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# Pulmonary Staple-Stump Granuloma After Segmentectomy: Two Case Reports and Comparison with Cases of Stump Recurrence

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

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**Conflict of interest:** None declared

**Case series**
**Patient:** Male, 70 • Female, 60
**Final Diagnosis:** Staple stump granuloma
**Symptoms:** Abnormal shadow on computed tomography
**Medication:** —
**Clinical Procedure:** —
**Specialty:** Surgery

**Objective:** Rare disease

**Background:** Correctly diagnosing a staple-line mass after pulmonary resection for lung malignant tumor can be difficult. Differential diagnoses of recurrence, infectious mass, granuloma, and so on must be considered, despite their rarity. We report two cases of pulmonary staple-stump granuloma after segmentectomy for lung cancer.

**Case Reports:** Case 1 involved a 70-year-old man with small nodule in the left upper lobe identified on computed tomography (CT). Video-assisted thoracoscopic (VATS) left upper division segmentectomy was performed. Histopathological examination revealed squamous carcinoma. Follow-up CT 1 year postoperatively showed a shadow at the staple-stump, with growth evident later. CT-guided biopsy found no malignancy. However, complete left upper lobectomy was performed because of the gradually enlarging lesion. Histopathological examination revealed epithelioid granuloma. Case 2 involved a 60-year-old with suspected lung cancer in the right upper lobe. VATS right upper division segmentectomy (S2) was performed. CT at 30 months postoperatively showed a shadow at the staple line, with subsequent growth. VATS right upper lobectomy was performed. Intraoperative rapid diagnosis revealed epithelioid granuloma. These two cases were compared with five cases of staple-stump recurrence in our institution. All cases of recurrence grew concentrically or radially from the staple line with the mass surrounding the staple line. On the other hand, cases of granuloma extended along the long axis of the staple line, and 3-dimensional CT (3DCT) may help to understand the morphology.

**Conclusions:** Although preoperative differentiation of staple-line granuloma is difficult and pathological diagnosis is important, characteristic radiologic features and 3DCT may facilitate diagnosis.

**MeSH Keywords:** Granuloma, Foreign-Body • Neoplasm Recurrence, Local • Surgical Staplers

**Abbreviations:** **CT** – computed tomography; **3DCT** – 3-dimensional computed tomography; **FDG-PET** – fluorodeoxyglucose positron emission tomography; **MRI** – magnetic resonance imaging

**Full-text PDF:** https://www.amjcaserep.com/abstract/index/idArt/916906





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## Background

A staple-stump mass after pulmonary resection is generally initially presumed to represent recurrence of the resected malignant tumor. Preoperative diagnosis of rarer differential diagnoses such as infectious mass and granuloma is difficult. We report two cases of pulmonary staple-stump granuloma after segmentectomy for lung cancer.

## Case report

### Case 1

A 70-year-old man without known allergies had been followed-up due to pneumoconiosis, detecting a small, 5-mm nodule in the left upper lobe (S1+2) on computed tomography (CT). The lesion had increased 10 mm in diameter by 6 months later. Subsequent fluorodeoxyglucose (FDG)-positron emission tomography (PET) confirmed slight accumulation and showed no metastases including contrast-enhanced magnetic resonance imaging (MRI) of the brain. Lung cancer was suspected and video-assisted thoracoscopic (VATS) left upper division segmentectomy and lymphadenectomy were performed. A4 and A5 were interlobar type and preserved. Although V3 was dissected, V4+5 was preserved. Residual lung expansion was good. Pathological findings showed left upper squamous lung carcinoma classified as pT1aN0M0 Stage IA according to the Union for International Cancer Control classification (seventh edition). Follow-up CT a year after surgery revealed a shadow at the staple-stump. This shadow had increased in diameter on CT performed 3 months later. Subsequent FDG-PET confirmed abnormal accumulation in the same region, maximum standardized uptake value (SUVmax) in the early phase was 9.42 and 13.31 in the delayed phase. FDG-PET and contrast-enhanced MRI of the brain showed no metastasis. CT-guided biopsy showed no evidence of malignancy. Preoperative 3-dimensional computed tomography (3DCT) revealed the mass extending along the long axis of the staple line (Figure 1). Complete left upper lobectomy was performed because the mass had been growing gradually. The residual lingular segment was firmly adherent to the chest wall and mediastinum. Pathological findings revealed non-caseating epithelioid cell granuloma (Figure 2).

### Case 2

A 60-year-old woman without known allergies was being followed-up due to dyslipidemia. Cancer-screening CT had revealed a ground-glass nodule in the right upper lobe (S2) 3 year before the first visit to our hospital. Follow-up CT at 1 week before the first visit to our hospital had revealed that the nodule had grown to 12 mm in size, part of the nodule showed slightly high density, and the patient was referred to our hospital. FDG-PET, contrast-enhanced MRI of the brain and transbronchial biopsy were performed, but no definitive diagnosis was reached. However, lung adenocarcinoma in the right upper lobe (S2) without an invasive part or metastasis was suspected. VATS right upper division segmentectomy (S2) and lymphadenectomy were performed. A2b and V2b were dissected. Recurrent A2 was unclear. Residual lung expansion was good. Follow-up CT at two-and-a-half years after the surgery showed a shadow at the staple line (37 mm in diameter) that continued growing gradually. Subsequent FDG-PET confirmed abnormal accumulation, but no metastases. Pathological diagnosis from transbronchial or transcutaneous biopsy proved difficult. Preoperative 3DCT revealed the mass extending along the staple line (Figure 3). VATS right upper lobectomy was performed. Intraoperative rapid diagnosis reveled epithelioid granuloma. Lymphadenectomy was not performed. Bacterial and acid-fast bacterial cultures yielded negative results. Pathological findings revealed epithelioid cell granuloma (Figure 2).

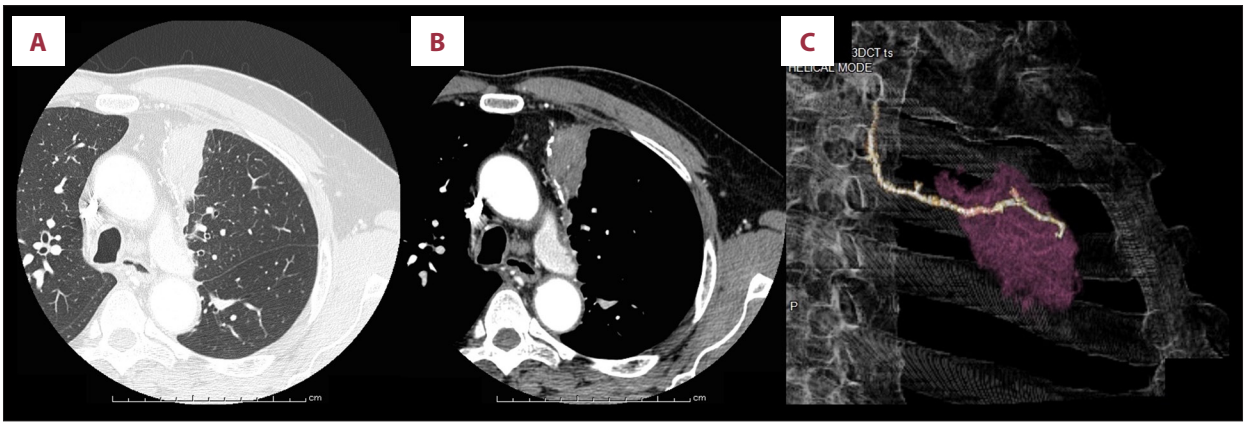


**Figure 1.** Findings from preoperative computed tomography of the chest in Case 1. (**A, B**) Lung window setting (**A**) and mediastinal window setting (**B**) show a smooth marginated mass along the staple line of the left lingular segment. (**C**) Three-dimensional computed tomography helps to understand the morphology of the mass (purple shadow).



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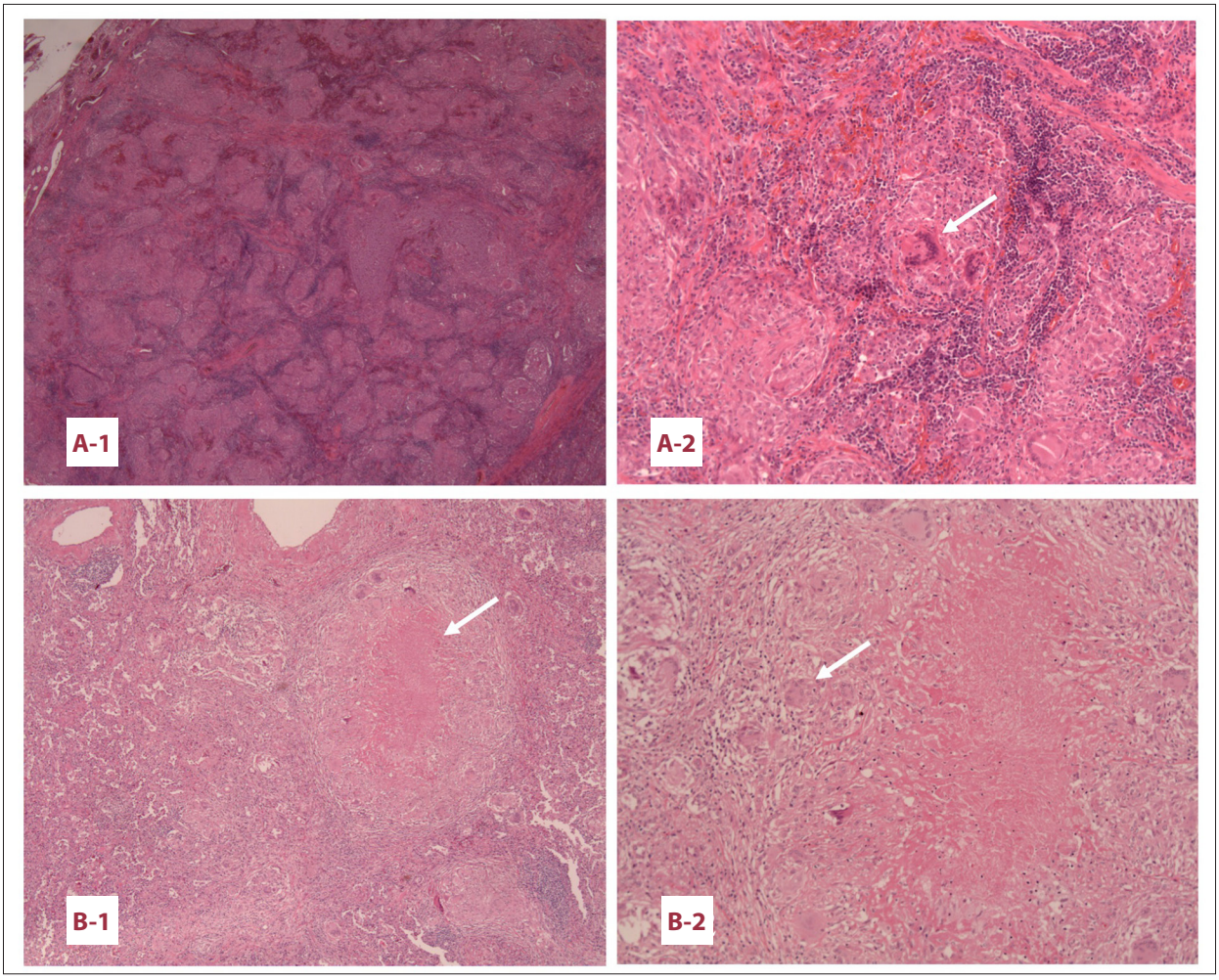


**Figure 2.** Pathological findings of Case 1 (**A-1, A-2**) and Case 2 (**B-1, B-2**). (**A-1**) The picture shows epithelioid cell granuloma without necrosis (H&E, 40×). (**A-2**) Multinucleated giant cells are identified such as white arrow (H&E, 100×). (**B-1**) The picture shows epithelioid cell granuloma with necrosis such as white arrow (H&E, 40×). (**B-2**) Multinucleated giant cells are identified such as white arrow (H&E, 100×).

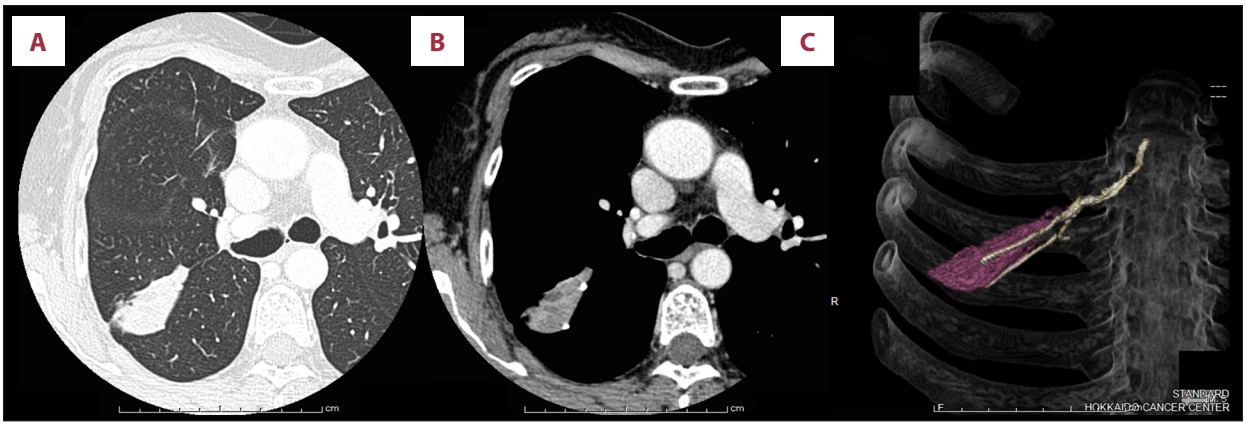


**Figure 3.** Findings from preoperative computed tomography of the chest in Case 2. (**A, B**) Lung window setting (**A**) and mediastinal window setting (**B**) show a smooth marginated mass along the staple line of the right upper lobe. (**C**) Three-dimensional computed tomography helps to understand the morphology of the mass (purple shadow).



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**Table 1.** Pulmonary staple-stump granuloma: a review of the literature.

| First author | Year | Age | Sex | Primary disease | Primary surgery | History of allergy | Interval (months) | Site of occurrence |
|---|---|---|---|---|---|---|---|---|
| Tomita | 2003 | 74 | M | Metastasis of colon cancer | Wedge resection | No | 5 | Left upper lobe |
| Tanaka | 2003 | 50 | F | Lung cancer | Segmentectomy | NR | 60 | Left upper lobe (S4+5) |
| Kono | 2005 | 60 | M | Lung cancer | Segmentectomy | NR | 28 | Left lower lobe (basal segment) |
| Furukawa | 2007 | 57 | F | Lung cancer | Segmentectomy | NR | 48 | Right upper lobe |
| Matsuoka | 2007 | 62 | F | Lung cancer | Lobectomy + Segmentectomy | NR | 51 | Right lower lobe |
| Yuksel | 2007 | 60 | F | Endometrial adenocarcinoma | Lobectomy | NR | 4 | Right middle lobe |
| Ohtsuka | 2008 | 69 | F | Rectal cancer | Wedge resection | NR | 57 | Left upper lobe (S3) |
| Sawada | 2008 | 67 | M | Pneumothorax | Wedge resection | NR | 72 | Right upper lobe |
| Eguchi | 2008 | 68 | M | Aspergilloma | Wedge resection | NR | 30 | Right upper lobe |
| Murakami | 2009 | 72 | F | Lung cancer | Lobectomy | NR | 84 | Right upper lobe |
| Motono | 2012 | 64 | M | Renal cell carcinoma | Wedge resection | No | 7 | Left lower lobe (S10) |
| Tempaku | 2012 | 59 | F | Rectal cancer | Wedge resection | NR | 60 | Right lower lobe (S10) |
| Yoshino | 2014 | 70 | M | Lung cancer | Segmentectomy | NR | 12 | Left lower lobe |
| Yoshida | 2014 | 71 | M | Lung abscess | Lobectomy | NR | 72 | Right upper lobe (S3) |
| Kamata | 2015 | 42 | F | Metastasis of cervical cancer | Wedge resection | NR | 144 | Left upper lobe (S1+2) |
| | | | | Lung cancer | Segmentectomy | NR | 36 | Right lower lobe (basal segment) |
| Sanada | 2016 | 69 | M | Rectal cancer | Lobectomy + wedge resection | NR | 4 | Right middle lobe |
| Mizuno | 2017 | 43 | F | colorectal cancer | Segmentectomy | NR | 15 | Right lower lobe (basal segment) |
| | | 72 | M | Lung cancer | Segmentectomy | NR | 26 | Right upper lobe |
| | | 72 | F | Lung cancer | Segmentectomy | NR | 47 | Right upper lobe |
| | | 73 | F | Lung cancer | Segmentectomy | NR | 24 | Right upper lobe |
| Hashimoto | 2017 | 66 | F | Lung cancer | Lobectomy + wedge resection | No | 60 | Right middle lobe |
| Matsuoka | 2018 | 73 | F | Lung cancer | Segmentectomy | NR | 31 | Right lower lobe |
| | | 65 | M | Lung cancer | Wedge resection | NR | 5 | NR |
| | | 61 | M | Metastatic lung cancer | Segmentectomy | NR | 5 | Right lower lobe |
| | | 78 | F | Lung cancer | Segmentectomy | NR | 84 | Right lower lobe |
| | | 75 | M | Hamartoma | Segmentectomy | NR | 192 | Left upper lobe |
| | | 76 | M | Lung cancer | Lobectomy | NR | 66 | NR |
| This study | 2019 | 70 | M | Lung cancer | Segmentectomy | No | 12 | Left upper lobe (S4+5) |
| | | 60 | F | Lung cancer | Segmentectomy | No | 30 | Right upper lobe |





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**Table 1 continued.** Pulmonary staple-stump granuloma: a review of the literature.

| First author | Size (mm) | Staple line | FDG- PET SUV max | Preoperative biopsy and pathological diagnosis | Surgical intervention | Culture |
|---|---|---|---|---|---|---|
| Tomita | NR | Edge of mass | NR | Not performed | Wedge resection | Negative |
| Tanaka | 20 | Edge of mass | NR | Bronchoscopy, not diagnosed | Wedge resection | Tuberculosis |
| Kono | 50 | Edge of mass | NR | Bronchoscopy, not diagnosed | Lobectomy | Mycobacterium intercellurare |
| Furukawa | 50 | Edge of mass | NR | Bronchoscopy, not diagnosed | Bilobectomy | Mycobacterium avium |
| Matsuoka | 20, 15 (Two) | Edge of mass | NR | CT-guided biopsy, granuloma | Wedge resection | Mycobacterium avium |
| Yuksel | NR | NA | 3.5 | Not performed | Wedge resection | NR |
| Ohtsuka | 20 | Edge of mass | NR | Not performed | Segmentectomy | Negative |
| Sawada | 23 | Surrounded by mass | NR | Not performed | Wedge resection | NR |
| Eguchi | 40 | Edge of mass | NR | Not performed | Lobectomy | Mycobacterium avium |
| Murakami | 23 | Edge of mass | 4.59 | Not performed | Lobectomy | Negative |
| Motono | NR | Edge of mass | NR | Not performed | Wedge resection | Negative |
| Tempaku | 20 | Edge of mass | 1.9 | Not performed | Wedge resection | Negative |
| Yoshino | NR | Edge of mass | 11.1 | Bronchoscopy, not diagnosed | Lobectomy | Mycobacterium avium |
| Yoshida | 20 | Surrounded by mass | 10 | Bronchoscopy, not diagnosed | Wedge resection | Negative |
| Kamata | 35 | Edge of mass | 4.9 | Not performed | No | NR |
| | 25 | Edge of mass | 14.5 | Non-necrotic granuloma | No | NR |
| Sanada | 39 | Edge of mass | 6 | Bronchoscopy, not diagnosed | Wedge resection | Mycobacterium intercellurare |
| Mizuno | 17 | Edge of mass | 6 | Not performed | Lobectomy | Negative |
| | 24 | Edge of mass | 1.5 | CT-guided biopsy | No | One of three cases had Mycobacterium avium |
| | 41 | Edge of mass | 7 | CT-guided biopsy | No | |
| | 47 | Edge of mass | NR | CT-guided biopsy | No | |
| Hashimoto | NR | Edge of mass | 3.24 | Bronchoscopy, not diagnosed | Lobectomy | NR |
| Matsuoka | NR | Edge of mass | NR | NR | Lobectomy | Mycobacterium avium |
| | NR | Edge of mass | 13.2 | NR | Wedge resection | Mycobacterium avium |
| | NR | Edge of mass | 7.03 | NR | Lobectomy | Mycobacterium avium |
| | NR | Edge of mass | 3.3 | NR | Lobectomy | Mycobacterium avium |
| | NR | Edge of mass | NR | NR | Lobectomy | Mycobacterium avium |
| | NR | Edge of mass | 1.96 | NR | Wedge resection | Mycobacterium avium |
| This study | 27 | Edge of mass | 9.42 | CT-guided biopsy, not diagnosed | Lobectomy | Negative |
| | 37 | Edge of mass | 3.5 | Not performed | Lobectomy | Not performed |

NR – not reported; Interval – disease-free interval from primary surgery to radiological diagnosis; NA – not available.



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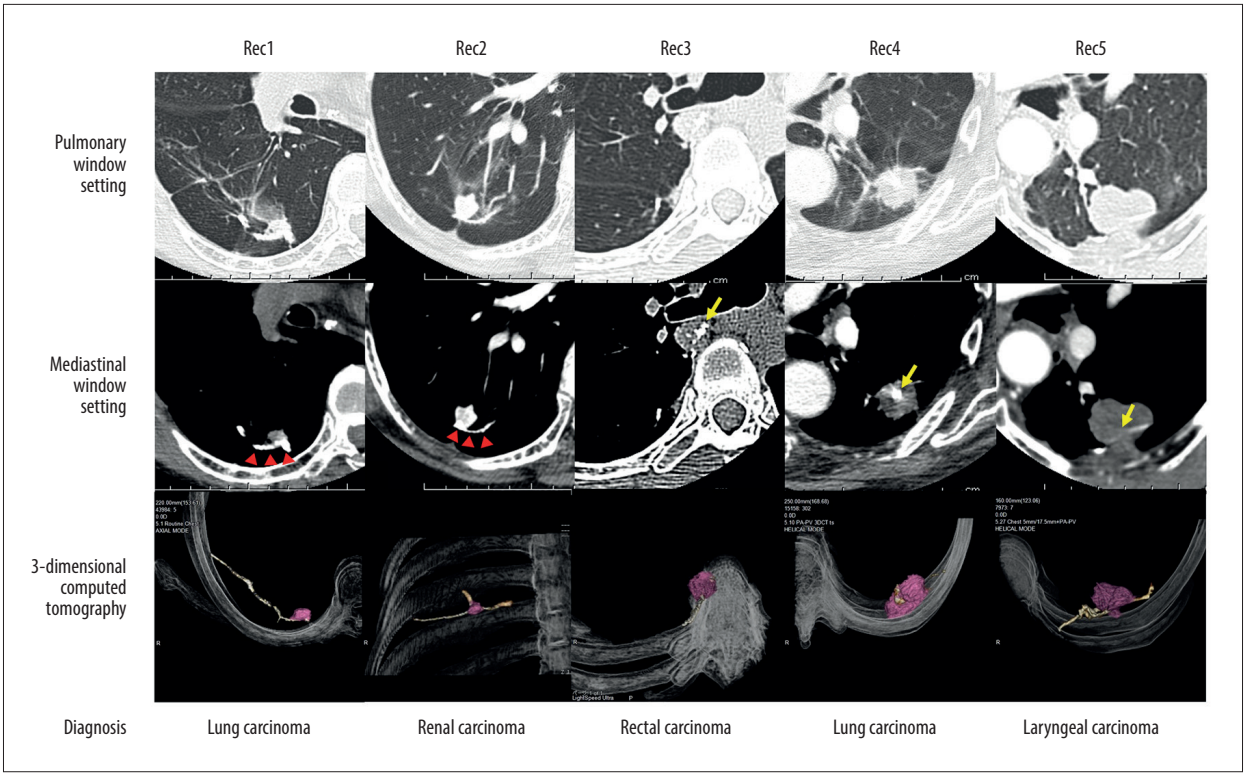


**Figure 4.** Five cases of stump recurrence in our institution (Rec1–5). All cases underwent wedge resection. Staple lines in Rec1 and Rec2 are along the edge of tumor (red arrowheads). Staple lines in Rec 3–5 are surrounded by tumor (yellow arrows). All lesions are irregular in shape, as inaccurate circles. 3-dimensional computed tomography reveals that all cases of recurrence (purple shadow) are shaped like almost sphere and grow concentrically or radially from the staple line (line of khaki).

## Discussion

The most likely differential diagnosis for postoperative shadows around a surgical stump is recurrence of the resected malignancy, although infection, granuloma and inflammatory lesion are other differential diagnoses. Suture granuloma of the stump has been reported [1–3]. Absorbable or monofilament sutures should be used to prevent suture granuloma. In recent years, surgical staples have seen wide use in thoracic surgery, especially in VATS. Staple granuloma of the stump as reported here is rare, and 28 cases of staple-line granuloma have been reported to date (Table 1) [4–22].

Metals such as cobalt, chromium and nickel are easily ionized. The frequency of sensitivity to various metals in patients with orthopedic metallic implants has been reported as 0.2% for chromium, 1.3% for nickel, and 1.8% for cobalt [23]. On the other hand, surgical staples are commonly made from titanium, which shows high resistance to corrosion and very high biocompatibility in physiological environments. Given these features, titanium is broadly used in clinical fields and allergy to titanium has rarely been reported [24]. Despite titanium's hypoallergenic properties, if there is a possibility of allergy, type IV allergy may be presumed in these cases of granuloma. Patch testing is one of the diagnostic tests for titanium allergy and probably should have been performed, although neither of our cases had any history of allergic reactions. In addition, infection may cause local granuloma around the staple line. Thirteen cases of granuloma caused by infection have reported (Table 1). Mycobacterium were detected in each of those cases. In our cases, Case 2 showed negative results, but bacterial cultures were not prepared in Case 1.

Using an autosuture device causes atelectasis or ventilation and perfusion impairment along the staple line. Mycobacterium infection is assumed to occur pre- or postoperatively for this compromised location, resulting in development of a staple-line mass [4,14,19]. Likewise, cases of post-segmentectomy pseudotumor are surmised to result from obstruction of the blood supply and drainage [25]. Staple-line granuloma seems to arise when a foreign body reaction is added to this scenario.

The purpose of using staples is to prevent postoperative pulmonary leak. In our cases, branches of the pulmonary artery and vein were preserved. Intraoperative lung expansion and the color of the lung surface seemed satisfactory in each case. However, we considered that the reason why granuloma developed was probably insufficient blood supply or drainage



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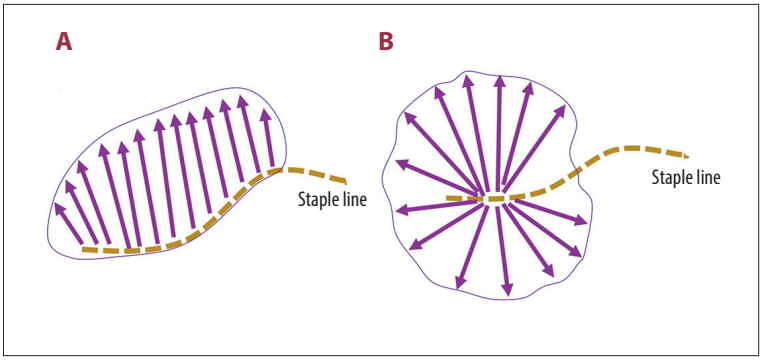


**Figure 5.** Schema of staple-stump granuloma and stump recurrence. (**A**) The schema shows staple-stump granuloma of which a smooth marginated mass long contact with the staple line. (**B**) The schema shows stump recurrence. It can be presumed that a mass grows concentrically or radially from the staple line.

and air inflation or deflation in part of the residual segment. Staple-line granuloma would then have arisen with the addition of the rare foreign body reaction to titanium.

Mizuno et al. reported that stump recurrence should be suspected for cases of stump mass with a short disease-free interval (DFI), high SUVmax and CEA levels, and a staple line located in the middle [18]. Our cases showed high SUVmax and short DFI. In terms of the morphology, the present cases of granuloma showed a mass along the staple line similar to previously reported cases. On the other hand, although stump recurrence has been reported to surround the staple line [5], in two of the five cases of stump recurrence treated at our institution between 2009 and 2017 (Rec1, Rec2) (Figure 4), the staple was present at the edge as in the cases of granuloma. However, all cases of recurrence were irregular, inaccurate circles and seemed morphologically different from cases of granuloma. For the purpose of identifying pulmonary branches preoperatively as past study [26], 3DCT of the pulmonary vessels has usually been performed using contrast medium. However, it is difficult to distinguish artery from vein without contrast medium. When deference of CT number between adjacent structures is clear, it is easy to create 3DCT. Therefore, 3DCT without contrast medium uses in the field of colorectal cancer screening, and helps to detect small mass and to apprehend the morphology [27]. We applied 3DCT to a staple-line mass after pulmonary resection. It may help in achieving a better understanding of the morphology. 3DCT reveals that staple-stump granuloma is a smooth marginated mass long contacted with the staple line. It indicates that all cases of recurrence are shaped like almost sphere and grow concentrically or radially from the staple line (Figures 1, 3–5). It is possible that staple-stump granuloma decreases [5]. Taking these matters in account, when definitive diagnosis by CT is thus difficult, it needs biopsy or surgery.

## Conclusions

Although preoperative diagnosis of staple-line granuloma is difficult and pathological diagnosis is important, characteristic radiologic features and 3DCT may facilitate diagnosis.

### Acknowledgements

The authors would like to acknowledge Yoshifumi Yamashita, the radiological technician, for his contribution in creating the 3DCT images and all the staffs involved in the patient's care, in the department of thoracic surgery at National Hospital Organization, Hokkaido Cancer Center.

### Conflict of interest

None.

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