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Case Report: Bilateral Pneumothoraces due to Targeted Tumor Therapy with Regorafenib in a Young Woman with Metastatic Colorectal Cancer

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Abstract

Background: Colorectal cancer is one of the most common cancer types, frequently metastasizing into the lungs. Treatment options have been vastly improved over the last years. With the increasing use of targeted therapies, novel and rare adverse effects can be seen. **Case Presentation:** A 43-year-old woman presented in our oncology department with chest pain and dyspnea. The patient was diagnosed with colorectal cancer seven years earlier and had received chemoradiation, surgery, and multiple chemotherapies before she was started on regorafenib because of progressive pulmonary metastases. Computed tomography scans demonstrated cavitation of former nodular bilateral pulmonary metastases. After drainage and resolution of the right-sided pneumothorax, the patient returned eleven days later with recurrent symptoms caused by left-sided tension pneumothorax. Video-assisted thoracoscopy and bilateral pleurodeses were performed. Persistent air leaks with severe pain and pulmonary infiltrates led to the death of the patient. **Conclusions:** This case demonstrates the efficacy of oral antiangiogenetic therapy in advanced metastatic colorectal cancer. Nevertheless, it also depicts an important potential side effect by transforming multiple solid lung metastases into cavitations which led to recurrent pneumothoraces. Special attention should be paid to this phenomenon as treatment of these complications can be challenging.

Keywords

Regorafenib, Pneumothorax, Pulmonary Metastases, Colorectal Cancer

1. Background

Metastatic colorectal cancer (mCRC) is the third most common cause of cancer mortality worldwide. Up to 50% of patients present with or develop metastatic disease mainly in the liver and the lungs [1] [2]. The management of mCRC has undergone a strategic revolution in imaging, innovations in surgical and local ablative techniques, and unprecedented advances in systemic medical therapy (cytostatic agents, immunotherapies, and targeted therapies). Molecular profiling of mCRC unfolded biological determinants of the disease and led to better treatment selection for more efficient therapeutic strategies. Moreover, it reduced the need for cytotoxic therapies with its associated high level of toxicities [3]. However, the use of targeted therapies may be associated with novel and rare adverse effects.

In this report, we present the rare case of recurrent spontaneous bilateral pneumothorax due to rapid tumor reduction during the administration of the oral multi-kinase inhibitor regorafenib in a patient with multiple lung metastases from mCRC.

2. Case Presentation

Medical History

Our patient was diagnosed with colorectal cancer in August 2013. The initial clinical staging was cT3 cN1 cM0 (UICC IIIB). After neoadjuvant chemoradiation, lower anterior resection was performed in November 2013. Resection was complete (R0), and final pathological staging showed a stage IIIC (ypT3 pN2b (8/13) cM0). Hereditary tumor syndromes were excluded by genetic analysis. Adjuvant mono-chemotherapy with 5-fluorouracil (5-FU) was started but had to be modified to oral therapy with capecitabine because of poor tolerance. The patient received three complete cycles. Follow-up examinations showed no signs of local tumor recurrence or metastases. In November 2014 two pulmonary metastases were detected, which could be resected. From February to April 2015 another chemotherapy (FUFOX-scheme = fluorouracil/folinic acid/oxaliplatin) was applied. Tolerance was poor with treatment associated anaphylactic reactions, most likely caused by oxaliplatin, infection and chest pain. Consequently, chemotherapy had to be discontinued. In November 2015, a solitary left-sided pulmonary metastasis was diagnosed and resected. Molecular testing showed an NRAS mutation and chemotherapy with 5-FU, folic acid, irinotecan and bevacizumab was initiated. Due to severe side effects, the therapy was switched to mitomycin and bevacizumab. In September 2016 relapse was detected with pulmonary metastases and bilateral pleural effusions. The patient was switched to 5-FU, folic acid and bevacizumab which resulted in stable disease with stable to slow-growing pulmonary metastases until October 2018. In November 2018, wedge-resection of pulmonary metastasis was performed for whole genome sequencing, which showed a pathogenic tumor protein P53 (TP53)-mutation, an NRAS G12D mutation and a high mutational burden. In January 2019 severe

diarrhea developed and the dose of 5-FU had to be reduced. Follow-up CT scans showed slowly progressing pulmonary metastases. In June 2019, bevacizumab was replaced by aflibercept while continuing a dose-reduced regimen of 5-FU, folic acid, and irinotecan. In January 2020, a CT scan suggested local recurrence of the tumor accompanied by perirectal abscesses. Finally, surgical resection showed no malignancy but local infection. Chemotherapy was continued until June 2020 when imaging showed disease progression. Over time, the patient had received a cumulative dose of 171,200 mg fluorouracil. Intravenous therapy was discontinued and switched to oral therapy with trifluridine/tipiracil. In September two brain metastases were detected in a routine magnetic resonance imaging (MRI) scan and therapy with regorafenib was initiated before immunotherapy could be instituted as off-label use.

In October 2020 she presented in our oncology department with chest pain and dyspnea. Clinical examination revealed no breath sounds in the right hemithorax. The patient was tachycardic and orthopneic. Chest X-ray showed right-sided pneumothorax (**Figure 1**). Computed tomography (CT) scans revealed cavitation of former nodular bilateral pulmonary metastases (**Figure 2**) but no progressive disease. Pneumothorax resolved after insertion of a chest tube and suction therapy. Dyspnea resolved promptly and the patient could be discharged a few days later after the removal of the chest tube.

Eleven days later, the patient was readmitted due to recurrent dyspnea, chest pain and subcutaneous emphysema. Chest X-ray not only showed recurrence of the right-sided pneumothorax but also another pneumothorax in the left apex of the lung (**Figure 3(A)**). After insertion of bilateral chest tubes, subsequent x-rays showed complete resolution of the left-sided and partial resolution of the right-sided pneumothorax (**Figure 3(B)**). Four days later, the patient reported once more massive chest pain. Chest X-ray revealed left-sided tension pneumothorax and another chest tube was inserted. Furthermore, video-assisted thoracoscopy and bilateral pleurodeses were performed. However, the chest tubes

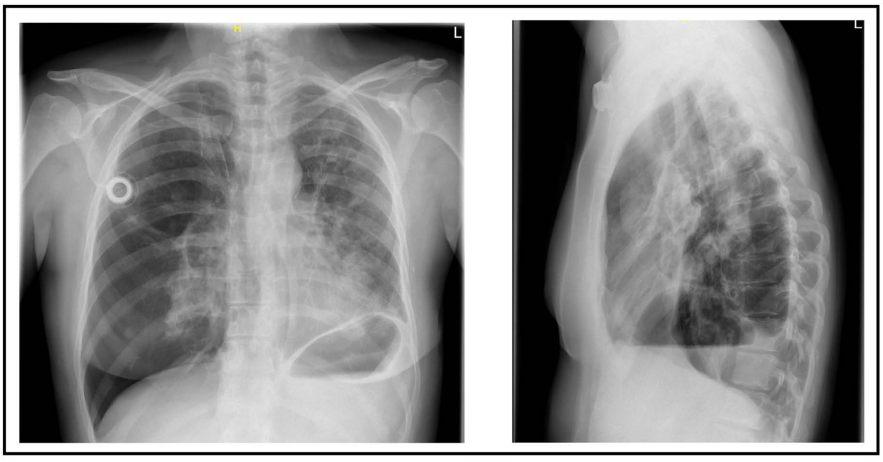

Figure 1. Chest X-ray for the reason of suddenly developed chest pain and shortness of breath showing right sided pneumothorax.

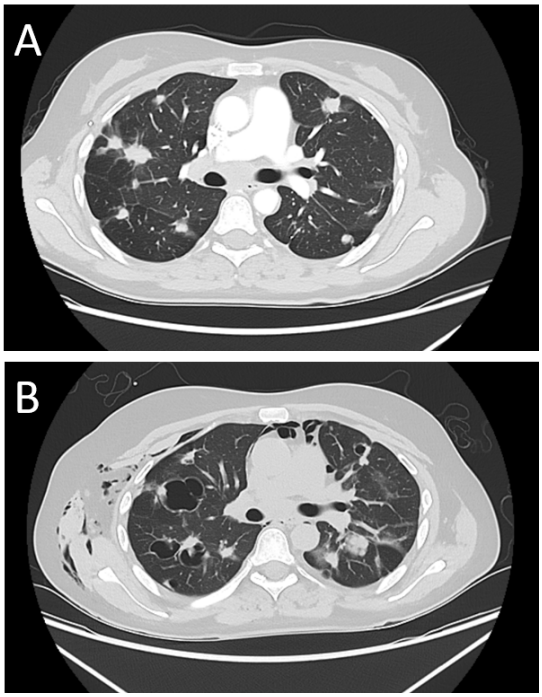

Figure 2. Thoracic CT scans before treatment with regorafenib (A) showing multiple bilateral nodular pulmonary metastases and 6 weeks after initiation of TKI-treatment (B) with bullous transformation and subcutaneous emphysema.

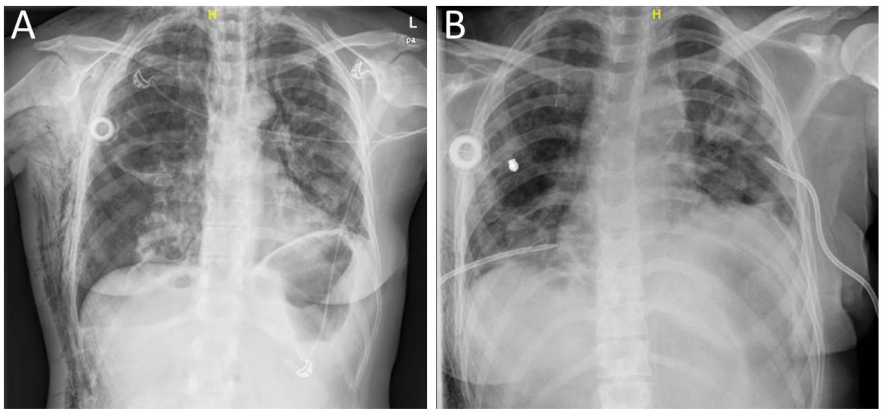

Figure 3. Recurrence of right sided pneumothorax and new left-sided apical pneumothorax (A), resolution after insertion of two chest tubes (B).

could not be removed due to persistent air leaks. In addition, antibiotic treatment was started because of pneumonia. After the surgical procedures, chest pain worsened continuously, and the patient received specialized pain treatment and palliative sedation. Finally, the patient died 30 days after readmission due to infectious complications and persistent air leaks.

3. Discussion and Conclusions

Regorafenib is a multikinase inhibitor. Antiangiogenic activity is mainly mediated by binding to vascular endothelial growth factor receptor (VEGFR) 1-3.

Moreover, it inhibits tyrosine-protein kinase KIT- and rearranged during transfection (RET)-signaling cascades which are important for tumor development and progression. Activation of fibroblast growth factor receptor (FGFR) and platelet-derived growth factor receptor (PDGFR)-kinases, which are inhibited by the substance as well, has been implicated in tumor progression and metastasis. Regorafenib showed survival benefits in mCRC which had progressed after standard therapies [4]. The substance was approved for the treatment of mCRC by the Food and Drug Administration in 2012 and in 2013 by the European Medical Association (EMA). A recently published trial confirmed the effects in a real-world setting [5].

Our heavily pretreated patient responded surprisingly well to regorafenib with the complete transformation of the pulmonary metastases to cavities. This effect has been recently described in a few case reports [6] [7]. By analogy with our case, both patients were diagnosed with RAS-mutated colorectal cancer and pretreated with intravenous cytostatic agents and bevacizumab. The administration of regorafenib led to quick tumor shrinkage and characteristic cavitation in metastatic sites. The exact mechanism of cavity formation remains unclear but central tumor necrosis caused by antiangiogenic activity is suspected to be the most likely cause [8] [9].

Cavitary transformation of solid metastases has been observed with anti-angiogenic treatment in NSCLC with reported frequencies between 14% and 24% [8] [9] and pneumothorax was reported with the use of bevacizumab, sunitinib and pazopanib in solid tumours particularly when localized near the pleural space [10].

In our case, relapsing pneumothoraces could not be sufficiently controlled by chest drainage and surgery was necessary. We terminated the treatment with regorafenib after the initial pneumothorax. However, further cavitation and pneumothoraces occurred even after discontinuation of treatment, leading to severe chest pain.

Regorafenib is an effective agent for the treatment of colorectal cancer in pretreated patients. Large randomized, double-blind, multinational, phase 3 clinical trials showed benefits regarding progression-free and overall survival [4] [6]. Our case illustrates the effectiveness of regorafenib in a highly pretreated patient. However, in our patient, the ensuing cavitation of the multiple nodes led to recurrent pneumothoraces and associated infectious complications. Therefore, special surveillance should be implemented to detect the potential transformation of solid pulmonary metastases during treatment with this multi-kinase inhibitor.

Consent for Publication

The patient's husband consented for publication of this case report.

Authors' Contribution

TR, TS, TE, HS and SML contributed to the writing of the manuscript, all au-

thors have read and approved the manuscript.

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All relevant data are included in this published article.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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List of Abbreviations

mCRC = metastatic colorectal cancer
CT = computed tomography
5-FU = 5-fluorouracil
FUFOX = fluorouracil/folinic acid/oxaliplatin
KRAS = oncogen detected in Kirsten RAt Sarcoma virus
TP53 = tumor protein p53
MRI = magnetic resonance imaging
VEGFR = vascular endothelial growth factor receptor
KIT = tyrosine-protein kinase KIT
RET = rearranged during transfection
FGFR = fibroblast growth factor receptor
PDGFR = platelet derived growth factor receptor
EMA = European Medical Association