risk of complications compared to the former method, but if the lesion is too faint to be identified using fluoroscopy or when it located deep to the pleura, the marking procedure itself tends to be difficult because the positional relationship between the marking position and the tumor cannot be grasped. In this case, because the lesion seemed to be difficult to detect by fluoroscopy and could not be palpated because of the small size and a morphology of the cavity, we planned a more reliable and less invasive preoperative marking following resection using a cone-beam CT in a hybrid operating room. A quarter of reported CMPT cases were treated with lobectomies despite the small lesion size. Despite the potential

![Fig. 3](image_url)
Table 1 Clinical features of reported CMPT cases

| Author         | Age | Sex | Location | CT finding         | Size (mm) | Operative procedure | Intraoperative pathological diagnosis                  | Outcome (months) |
|----------------|-----|-----|----------|-------------------|-----------|--------------------|--------------------------------------------------------|-----------------|
| Ishikawa (2002)| 50  | F   | RUL      | Nodule            | 15        | L                  | n/a                                                    | 120             |
| Harada (2008)  | 62  | M   | LLL      | Nodule            | 9         | W                  | n/a                                                    | n/a             |
| Sato (2010)    | 67  | M   | RUL      | Nodule with GGO   | 5         | W                  | Low-grade malignant tumor                              | 10              |
| Ishikawa (2013)| 57  | F   | RLL      | GGO with cavity   | 7         | W                  | CMPT                                                   | 18              |
| Yuki (2013)    | 76  | F   | LLL      | Nodule with cavity| 11        | L                  | Adenocarcinoma                                         | 6               |
| Hata (2013)    | 70  | F   | RLL      | Nodule            | 8         | W                  | n/a                                                    | n/a             |
| Chuang (2014)  | 68  | M   | RLL      | Nodule            | 12        | W                  | Adenocarcinoma                                         | 48              |
| Kamata (2015)  | 61  | M   | RUL      | Nodule            | 10        | W                  | n/a                                                    | 76              |
| F              | 60  | L   | Nodule   | 15                | W         | n/a                |                                                        | 33              |
| 78             | M   | RLL  | Nodule   | 9                 | S         | n/a                |                                                        | 66              |
| 63             | M   | RLL  | Nodule   | 11                | L         | n/a                |                                                        | 63              |
| 75             | M   | LLL  | Nodule   | 6                 | W         | n/a                |                                                        | 44              |
| 62             | F   | LLL  | Nodule   | 13                | W         | n/a                |                                                        | 45              |
| 57             | M   | RLL  | Nodule   | 12                | W         | n/a                |                                                        | 7               |
| 56             | M   | RLL  | Nodule   | 11                | W         | n/a                |                                                        | 4               |
| 66             | M   | LLL  | Nodule   | 7                 | W         | n/a                |                                                        | 88              |
| Chu (2015)     | 56  | M   | LUL      | Nodule            | 11        | S                  | Mucinous adenocarcinoma                                | 5               |
| Lau (2016)     | 19  | F   | RLL      | Nodule with cavity| 13        | W                  | Mucinous neoplasm                                      | n/a             |
| Ishikawa (2016)| 66  | M   | RUL      | Nodule            | 13        | L                  | Mucinous cystic neoplasm                               | 58              |
| 82             | F   | LLL  | Nodule   | 10                | W         | No malignancy      |                                                        | 55              |
| 77             | M   | LLL  | Mass with cavity | 45      | L                  | Adenocarcinoma suspected                              | 48              |
| 70             | M   | RLL  | GGO      | 35                | W         | CMPT                                                            | 19              |
| 67             | F   | RLL  | Nodule   | 5                 | W         | No malignancy      |                                                        | 28              |
| Liu (2016)     | 60  | M   | RLL      | Nodule            | 12        | W                  | n/a                                                    | 7               |
| 83             | F   | RML  | Nodule   | 4                 | L         | No malignancy      |                                                        | n/a             |
| 81             | F   | R/a  | Nodule   | 4                 | W         | No malignancy      |                                                        | n/a             |
| 71             | F   | LUL  | Nodule   | 12                | W         | Glandular papilloma                                         | 120             |
| Kon (2016)     | 80  | M   | LLL      | Nodule with cavity| 7         | W                  | n/a                                                    | 29              |
| 67             | M   | RLL  | Nodule   | 10                | W         | n/a                |                                                        | 25              |
| 66             | M   | RLL  | Nodule   | 13                | L         | n/a                |                                                        | 14              |
| 73             | F   | LUL  | Nodule   | 9                 | W         | n/a                |                                                        | 5               |
| 70             | F   | RLL  | Nodule   | 8                 | W         | n/a                |                                                        | 48              |
| Taguchi (2017) | 84  | F   | RLL      | Nodule            | 8         | W                  | n/a                                                    | 10              |
| Segawa (2017)  | 42  | M   | LLL      | Nodule with cavity| 11        | L                  | Mucinous adenocarcinoma                                | 24              |
| Jin (2017)     | 59  | F   | RLL      | Nodule with cavity| 8         | L                  | Atypical glandular lesion                               | 6               |
| Udo (2017)     | n/a | F   | R/a      | r/a               | n/a       | n/a                |                                                        | n/a             |
|               |     |     |          | r/a               | n/a       | n/a                |                                                        | n/a             |
| Kita (2018)    | 67  | F   | LUL      | Nodule            | 7         | W                  | No malignancy                                          | 24              |
| Miyai (2018)   | 67  | F   | RML      | Nodule with GGO   | 20        | W                  | n/a                                                    | 4               |
| Shen (2019)    | 58  | M   | RLL      | Nodule            | 11        | L                  | Papillary carcinoma                                    | n/a             |
| 64             | F   | LLL  | Nodule   | 8.5               | W         | Adenocarcinoma                                              | n/a             |
| Matsuoka (2019)| 76  | F   | RLL      | Nodule            | 10        | W                  | Mucinous adenocarcinoma                                 | 24              |
| Yao (2019)     | 67  | F   | LUL      | Nodule            | 12        | S                  | No malignancy                                          | 10              |
| Cheung (2019)  | 61  | M   | RLL      | Nodule with cavity| 10        | L                  | Mucinous adenocarcinoma                                 | 12              |
malignancy of CMPT, no recurrence or metastasis has been reported for up to 10 years by wedge resection, and thus additional resection was not planned after the final diagnosis of CMPT.

Conclusions
CMPT can present as GGO, nodules, or (rarely) cavitary formation with irregular wall thickness mimicking a metastasis. Its pathology is not clearly defined, and it may have benign or malignant properties, depending on the molecular alterations. Although no recurrence or metastasis has been reported, CMPT should be resected with sufficient margins.

Abbreviations
CMPT: Ciliated muconodular papillary tumor; CT: Computed tomography; CRC: Colorectal cancer; CK7: Cytokeratin-7; CDX2: Caudal type homeobox-2; GGO: Ground glass opacity; EGFR: Epidermal growth factor receptor; ALK: Anaplastic lymphoma kinase.

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KM and YY wrote the manuscript. HD supervised the case. All other authors reviewed the manuscript. All authors read and approved the final manuscript.

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Ethics approval and consent to participate
Not applicable.

Consent for publication
Written informed consent was obtained from the patient for the publication of this report.

Competing interests
The authors declare that they have no competing interests.

Table 1 (continued)

| Author | Age | Sex | Location | CT finding | Size (mm) | Operative procedure | Intraoperative pathological diagnosis | Outcome (months) |
|--------|-----|-----|----------|------------|-----------|---------------------|--------------------------------------|------------------|
| Shao (2019) | 58 | F | LLL | Nodule with GGO | 8 | W | n/a | n/a |
| 66 | F | RLL | Nodule | 6 | W | n/a | n/a |
| Our case | 70 | F | RLL | Nodule with cavity | 6 | W | No malignancy | 7 |

We did not add the 16 cases reported by Onishi et al. to the table at this time because the details of the clinical findings of the patients had not been described in the text

Table 1 (continued)

M male, F: female, RUL: right upper lobe, RML: right middle lobe, RLL: right lower lobe, LUL: left upper lobe, LLL: left lower lobe, GGO: ground glass opacity, L: lobectomy, S: segmental resection, W: wedge resection, CMPT: Ciliated muconodular papillary tumor, n/a: not applicable.

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