CASE REPORT

Refractory IgG4-related Pleural Disease with Chylothorax: A Case Report and Literature Review

Komei Sakata, Jun Kikuchi, Katsura Emoto, Tomomi Kotaki, Yuichiro Ota, Naoshi Nishina, Hironari Hanaoka, Kotaro Otomo, Katsuya Suzuki, Yuko Kaneko and Tsutomu Takeuchi

Abstract:
We herein report a rare case of a 66-year-old man with refractory chylothorax. Although he had been treated with moderate doses of prednisolone (PSL) on suspicion of pleuritis with Sjögren syndrome, the pleural effusion expanded after the reduction of prednisolone. Further workup including histopathological examinations of pleura led to the diagnosis of IgG4-RD with bilateral chylothorax without any leakage from the thoracic duct. Combination therapy with high-dose PSL plus rituximab successfully decreased the pleural effusion. This is a very rare case of IgG4-related pleuritis with chylothorax and the first report of its successful treatment with rituximab.

Key words: IgG4-related disease, pleuritis, chylothorax, rituximab

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Introduction
Immunoglobulin G4-related disease (IgG4-RD) is a systemic fibro-inflammatory disease characterized by serum IgG4 elevation and distinctive histopathological findings, such as lymphoplasmacytic infiltrate with abundant IgG4-positive plasma cells, storiform fibrosis, and obliterative phlebitis (1, 2). Almost all organs in the body, such as the central nervous system (CNS), lacrimal glands, salivary glands, thyroid, lungs, pancreas, biliary duct, liver, gastrointestinal tract, kidneys, prostate, retroperitoneum and lymph nodes, can be affected by IgG4-RD (3).

While the lungs are involved in 9%-18% of IgG4-RD patients (4-7), pleural involvement is observed in only 4% (4, 5). Pleural effusion is uncommon, but previous reports have shown that it is usually exudative (8).

Chylothorax, which is characterized by milky-appearing pleural fluid with elevated triglyceride levels or the presence of chylomicrons, is caused by the extravasation of chyle into the pleural space due to obstruction or damage of a thoracic duct or its tributaries or transdiaphragmatic flow from the peritoneal cavity (9). The etiologies of chylothorax include several causes, such as trauma (surgical or non-surgical), malignancy, lymphatic disorders, infection, chylous ascites, and other miscellaneous causes (10); however, chylothorax due to IgG4-RD has almost never been reported.

We experienced a rare case of IgG4-RD with refractory chylothorax that was successfully treated with high-dose prednisolone (PSL) and rituximab (RTX). We report this case with a review of previous case reports of IgG4-related pleuritis.

Case Report
A 66-year-old Japanese man with a history of pollen allergy and thyroidectomy for Graves-Basedow disease was admitted to another hospital with a 2-month history of leg edema, eyelid edema, and dyspnea on exertion. Computed tomography (CT) demonstrated pleural and pericardial effusions, and a pericardiocentesis revealed the fluid as a non-specific inflammatory effusion with increased numbers of

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right pleural effusion was exudative with a total cell count demonstrated pericardial effusion, bilateral pleural effusion, lymphocytes without any infection. Increasing the levothy-
positive (15.4 U/mL; normal range, <10.0 U/mL) on an
At his first admission to our hospital, whole-body CT (lymphocytes, 75%) and neither malignant
antibod
aminase
am
T
γ
Am
T
g
TSH 1.67 μIU/mL fT4 1.7 n
fT3 1.7 n/g/dL β-D <6.0 pg/mL fT4 1.7 n/g/dL CMV-Ag negative
fT3 2.9 ng/dL GPILcore-IgA negative
BNP 8.0 pg/mL T-Spot negative
41.5 n/g/dL proGRP Ty-cho 192 mg/dL
CK 70 U/L
Am 62 U/L SCC 0.7 ng/mL
ALP 235 U/L CYFRA 1.7 ng/mL
LDH 163 U/L CEA 1.6 ng/mL
ALT 10 U/L sIL-2R 394 U/mL
AST 13 U/L
Cl 100 mEq/L
K 3.8 mEq/L PR3-ANCA <1.0 U/mL
Na 139.5 mEq/L MPO-ANCA <1.0 U/mL
UA 9.2 mg/dL RNP <2.0 U/mL
Cre 1.25 mg/dL ds-DNA 3.8 U/mL
BUN 24.2 mg/dL SS-B <1.0 U/mL Hylauronic Acid 6,670 ng/mL
Crea 1.25 mg/dL
Hb 15.5 g/dL C4 24 mg/dL Alb 3.3 g/dL
RBC 5.05 ×10¹²/μL C3 109 mg/dL TP 5.7 g/dL
IgM 70 mg/dL specificity gravity 1.016
IgG 2,266 mg/dL pH 7.5
IgA 226 mg/dL
Baso 0.2 %
IgM 70 mg/dL
IgG 2,264 mg/dL others 130 μL
Eosino 0.2 %
IgA 226 mg/dL
Mon 3.2 %
IgG4 264 mg/dL
Lymph 8.7 %
IgG 1,500 mg/dL mono 680 μL
Neut 87.7 %
Ferritin 85 ng/mL poly 0 μL
WBC 8,200 /μL
ESR 15 mm/hr Cell count 810 /μL
Peripheral blood CRP 0.04 mg/dL Pleural effusion
Biochemistry/Serology TP 7.4 g/dL Antibody T-cho 84 mg/dL
Alb 4.2 g/dL ANA negative TG 300 mg/dL
T-Bil 0.5 mg/dL SS-A 3.3 U/mL ADA 25.1 U/L
BUN 24.2 mg/dL SS-B <1.0 U/mL Hylauronic Acid 6,670 ng/mL
Cre 1.25 mg/dL ds-DNA 3.8 U/mL
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Cl 100 mEq/L
AST 13 U/L
ALT 10 U/L sIL-2R 394 U/mL
LDH 163 U/L CEA 1.6 ng/mL
ALP 235 U/L CYFRA 1.7 ng/mL
γ-GTP 55 U/L SCC 0.7 ng/mL
Amy 62 U/L proGRP 41.5 ng/mL
CK 70 U/L
T-cho 192 mg/dL
HbA1c 7.0 % procalcitonin <0.03 ng/mL
KL-6 193 U/mL T-SPOT negative
BNP 8.0 pg/mL GPILcore-IgA negative
fT3 2.9 ng/dL CMV-Ag negative
fT4 1.7 ng/dL β-D <6.0 pg/mL
TSH 1.67 μIU/mL

**Table 1. Laboratory Data on 2nd Admission.**

<table>
<thead>
<tr>
<th>Peripheral blood</th>
<th>CRP</th>
<th>Pleural effusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC 8,200 /μL</td>
<td>ESR 15 mm/hr</td>
<td>Cell count 810 /μL</td>
</tr>
<tr>
<td>Neut 87.7 %</td>
<td>Ferritin 85 ng/mL</td>
<td>poly 0 μL</td>
</tr>
<tr>
<td>Lymph 8.7 %</td>
<td>IgG 1,500 mg/dL</td>
<td>mono 680 μL</td>
</tr>
<tr>
<td>Mono 3.2 %</td>
<td>IgG4 264 mg/dL</td>
<td>others 130 μL</td>
</tr>
<tr>
<td>Eosino 0.2 %</td>
<td>IgA 226 mg/dL</td>
<td>pH 7.5</td>
</tr>
<tr>
<td>Baso 0.2 %</td>
<td>IgM 70 mg/dL</td>
<td>specific gravity 1.016</td>
</tr>
<tr>
<td>RBC 5.05 ×10¹²/μL</td>
<td>C3 109 mg/dL</td>
<td>TP 5.7 g/dL</td>
</tr>
<tr>
<td>Hb 15.5 g/dL</td>
<td>C4 24 mg/dL</td>
<td>Alb 3.3 g/dL</td>
</tr>
<tr>
<td>Pt 288 ×10¹³/μL</td>
<td>CH50 59.3 U/mL</td>
<td>Amy 45 U/L</td>
</tr>
<tr>
<td>Cryoglobulin</td>
<td>negative</td>
<td>Glu 131 mg/dL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LDH 88 U/L</td>
</tr>
</tbody>
</table>

**Biochemistry/Serology**

| TP 7.4 g/dL | Antibody T-cho 84 mg/dL |
| Alb 4.2 g/dL | ANA negative TG 300 mg/dL |
| T-Bil 0.5 mg/dL | SS-A 3.3 U/mL ADA 25.1 U/L |
| BUN 24.2 mg/dL | SS-B <1.0 U/mL Hylauronic Acid 6,670 ng/mL |
| Cre 1.25 mg/dL | ds-DNA 3.8 U/mL |
| UA 9.2 mg/dL | RNP <2.0 U/mL |
| Na 139.5 mEq/L | MPO-ANCA <1.0 U/mL |
| K 3.8 mEq/L | PR3-ANCA <1.0 U/mL |
| Cl 100 mEq/L | |

**AST 13 U/L**

| ALT 10 U/L | sIL-2R 394 U/mL |
| LDH 163 U/L | CEA 1.6 ng/mL |
| ALP 235 U/L | CYFRA 1.7 ng/mL |
| γ-GTP 55 U/L | SCC 0.7 ng/mL |
| Amy 62 U/L | proGRP 41.5 ng/mL |
| CK 70 U/L | |
| T-cho 192 mg/dL | |

**HbA1c 7.0 %**

| procalcitonin <0.03 ng/mL |
| KL-6 193 U/mL | T-SPOT negative |
| BNP 8.0 pg/mL | GPILcore-IgA negative |
| fT3 2.9 ng/dL | CMV-Ag negative |
| fT4 1.7 ng/dL | β-D <6.0 pg/mL |
| TSH 1.67 μIU/mL | |

**Infection marker**

**Lymphocytes without any infection. Increasing the levothyroxine dose for latent hypothyroidism and initiation of furosemide therapy did not decrease the effusion. He was transferred to our department.**

At his first admission to our hospital, whole-body CT demonstrated pericardial effusion, bilateral pleural effusion, and testicular hydrocele. No swelling of the lacrimal or salivary glands nor pancreatic enlargement was observed. The right pleural effusion was exudative with a total cell count of 2,410/mm³ (lymphocytes, 75%) and neither malignant cells nor bacteria. Serum anti-SS-A/Ro antibody was slightly positive (15.4 U/mL; normal range, <10.0 U/mL) on an enzyme-linked immunosorbent assay but negative with the double immunodiffusion method. Other autoantibodies, including anti-SS-B/La, anti-CCP, anti-dsDNA, anti-RNP, anti-Scl70, and anti-neutrophil cytoplasmic antibodies, were all negative. Sialometry showed a rate of 1.008 mL/minute (within normal range), while salivary gland scintigraphy showed a slightly decreased uptake and secretory function. A lip biopsy demonstrated grade 2 lymphocytic infiltration according to Greenspan’s classification (11), with only a few IgG4-positive plasma cells. The Schirmer test and rose bengal dye staining test were positive only in the left eye. Although he did not meet the ACR 2012 classification criteria (12), we suspected Sjögren syndrome with serositis. PSL 40 mg/day (0.5 mg/kg) was initiated. Both the pleu-
ral and pericardial effusion amount decreased; however, tapering of the PSL led to exacerbation of the pleural effusion.

At his second admission, he presented with swelling of the lacrimal glands. Laboratory data are shown in Table 1. The white blood cell count in the peripheral blood was 8,200/μL (neutrophil 87.7%, lymphocyte 8.7%). Serum IgG and IgG4 levels were 1,500 mg/dL and 264 mg/dL, respectively. Autoantibodies were all negative. Serum levels of C-reactive protein (CRP), soluble interleukin-2 receptor (IL-2R), free T3, free T4, and thyroid-stimulating hormone (TSH) were also within the normal ranges (0.04 mg/dL, 394 U/mL, 2.9 pg/mL, 1.7 ng/dL and 1.67 μIU/mL, respectively). Chest CT showed marked bilateral pleural effusion with passive atelectasis and slight pericardial effusion (Fig. 1B). Thoracentesis for the right pleural effusion (Table 1) revealed turbid yellow fluid (Fig. 1A) with a total cell count of 810/μm³ (lymphocytes 84%), total protein 5.7 g/dL, adenosine deaminase (ADA) 25.1 U/L, total cholesterol 84 mg/dL, triglyceride 300 mg/dL, and the presence of chylomicrons, compatible with chylothorax. A cytologic examination was negative for malignancy. General bacterial and mycobacterial cultures of the pleural fluid were negative. He had no history of trauma or thoracic surgery. Lymphangiography did not show any leakage or obstruction of the thoracic duct (Fig. 2). While thoracoscopy did not reveal any tumor, amyloid deposits, or leakage from the thoracic duct, a thorascoscopic surgical pleural biopsy demonstrated infiltration by lymphocytes and plasma cells with ectopic germinal centers under the pleural mesothelium. Approximately 50% of IgG-positive plasma cells were IgG4-positive (Fig. 3). Storiform fibrosis and obstructive phlebitis were not found in this small specimen.

We performed another lip biopsy, and the specimen showed excessive IgG4-positive plasma cell infiltration (48 cells/high-power field [HPF]) with >50% IgG4/IgG (Fig. 4). According to the diagnostic criteria of IgG4-related respiratory disease (13), the patient met the following: i) pleural involvement with CT, ii) elevated serum IgG4 level, iii) pleural biopsy findings (lymphoplasmacytic infiltration and increased IgG4 positive cells), and iv) IgG4-related sialadenitis confirmed with a lip biopsy. Thus, we diagnosed him with “definite” IgG4-related disease.

Regarding mimickers of IgG4-RD, sarcoidosis was considered unlikely because of the lack of any elevation in the level of angiotensin-converting enzyme (ACE) or hypercalcemia on blood tests and no findings of granulomas in the biopsy specimens. The pleural specimens did not show angiocentricity or granuloma formation, so lymphomatoid granulomatosis was also deemed unlikely in this case. No
fever or high CRP levels were observed in this patient, which made Multicentric Castleman disease unlikely.

The treatment and clinical course of this patient are shown in Fig. 5. We first performed continuous drainage of the pleural fluid with fasting, intravenous hyperalimentation, and octreotide for two weeks. The octreotide was used in an off-label manner with the patient’s consent to reduce lymphatic flow in the thoracic duct (14). The pleural drainage decreased the effusion temporarily, but the production of new fluid did not cease, resulting in the marked loss of serum levels of albumin, IgG, and IgG4. We started high-dose PSL 70 mg (1 mg/kg/day) with RTX (375 mg/m², weekly, 4 times). The off-label use of RTX for IgG4-RD was approved by the authorized committee in our hospital [approval number: 2020-012] with informed consent from the patient. The pleural effusion gradually decreased. Later, we switched from PSL to methylprednisolone (mPSL) due to the latter’s lower mineralocorticoid activity and better transferability to the lung (15, 16). Six months from induction therapy, the pleural effusion had significantly improved (Fig. 1C).

**Discussion**

The present patient developed refractory chylothorax due

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**Figure 2.** Lymphangiography images. Lymphangiography showed the intact structure of the thoracic duct (yellow arrows) and revealed no leakage or obstruction of the duct.

**Figure 3.** Histopathological images from the pleural biopsy. A pleural biopsy showed the infiltration of lymphocytes and plasma cells with ectopic germinal centers under the pleural mesothelium, and more than 50% of IgG-positive plasma cells were IgG4-positive. HE: Hematoxylin and Eosin staining, LPF: Low-power field, HPF: High-power field.
Figure 4. Histopathological images from the lip biopsy. A lip biopsy revealed focal IgG4-positive plasma cell infiltration, with up to 48 cells/HPF and an IgG4/IgG ratio exceeding 50%. HE: Hematoxylin and Eosin staining, LPF: Low-power field, HPF: High-power field.

Figure 5. Summary of clinical course of this patient. The pleuritis showed an insufficient response to the first induction therapy with moderate-dose PSL and diuretics. However, the second induction therapy with high-dose PSL and RTX resulted in the significant improvement of pleuritis and a reduction in the serum IgG4 levels. PSL: prednisolone, mPSL: methylprednisolone, RTX: rituximab, Tx: treatment.
| Case No. | Reference/Author, year | Age | Gender | Side | Cell count (µL) | Lymph (%) | IgG (mg/dL) | IgG4 (mg/dL) | ADA (IU/L) | IgG4-positive plasma cells (MPF) | IgG4 IgG | IgG (mg/dL) | IgG4 (mg/dL) | Associated diseases | Initial PSL, dose (day) | Immunosuppressant | PSL effect for plasmacytoma?
| 1 | Yamashita K, 2008 [18] | 74 | M | Right | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | none | none | - | Good response |
| 3-7 (5 cases) | | | | | | | | | | | | | | | | | | | |
| 9 | Yamamoto H, 2011 [22] | 78 | M | Bilateral | Exudative | N/D | N/D | 4.000 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 10 | Tamaki H, 2011 [23] | 85 | M | Bilateral (Left dominant) | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 13 | Kohjima M, 2013 [26] | 57 | M | Bilateral | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 14 | Hara Y, 2013 [27] | 69 | M | Right | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 15 | Ishida M, 2014 [28] | 71 | F | Right | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 16 | Ishida A, 2014 [29] | 74 | F | Bilateral | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 18 | Corcoran RP, 2015 [31] | 65 | M | Right | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 19 | Wada W, 2015 [32] | 74 | M | Left | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 20 | Ohtsuki H, 2015 [33] | 68 | M | Right | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 21 | Gagwica ML, 2016 [34] | 58 | M | Bilateral | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 22 | Karim AM, 2016 [35] | 32 | M | Bilateral | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 23 | Kondo M, 2016 [36] | 78 | M | Bilateral | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 24 | Gonzalez-Moreno L, 2016 [37] | 70 | M | Bilateral | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 25 | Ikayama Y, 2017 [38] | 70 | M | Bilateral (Right dominant) | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 26 | Kensei ML, 2017 [39] | 84 | M | Bilateral | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 27 | Tong X, 2017 [40] | 47 | F | Right | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 28 | Yu K, 2017 [41] | 55 | M | Left | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 29 | Kita T, 2018 [42] | 65 | M | Right | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 30 | Nagayasu A, 2018 [43] | 81 | M | Bilateral | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 31 | Fuchida M, 2018 [44] | 50 | F | Left | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 32 | Makimoto G, 2019 [45] | 72 | M | Bi lateral | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 33 | Yonokawa N, 2019 [46] | 46 | M | Bilateral | Exudative | N/D | N/D | 3.005 | 2,000 | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 34 | Cytolymphocytosis cases | | | | | | | | | | | | | | | | | | | |
| 35 | Kaet O, 2014 [47] | 69 | M | Exudative | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 36 | Glaab B, 2015 [48] | 26 | M | Exudative | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| 37 | Glaab B, 2015 [48] | 35 | F | Exudative | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |
| present case | Sakata 2019 | 66 | M | Exudative | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | N/D | 4.121 | 2,740 | - | - | Partial response |

**Table 2.** a Summary of 37 Previous Case Reports with IgG4-RD Related Plasmacytosis.
to IgG4-RD diagnosed histopathologically with a pleural specimen. The response to a moderate dose of PSL was poor. High-dose PSL and additional RTX resulted in marked improvement. Chylothorax presenting as IgG4-related pleuritis is quite rare, and to our knowledge, this is the first report of the successful treatment of IgG4-related pleuritis with RTX.

Pleural involvement is reportedly rare; indeed, Fei et al. found that 87 of 248 patients with IgG4-RD in a prospective cohort (35.1%) had intrathoracic involvement (17), although the involvement was mainly in the lungs and lymph nodes, including hilar and mediastinal lymphadenopathy, in 52.9%, solid nodules in the lungs in 25.3%, alveolointerstitial opacities in 20.7%, round ground-glass opacities in 9.2%, and bronchovascular opacities in 20.7%. Pleural nodules and thickening were observed in 16.1%, but pleural effusion was seen in only 4.6%.

We summarized 37 previous case reports with IgG4-RD related pleuritis in Table 2 (18-48). Patients with IgG4-related pleuritis were predominantly men (78%), and the mean age was 63.5±14.7 years old. Bilateral pleural effusion was seen in 21 cases, while 11 cases (right, n=7 cases; left, n=4) had unilateral effusion. In the 24 cases with pleural effusion findings available, 22 showed an exudative pattern, while bloody effusion was seen in 2 cases and transudative effusion in 1 case. Pleural effusion cytometry revealed predominantly lymphocytes among total cases, with a high concentration of IgG4 revealed in 10 cases. Our present findings were consistent with those of previous cases with regard to the age, percentage of men, and rate of bilateral exudative pleural effusion.

Interestingly, in previously reported cases of IgG4-related pleuritis, 10 out of 15 cases showed high levels of ADA in the pleural fluid (>40 U/L), which is usually measured as an auxiliary tool for the diagnosis of tuberculous pleuritis (49). Although careful ruling out of tuberculous pleuritis is necessary using other examinations, such as Ziehl-Neelsen staining (50), elevated ADA levels in pleural fluid may be useful for identifying IgG4-RD pleuritis because such a condition reflects the strong activation of lymphocytes. The levels of ADA in the pleural fluid of the present case were within normal limits.

Only two previous cases of IgG4-related pleuritis presenting as chylothorax have been reported (47, 48). Kato et al. reported a 69-year-old man with IgG4-related pleuritis, demonstrating right-sided chylothorax and left-sided non-chylothorax pleuritis (47). The right-side chylothorax persisted while the left-side pleuritis improved with corticosteroids. Another case, reported by Goag et al., was a young man with bilateral chylothorax (48) unresponsive to high-dose PSL with azathioprine or octreotide and a limited low-fat diet with medium-chain triglyceride supplementation. He ultimately had to undergo exploratory thoracotomy and surgical obliteration. In contrast to most non-chylothorax IgG4-pleuritis patients, who tend to show a good response to treatment, IgG4-related pleuritis with chylothorax is likely to have a poor response to PSL. The pathogenesis of chylothorax in IgG4-RD is unclear. Lymphangiography in our case did not reveal any leakage from the thoracic duct, suggesting potential micro-damage to the lymphatic channels hampering centripetal lymph propulsion from the periphery of the pleural surface. However, we lacked histological evidence of this, so more cases need to be accumulated to clarify the mechanism involved.

Many kinds of immunosuppressant drugs, such as azathioprine, methotrexate, cyclophosphamide, and mycophenolate mofetil, have been used to try to treat refractory IgG4-RD, but the optimal drug in combination with PSL is still unclear (51). Reports of the effectiveness of RTX in IgG4-RD have been increasing (51-54). Regarding the mechanisms underlying IgG4-RD, RTX, which depletes peripheral B cells, is a reasonable addition to therapy not only to prevent the repletion of short-lived plasma blasts and plasma cells but also to interfere with the maintenance of CD4+ T cell memory (55). Furthermore, a French nationwide study demonstrated the efficacy of RTX for both induction therapy and the maintenance of remission (56). Therefore, we selected RTX in our refractory case, and his pleural effusion gradually disappeared with a steroid-sparing effect. To our knowledge, this is the first case report suggesting the effectiveness of RTX in IgG4-related pleuritis.

In conclusion, we experienced a case of refractory IgG4-related pleuritis with chylothorax that was improved with high-dose PSL and RTX. More cases need to be accumulated in order to clarify the clinical manifestations of IgG4-RD pleuritis and its appropriate treatment.

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

Source of support: none

Patients consent: We declare that we have obtained written informed consent from this patient to publish this case report.

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