



# Immune checkpoint inhibitor-related pneumonitis induced by camrelizumab: a case report and review of literature

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**Abstract:** Immune checkpoint inhibitors (ICIs) are new agents that are efficacious in a variety of cancers. However, they are associated with immune-related adverse events due to activated immune system. Among them, checkpoint inhibitor pneumonitis (CIP) deserves more special attentions, because diagnosis and therapy are still challengeable. camrelizumab is a programmed cell death 1 (PD-1) inhibitor that was developed by Jiangsu Hengrui Medicine Co. CIP that is induced by camrelizumab was rarely reported. We described a case that a patient developed CIP 12 days later after one dose of camrelizumab. A 60-year-old man with advanced esophageal squamous cell carcinoma received 6 cycles of Tislelizumab/placebo, capecitabine and cisplatin first. Owing to the poor control of the disease, the patient used Nimotuzumab and docetaxel on April 3, 2020 and April 24, 2020, respectively. Later, he obtained the combination of 200 mg of camrelizumab and 140 mg of docetaxel regimen for once on May 14, 2020. After 12 days, he was diagnosed with CIP in Outpatient. Multiple ground glass opacities were revealed in bilateral lungs from routine CT examination. After giving 40 mg of prednisolone orally once a day, his CIP improved. Meanwhile, camrelizumab was not used again. Teaching point: same as other PD-1 inhibitors, camrelizumab can also cause immune-related pneumonitis. Close observation, regular CT examination and timely corticosteroids intervention are essential.

**Keywords:** Checkpoint inhibitor pneumonitis (CIP); anti-programmed cell death (PD-1) blockade; immune-related pneumonitis (IMP); camrelizumab; case report

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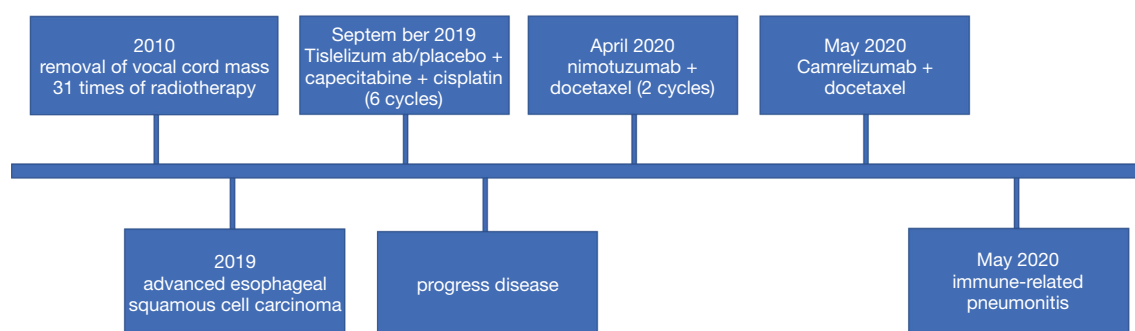
## Introduction

The incidence of immune-related pneumonitis (IMP) caused by programmed cell death (PD-1) and programmed cell death ligand 1 (PD-L1) inhibitors is about 2.2% (1). The incidence is not high, while the number of death due to IMP is considerable (2). The probability of IMP that is induced by PD-1 inhibitors is higher than other immune checkpoint inhibitors (ICIs). Compared with other pneumonitis, the occurrence of checkpoint inhibitor pneumonitis (CIP) is relatively late (3-7). The risks of CIP are still vague, but the occurrence of CIP may be closely related to smoking history, previous treatment (whether radiotherapy), combination therapy, the type of primary tumor, and baseline lung disease (8-10). The predictive

biomarkers for CIP are also unclear. Some studies revealed that the increase in CXCR2, IL1ra and IL2ra is correlated with the development of CIP (11). At the same time, CIP patient has higher level of baseline peripheral-blood absolute eosinophil count (AEC) (12).

Camrelizumab is a novel humanized high-affinity IgG4-kappa monoclonal antibody and it was approved for the treatment of patients with relapsed or refractory classical Hodgkin lymphoma. The most common adverse reactions ( $\geq 10\%$ ) include cutaneous capillary endothelial hyperplasia, anemia, fever, fatigue, hypothyroidism, proteinuria, and cough (13,14). There are few reports on pneumonitis caused by camrelizumab. We describe a case that a patient developed IMP 12 days after one dose of camrelizumab.

We present the following article in accordance with



**Figure 1** Timeline of disease and treatment.

the CARE reporting checklist (available at <http://dx.doi.org/10.21037/apm-21-23>).

### Case presentation

The patient was a 60-year-old male, 181 cm in height, 65 kg in weight, and 1.84 m<sup>2</sup> in surface area. He has been smoking for 25 years, with the average of 20 cigarettes a day. Ten years ago, the patient underwent surgical resection for a mass on the vocal cord. Postoperative pathology suggested squamous epithelial dysplasia with precancerous lesions. In order to prevent malignant lesions, 31 times of radiotherapy were performed after surgery. In September 2019, he was diagnosed with advanced esophageal squamous cell carcinoma with an Eastern Cooperative Oncology Group Score (ECOG) of 1, with the stage of T4NxM1. Afterwards, he participated in a Phase III clinical trial: A phase 3 study on Tislelizumab (BGB-A317) in the combination with chemotherapy as the first-line treatment for unresectable, locally advanced, recurrent or metastatic esophageal squamous cell carcinoma. It is a randomized, placebo-controlled, and double-blind study. The patient was treated through chemotherapy (capecitabine 3.5 g day 1–15; cisplatin 109 mg q3w) and Tislelizumab/placebo 200 mg q3w (*Figure 1*). After 6 cycles of treatment, he withdrew from the trial due to the development of the disease. The following treatment was started with the administration of nimotuzumab and docetaxel. He received the regimen for twice on 2 April 2020 and 24 April 2020, respectively.

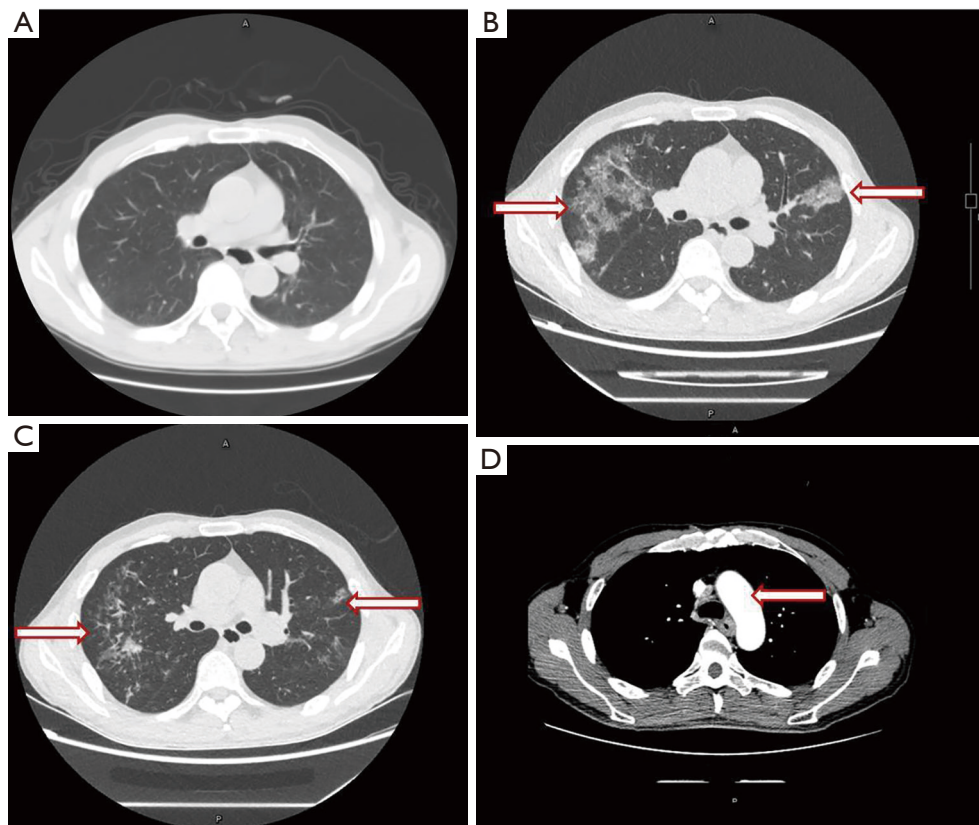
The patient was admitted to the hospital on May 13 to further adjust the anticancer drug, and received 200 mg of camrelizumab plus 140 mg of docetaxel in the following day. However, after 12 days, multiple ground glass

opacities were revealed in bilateral lungs from routine CT examination (*Figure 2*).

During the treatment of camrelizumab, the suffocation improved. The patient previously had coughs and hoarseness due to esophageal cancer, but it did not aggravate recently.

Routine blood examination: white blood cells (WBC):  $8.38 \times 10^9/L$ , absolute neutrophils (GR):  $7.04 \times 10^9/L$ , percentage of neutrophils (GR%): 84.0%, and C-reactive protein (CRP): 124.61 mg/L. The patient's blood and sputum culture were negative. He was thought to be developed with IMP. First, the patient's CT findings matched the typical features of the IMP (15). Second, although the patient had experienced radiotherapy, the ground-glass opacities were not limited to prior radiation field and were outside the high radiation dose. The possibility of RRP is low (16). Third, some researches indicated that radiation history represents one of the high risk factors of IMP (17). Fourth, the tumor location of patient did not overlap with the area of pneumonitis, so the situation of tumor pseudo progression could be ruled out.

He received 40 mg of Prednisolone per day orally. To prevent infection, the patient used fluconazole and moxifloxacin. Even with a significant radiographic improvement, camrelizumab was discontinued. In the follow-up treatment, the patient administered Paclitaxel for Injection (Albumin Bound), Oxaliplatin and Tegafur Gimeracil Oteracil Potassium Capsule and received 3 courses of treatment. The condition was assessed as SD. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committees and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient.



**Figure 2** Chest CT of patient. (A) Before administration of camrelizumab; (B) after administration of camrelizumab; (C) after treatment; (D) image of patient's tumor. Arrows indicate inflammatory lesions and cancer lesion respectively.

## Discussion

PD-1 is a receptor expressed by immune cells such as T cells, B Cells, and natural killer cells (18). Through PD1 pathway, immune response can be regulated to anticancer. There are currently eight PD-1/PD-L1 inhibitors on the market in China, namely atezolizumab, camrelizumab, durvalumab, nivolumab pembrolizumab, tislelizumab, toripalimab and sintilimab. The possible mechanisms of immune-related adverse reactions are as follows: PD-1/PD-L1 inhibitors up-regulate cellular immune checkpoint molecules, which may result in the destruction of immune tolerance (19). There are similar or identical antigens in the affected tissues and the tumor tissues (20-23).

The most common symptoms of pneumonitis include dyspnea, cough, chest pain and fever. But some patients have no symptoms (24). Radiographic pattern can be manifested as cryptogenic organizing pneumonitis, nonspecific interstitial pneumonitis, hypersensitivity pneumonitis, acute interstitial pneumonitis and acute

respiratory distress syndrome (25). If the patient meets the following three conditions: the history of ICIs, new pulmonary shadow in imageological examination and excluding pneumonitis caused by other circumstances, CIP can be diagnosed. Most patients get remission from pneumonitis, but those with grade 3 or higher pneumonitis or co-infection may have a poor prognosis. Early treatment with corticosteroids can reduce potentially life-threatening factors caused by pneumonitis. Depending on the severity of adverse reactions, the management methods are different (*Table 1*).

In this case, the patient obtained different treatments, we tended to think that it was due to the administration of camrelizumab for pneumonitis, while it could not rule out the efficiency of Tislelizumab. Immune-associated pneumonitis usually occurs after receiving 3-4 cycles of PD-1/PD-L1 inhibitors. However, the imaging of the lungs was normal after six cycles of Tislelizumab/placebo, including the dressing change process. Additionally, when the patient terminated camrelizumab, his pneumonitis

**Table 1** Management of immune-related pneumonitis

	ESMO (26)	NCCN (27)	ASCO (28)	SITC (29)
<b>Grade 1</b>				
Symptom	Radiographic changes only: ground glass change	Asymptomatic; confined to one lobe or less than 25% of the lung parenchyma; clinical or diagnostic observations only	Asymptomatic; confined to one lobe of the lung or <25% of lung parenchyma; clinical or diagnostic observations only	Asymptomatic; clinical or diagnostic observations only
PD-1 inhibitor	Delay	Delay	Hold	Consider holding
Investigations	High resolution CT +/- bronchoscopy and BAL pending appearances	Oxygen saturation; repeat CT in 4 weeks or sooner if clinically indicated for worsening symptoms; pulse oximetry reassess in 1 to 2 weeks	Offer one repeat CT and spirometry/DLCO in 3–4 weeks; pulse oximetry; CXR	Repeat CT at least every 3 weeks; oxygen saturation every 2–3 days; weekly clinic visits
Therapy	Monitor symptoms; if worsens: treat as grade 2 or 3–4	Monitor symptoms	Monitor symptoms; if no improvement, treat as g2	Monitor symptoms; if no improvement, treat as higher grade
<b>Grade 2</b>				
Symptom	Mild/moderate new symptoms	New/worsening symptoms	Symptomatic; involves more than one lobe of the lung or 25–50% of lung parenchyma; medical intervention indicated; limiting instrumental adl	Symptomatic; limiting instrumental adl; medical intervention indicated
PD-1 inhibitor	Withhold	Delay	Hold until resolution to g1 or less	Hold
Investigations	High resolution CT +/- bronchoscopy and BAL pending appearances; blood routine examination (CRP, neutrophil counts)	Nasal swab and sputum, blood, and urine cultures; bronchoscopy and BAL; monitor every 3 to 7 days with pulse oximetry	Bronchoscopy with BAL; every 3 days with pulse oximetry; CXR	Bronchoscopy with BAL; biopsies for atypical lesions
Therapy	Consider pneumocystis prophylaxis; start anti-infective treatment if suspicion of infection; prednisolone 1 mg/kg/day orally	Consider empiric antibiotics; methylprednisone/prednisolone at 1–2 mg/kg/day (>4–6 weeks); treat as grade 3 if no improvement after 48–72 hours of corticosteroid	Consider empiric antibiotics; prednisone 1–2 mg/kg/day and taper by 5–10 mg/week (>4–6 weeks); treat as grade 3 if no improvement after 48–72 hours of prednisone	Consider hospitalization; methylprednisolone 1 mg/kg/day (>1 month); treat as grade 3–4 if no improvement after 2–3 days
<b>Grade 3 or 4</b>				
Symptom	G3: severe symptoms	G3: severe symptoms; involves all or more than 50% of the lung parenchyma; limiting self-care ADL	G3: severe symptoms; involves all lung lobes or more than 50% of lung parenchyma; limiting self-care ADL; oxygen indicated	G3: severe symptoms; limiting self-care ADL; oxygen indicated
	G4: life-threatening	G4: life-threatening; impairment of respiratory function	G4: life-threatening; respiratory compromise; urgent intervention indicated	G4: life-threatening; respiratory compromise; urgent intervention indicated

**Table 1** (continued)

Table 1 (continued)

	ESMO (34)	NCCN (35)	ASCO (36)	SITC (37)
PD-1 inhibitor	Discontinue	Permanently discontinue	Permanently discontinue	Permanently discontinue (G3: after weighing risk/benefit)
Investigations	High resolution CT and respiratory review +/- bronchoscopy and BAL pending appearances	Complete infectious workup and bronchoscopy with BAL (like G2)	Bronchoscopy with BAL +/- transbronchial biopsy	Bronchoscopy with BAL; biopsies for atypical lesions
Therapy	Admit patient; (Methyl) Prednisolone IV 2–4 mg/kg/day; empiric anti-infective treatment; escalation and ventilation 48 h not improving; add infliximab 5 mg/kg or MMF	Inpatient care; consider empiric antibiotics; Methylprednisone/ Prednisolone at 1–2 mg/kg/day (>6 weeks) additional immunosuppression (infliximab, MMF, or IVIG) after 48 h if no improvement	Empirical antibiotics; (Methyl) Prednisolone IV 1–2 mg/kg/d (>4–6 weeks); after 48 hours, add infliximab 5 mg/kg or mycophenolate mofetil IV 1g bid or IVIG for 5 days or cyclophosphamide;	Hospitalize; consider ICU care; Methylprednisolone IV, 2 mg/kg/day, reduce to 1 mg/kg/day if improvement (>2 months); add infliximab or cyclophosphamide, mycophenolate mofetil or IVIG if no improvement

ESMO, European Society for Medical Oncology; NCCN, National Comprehensive Cancer Network; ASCO, American Society of Clinical Oncology; SITC, Society for Immunotherapy of Cancer; BAL, bronchoalveolar lavage; DLCO, carbon monoxide diffusing capacity; CXR, chest X-ray; ADL, activities of daily living; CRP, C-reactive protein; MMF, Mycophenolate Mofetil; IVIG, Intravenous immunoglobulin.

was improved quickly. Paradoxically, the patient suffered from pneumonitis after only one cycle of camrelizumab administration. We surmised that EGFR inhibitors increased the risk of immune-associated pneumonitis (30). Was it possible that the administration of nimotuzumab caused the increased lung sensitivity?

Camrelizumab received approval in China in May 2019. For patients suffering from nasopharyngeal carcinoma, hepatocellular carcinoma, esophageal squamous cell carcinoma, gastric/gastroesophageal junction cancer and classical Hodgkin lymphoma, camrelizumab is effective (14,31–36). The incidence of IMP caused by camrelizumab is 1–6.7% (14,32,34–36). Most of patients with grade 1–2 pneumonitis improved after treatment interruption. Only one died of pneumonitis. Some patients have basic lung diseases. It was reported that one patient who had received radiotherapy before developed radiation recall pneumonitis (RRP) after receiving camrelizumab. IMP also occurred in another two patients who administered camrelizumab combined with microwave ablation (37). Combined with this case, camrelizumab administration of radiotherapy, microwave ablation, and EGFR-TKI were the risk factors of pneumonitis. In terms of IMP patients, we are cautious about re-challenging the administration of camrelizumab. Some cases have more serious IMP due to the re-use of camrelizumab after the occurrence of IMP (33). Re-

challenge needs to be evaluated by clinicians by combining with clinical effects and patients' specific conditions.

The disadvantage of the case is that due to the effect of COVID-19, treatment and examination were limited by some objective factors. Meanwhile, as the patient participated in a double-blind clinical study, it is unclear whether the patient received Tislelizumab.

## Conclusions

In conclusion, we reported a case of IMP induced by anti-PD-1 blockade camrelizumab 12 days after first dose. The patient has the history of smoking, radiotherapy, and combination medication that are all risk factors of IMP. In clinical practices, it is significant to attach close attentions to patients who have risk factors, including elderly male, smoking history, radiotherapy history, combination therapy, and basic lung disease. Lung radiological examination, timely corticosteroids intervention and drug withdrawal are key treatments.

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## Footnote

**Reporting Checklist:** The authors have completed the CARE Reporting Checklist. Available at <http://dx.doi.org/10.21037/apm-21-23>

**Conflicts of Interest:** All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/apm-21-23>). The authors have no conflicts of interest to declare.

**Ethical Statement:** The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient.

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