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Case Report

Curative management of a cardiac metastasis from lung cancer revealed by an electrical storm

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ABSTRACT

Although cardiac metastases (CM) are more common than primary cardiac malignant tumors, they remain a rare localization of metastatic cancer. Until recently, CM were surgically treated as a palliative approach because of a lack of ablative solutions even for oligometastatic patients. Technological advances in radiation therapy (RT) in thoracic oncology have led to high precision delivery that enlarged the indications for stereotactic body radiotherapy (SBRT). To date, there are limited reports of cardiac SBRT for CM. Herein, we report a cardiac SBRT performed in curative intent for a lung cancer patient metastatic to the heart.

1. Introduction

Lung cancer is the most common cause of death from cancer worldwide [1]. Despite advances in early detection and standard treatment, non–small-cell lung cancer (NSCLC) is often diagnosed at a multi-metastatic stage of poor prognosis [2].

Radiation therapy (RT) has a well-established role in the multidisciplinary approach of both early and locally advanced NSCLC. Although surgery remains a standard of care in early-stage NSCLC, stereotactic body radiotherapy (SBRT) appears as an excellent alternative leading to high local control and low toxicity [3].

Ablative treatments either by surgery, SBRT or radiofrequency (RF) is increasingly used in the management of metastatic cancer patients. Such approaches have been successfully utilized in several clinical situations such as brain metastases with SBRT [4] or liver metastases with RF or surgery [5]. These ablative treatments are very efficient for controlling metastases and appear as a complement to systemic agents. Ablative treatments are especially useful in the context of oligometastatic disease described by Heilman and Weichselbaum [6]. Therefore, NSCLC patients with limited number of metastases could benefit from ablation of these metastases to prevent disease progression.

Among all metastatic sites, cardiac metastases (CM) are considered to be rare with a variable incidence reported in the literature ranging from 2.3% to 18.3% [7]. Most CM are clinically silent and diagnosed postmortem [8]. For symptomatic lesions, symptoms differ according to the involved cardiac substructure. If the conduction system has been infiltrated, typical presentation could be atrioventricular conduction disorders, premature beats, ventricular arrhythmias or electrical storm (ES) [7]. We report here an ablative cardiac SBRT performed in curative intent for a lung cancer patient metastatic to the heart.

2. Case presentation

2.1. Patient history

A 66-year-old female patient was hospitalized in our Cardiovascular Department for a first episode of syncope. Clinical history revealed smoking and hypercholesterolemia. The baseline ECG showed repetitive non-sustained ventricular tachycardia (VT) arising from the infero-basal interventricular septum (IVS) or the right ventricle. The diagnostic work-up of this syncopal episode included a coronary angiography that revealed a 50–70% stenosis of the left main coronary artery unrelated to the VT episode and treated with

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an active stent. The echocardiography was non-contributive, but the cardiac magnetic resonance imaging (MRI) revealed a localized thickening of the inferior IVS with hyper-intense inhomogeneous appearance on T2-weighted images. The high signal intensity on late normal values of gadolinium enhancement (Fig. 1) was indicative of a large interstitial space secondary to edema and hypervascularization. The following differential diagnoses were considered: cardiac sarcoidosis, metastatic tumor or infectious disease. Unfortunately, the endomyocardial biopsy was inconclusive. As the patient was an active smoker and lost 8 kg within a year, the diagnosis of malignancy was suspected. An 18-fluorodeoxyglucose (FDG) positron emission tomography (PET) integrated with computed tomography (CT) scan revealed an hypermetabolic activity within the IVS associated with an hypermetabolic nodule in the upper lobe of the right lung and paratracheal lymph nodes (Fig. 2). A mediastinal biopsy confirmed the diagnosis of lung adenocarcinoma.

2.2. Clinical management

Regarding the VT, the electrophysiological study showed that the VT was not inductible anymore under beta-blocker treatment even after isoprenaline infusion. The patient was discharged from the cardiovascular department with a prescription of propranolol. For the management of the metastatic lung cancer, a chemotherapy with carboplatin and pemetrexed was initiated. The patient received 3 cycles of chemotherapy followed by a new PET-CT scan. This exam showed a good clinical response with a reduction of the metabolic activity in all neoplastic lesions (including the cardiac lesion), and no new lesions. Due to the oligometastatic context, the thoracic tumor board recommended a cardiac SBRT with a curative intent, followed by a definitive mediastinal chemo-RT.

2.3. Radiotherapy planning and delivery

As a SBRT program for non-invasive VT ablation was launched in our institution in 2017, we used the same procedure as for radio-ablation of VT [9]. As the metastasis was located within the heart conducting system (i.e., the IVS), a double-chamber pacemaker (PM) was prevently implanted because of the risk of atrioventricular block after SBRT. A set of planning CT-scans was performed including a breath-hold CT-scan and a 4-dimentional CT-scan. Both exams were co-registered with the cardiac MRI and the PET/CT to help for volume delineation. Organs at risk (OAR), including lungs, esophagus, stomach, and coronary arteries, were delineated. Regarding the prescribed dose we decided to use a dose schedule routinely used in radiosurgery for brain or spine metastases: a single fraction of 20 Gy. Cardiac SBRT was delivered using robotic SBRT (Cyberknife®, Accuray Inc., Sunnyvale, CA); the whole treatment was catheter-free thanks to the right ventricular PM lead was used as fiducial marker for tracking.

3. Results

A dose of 20 Gy was delivered to the planning target volume (PTV) of 21 cc in a single 55-minute procedure (Fig. 3). Treatment was prescribed at the 88% isodose line leading to a mean PTV dose of 21.2 Gy, and a near PTV maximum dose (D2) and a near PTV minimum dose (D98) of 22.3 Gy and 19.7 Gy, respectively. One week after the SBRT procedure, the thoracic chemo-RT was

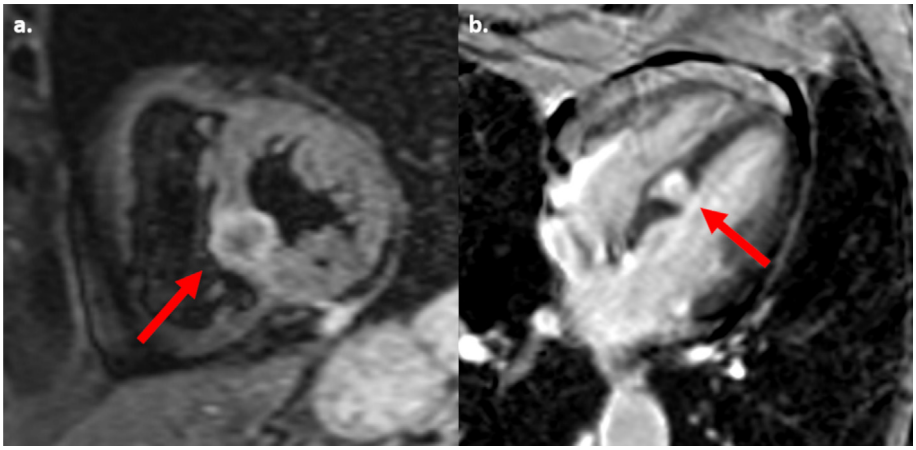

Fig. 1. a. T2-weighted cardiac magnetic resonance imaging (MRI) in a sagittal view showing a hyper-intense nodule within the inter-ventricular septum (red arrow). b. Cardiac MRI after gadolinium injection in an axial view showing a nodular enhancement within the inter-ventricular septum (red arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

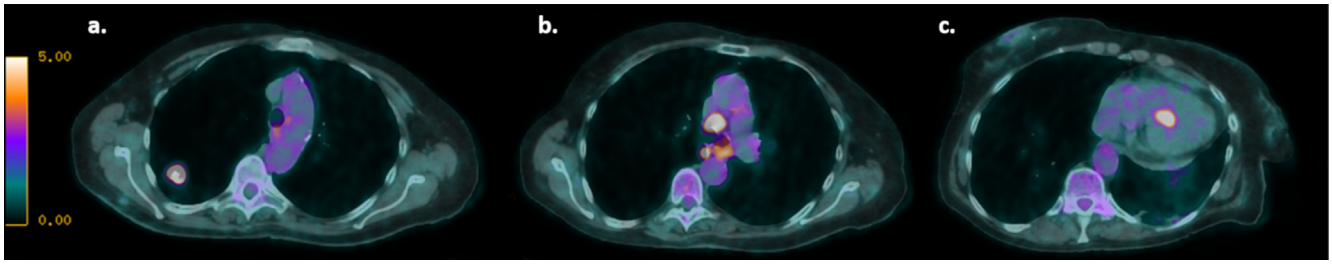

Fig. 2. a. 18-FDG PET/CT scan in an axial view showing the hypermetabolic right upper lobe lung lesion; b. 18-FDG PET/CT scan in axial view showing active paratracheal lymph nodes; c. 18-FDG PET/CT scan in an axial view showing an hypermetabolic lesion within the heart.

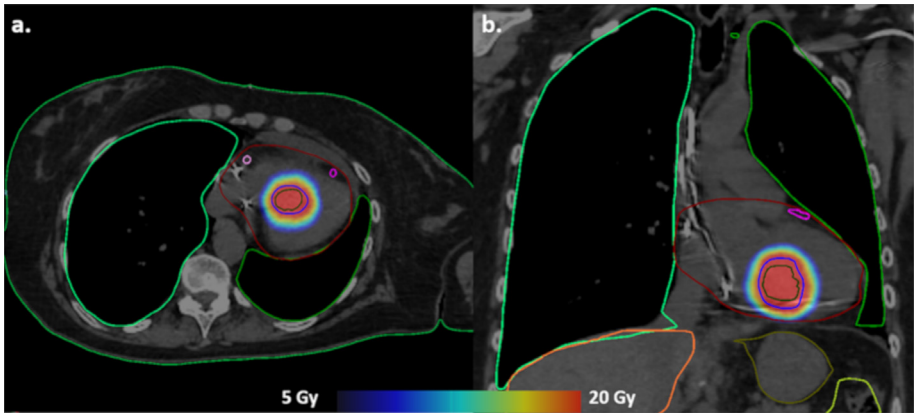

Fig. 3. Stereotactic body radiotherapy plan of the cardiac metastasis.

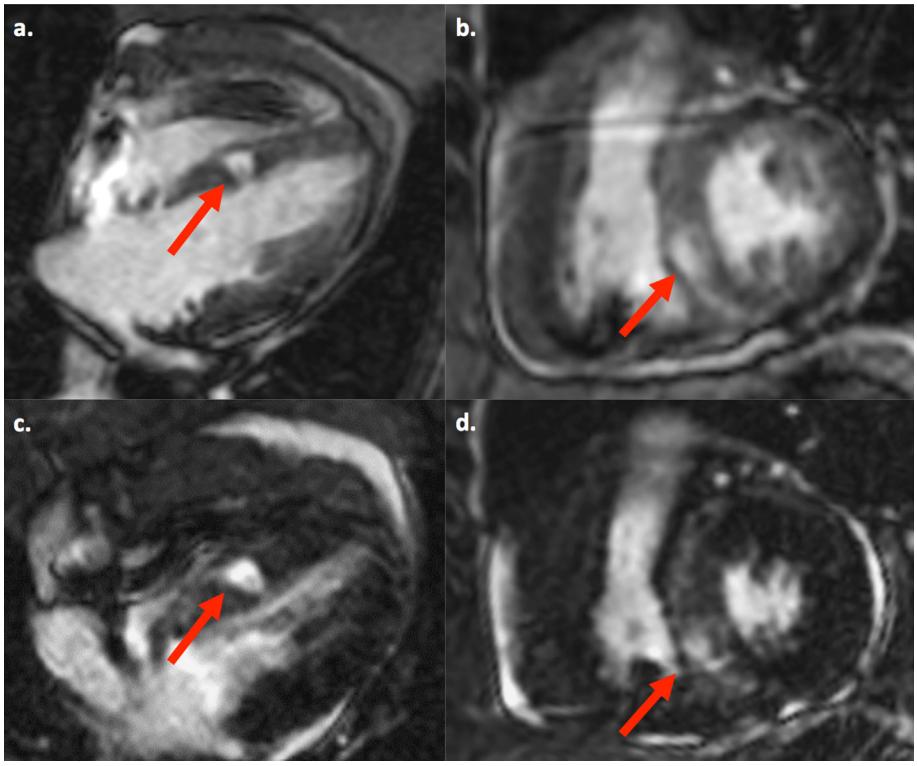

Fig. 4. Cardiac magnetic resonance imaging (MRI) in axial and sagittal view at 3 months (a, b) and 6 months (c, d) confirming the size reduction of the lesion and the emergence of a patch of edema on the 6-month images (c, d).

initiated (66 Gy in 33 fractions). Both treatments were well tolerated, but the patient was hospitalized for one week because of febrile neutropenia following the second cycle of chemotherapy. After completion of the chemo-RT, the patient declined any systemic maintenance therapy. The 3- and 6-month follow-up PET/CT were suggestive of a complete response. The 3 and 6-month follow-up cardiac MRI (Fig. 4) confirmed the good local response and a stable left ventricular ejection fraction. Nine months after the SBRT treatment and 18 months after the diagnosis, the patient has no sign of local relapse, no atrioventricular block, no VT relapse and no specific oncological treatment.

4. Discussion

CM are rare manifestations of cancers but seemed to increase in prevalence thanks to prolonged survival of oncologic patients and progresses in diagnostic and therapeutic modalities. Most CM are clinically silent but their prognosis is appalling when symptomatic. Consequently, the management of symptomatic cancer patients metastatic to the heart is generally palliative. Surgical resection of CM is the treatment of choice in highly selected patients with a long life expectancy and a good performance status [8,10]. In such cases, total excision remains nowadays challenging with high post-surgical morbidity and a need for adjuvant radio- or chemotherapy. Conventional RT is mainly used in palliative situations to relieve symptomatic patients [11]. Herein, we report a case of cardiac SBRT associated to a definitive chemoradiotherapy in curative intent for an oligometastatic lung cancer.

Technological advances in radiation delivery and tracking methods led to an expanded application of SBRT in oncology [12], however, there are only few examples of cardiac SBRT. Bonomo et al. [13] published the first case series of cardiac

malignancies treated with SBRT (3 × 8 Gy) using the Cyberknife® system. Among three patients, two were treated for relapsing cardiac angiosarcomas and one for a CM from melanoma. Importantly, all patients were locally controlled 6 months after the SBRT procedure. Very recently, Gabani et al. [14] used SBRT for the treatment of primary cardiac angiosarcoma causing hemodynamic instability. They delivered 30 Gy in 5 fractions over 5 days concomitantly with paclitaxel using the Varian EDGE system (Varian, Inc., Palo Alto, CA). Six months after SBRT, the patient was still alive with the lesion volume still decreasing.

Our approach was inspired by the outcomes of the phase 2 trial by Gomez et al. [15], where the authors randomized a local consolidative therapy (LCT) versus systemic maintenance therapy or observation for oligometastatic NSCLC after first-line systemic therapy. Eligible patients displayed no more than three metastases after completion of first line treatment and local consolidation could be surgery or radiation. Long-term results of this trial (median follow-up time of 38.8 months) showed a progression-free survival benefit in the LCT group compared to the maintenance therapy group (14.2 months vs. 4.4 months, p = 0.022). The authors also found a median overall survival benefit in the LCT arm compared to the maintenance therapy group (41.2 months vs. 17 months, p = 0.017). Similarly, Palma et al showed in a randomized trial in cancer patients with up to five metastases that SBRT to metastatic sites was associated with improved survival [12]. These findings confirm the potential benefit of a local treatment for selected oligometastatic NSCLC after first line systemic therapy.

Our case report also illustrates the feasability of SBRT in complex metastatic locations such as the heart. In this context, an important challenge will be to perform early diagnosis to avoid as much as possible to treat symptomatic lesion with a worse prognosis.

5. Conclusion

We describe here for the first time the delivery of curative-intent cardiac SBRT for a CM in a lung cancer patient. Cardiac SBRT appears to be promising as a curative approach for patients with CM thanks to its low toxicity and high precision.

Declaration of Competing Interest

The authors report no conflict of interest related to this work. The authors alone are responsible for the content and writing of the paper.

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