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CASE REPORT
Cardiac imaging

Prominent right ventricular mass in a young patient with a history of classic testicular seminoma: a case report

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Background The incidence of intracardiac masses is generally low. In most cases, the formation of a thrombus represents the principal diagnosis in clinical practice. The differential diagnosis mainly includes primary tumours of the heart as well as intracardiac metastases. Testicular cancer is a rare malignancy, accounting for approximately 1% of all male tumours. Cardiac metastasis of a seminoma is extremely rare.

Case summary A 30-year-old man with a history of a classic seminoma of the right testis was referred to our university hospital from an outside clinic. Transthoracic echocardiography showed a large space-occupying mass in the right ventricle (4.0 cm × 4.5 cm × 5.5 cm) attached to the apex and septum. Cardiac magnetic resonance imaging confirmed the finding of a 5.5 cm × 3.5 cm lesion without freely movable appendage or obstruction of the right ventricular outflow tract. Tissue characterization by T1- and T2-weighted black blood imaging revealed a signal behaviour comparable to pulmonary metastases. Additionally, positron emission tomography (PET) with 250 MBq induced 18-fluorodeoxyglucose (^{18}F-FDG) as part of a re-staging showed significant FDG-uptake. Thus, the final diagnosis of an intracardiac metastasis of the testicular seminoma was made, and the patient was treated with cisplatin, etoposide, and bleomycin chemotherapy according to the current guidelines. A repeat trans-thoracic echocardiogram (TTE) performed 2 weeks later already demonstrated a significant reduction of the metastasis with a diameter of 3.3 cm × 3.0 cm.

Discussion In the past few years, multimodality imaging has become essential in the diagnostic evaluation of cardiac disease. In order to improve the diagnostic accuracy, a modern approach should preferably contain the integration of different imaging modalities. Cardiac magnetic resonance imaging as well as ^{18}F-FDG-PET/computed tomography helped us reach the aetiological diagnosis of an intracardiac metastasis and to initiate prompt treatment.

Keywords Multimodality imaging • Intraventricular thrombosis • Intraventricular metastasis • Seminoma • Case report

Learning points

- Imaging studies are very useful for the differentiation of cardiac masses but sometimes it can be challenging to aetiologically distinguish one mass from another.
- For correct differentiation, multimodality imaging with an appropriate combination of various cardiovascular imaging techniques plays a pivotal role.

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Introduction

The incidence of intraventricular masses is generally low. In most cases, the formation of a thrombus represents the principal diagnosis in clinical practice. The differential diagnosis mainly includes primary tumours of the heart as well as intracardiac metastases, amongst other entities.[1]

Testicular cancer is a rare malignancy, accounting for approximately 1% of all male tumours, and generally occurring in younger men.[2] At the time of diagnosis, most cancers have spread to the infradiaphragmatic lymph nodes. According to the path that the testicles take in foetal life, metastases follow the retroperitoneal lymph vessels and afterwards reach the supradiaphragmatic lymph nodes in the mediastinum.[3] About 10% of all cancer patients develop cardiac metastases, which are usually not clinically apparent. Cardiac metastasis of a seminoma is extremely rare. These lesions are most commonly identified at autopsy; therefore, the actual incidence is unknown.[4]

As malignancy is a generally accepted prothrombotic factor, imaging studies are very useful for the differentiation of cardiac masses but sometimes it can be challenging to aetiologically distinguish one mass from another.

Here, we describe an extraordinary case of a young patient with a metastatic relapse of a seminoma and prominent right ventricular mass.

Case presentation

A 30-year-old man with a history of a classic seminoma of the right testis (pT2 cN0 cM0 L0 V1 R0) and consecutive orchiectomy in June 2016 was referred to our university hospital from an outside clinic, where he presented with back pain in the lumbar region and paraesthesia in the area of the right knee. The patient was haemodynamically stable and did not exhibit any signs of dyspnoea or pectoral angina. Cardiovascular examination revealed no irregularities regarding blood pressure (130/85 mmHg), heart rate (86 b.p.m.), respiratory rate (17 b.p.m.), oxygen saturation (SpO_2 97%), heart sounds, and lung auscultation. There were no signs of peripheral oedema. The electrocardiogram (ECG) at admission showed no abnormalities. Medical history included a mild haemophilia B, factor IX deficiency as well as a history of cocaine and cannabis abuse until recent times. A concise chronological sequence is provided in the timeline. On physical examination, the penis, scrotum, and testes were unremarkable on inspection and palpation. Sonographically his kidneys were normal. Blood tests revealed a slight increase of the inflammatory markers [C-reactive protein 19.3 mg/L (normal range: <5.0 mg/L) and leucocytes 12.31 $\times$ 10^9/L (normal range: 4.40–11.30 $\times$ 10^9/L)] as well as a substantial rise of lactate dehydrogenase (977 U/L, normal range: <250 U/L) were conspicuous. The analysis of tumour markers indicated an elevated human chorionic gonadotropin (HCG)-beta (71.1 U/L, normal range: <10 U/L) whereas levels of alpha-fetoprotein were unobtrusive (2.0 kU/L, normal range: <5.8 kU/L).

Timeline

June 2016	Diagnosis of a classic seminoma of the right testis (4 cm)
	Orchiectomy of the right testis
	pT2 cN0 cM0 L0 V1 R0
	Clinical Stage I according to Lugano
	Further diagnostic imaging: no evidence of lymphonodular or visceral metastasis (^{18}F-FDG-PET/CT)
July 2016	Recommendation of an active monitoring strategy according to the current guidelines
	No additional chemotherapy
25 January 2018	Presentation with back pain in the lumbar region and paraesthesia in the area of the right knee
	Computed tomography (CT) of the thorax: pulmonary and lymphogenic metastatic spread, large irregular mass in the right ventricle differential diagnosis thrombus metastasis
	Computed tomography of the abdomen: large mass in the area of the left adrenal gland and suspicion of bone metastases in the lumbar region
	Magnetic resonance imaging of the abdomen: diffuse osseous metastasis
	Computed tomography of the brain: no evidence of cerebral involvement
26 January 2018	Transthoracic echocardiography: large space-occupying mass in the right ventricle (4.0 cm $\times$ 4.5 cm $\times$ 5.5 cm) adhered to the apex and septum
	Cardiac magnetic resonance imaging revealed
	Increased signal intensity of the intracardiac mass after administration of contrast medium (gadolinium)
	Signal behaviour comparable to the pulmonary metastases
28 January 2018	^{18}F-FDG-PET/CT: nuclide enhancement of:
	The bipulmonary metastases
	The metastasis in the right ventricle
	The infracarinal, bilateral hilar, and paraaortic lymph nodes
	Osseous in the area of thoracic vertebrae 12 and lumbar vertebrae 2 and 3
	Interdisciplinary decision to start PEB-chemotherapy (cisplatin, etoposide, and bleomycin), no surgical treatment of the intracardiac metastasis
13 February 2018	Transthoracic echocardiography showed a significant reduction of the intracardiac metastasis

Due to the clinical complaints and the history of a seminoma, a computed tomography (CT) scan of the thorax and abdomen was performed. Radiological findings revealed a 5 cm × 5 cm large mass in the area of the left adrenal gland and the suspicion of bone metastases in the lumbar region. Apart from pronounced lymphogenic and pulmonary metastatic spread, an irregular filling defect, measuring 6 cm in diameter, in the right ventricle could be detected (*Figure 1*). Medical reports from baseline diagnostics in 2016 did not state any evidence of cardiac abnormalities in CT scans in context of the staging diagnostics at that time. Echocardiography showed a large space-occupying mass in the right ventricle (4.0 cm × 4.5 cm × 5.5 cm) adhered to the apex and septum (*Figure 2A*). Both left and right ventricular functions were preserved. No right heart burden could be detected since heart cavities were configured normal and pressure gradient over the tricuspid valve was not elevated. In conjunction to the inconspicuous ECG and the absence of dyspnoea, the presence of a relevant pulmonary embolism could be excluded.

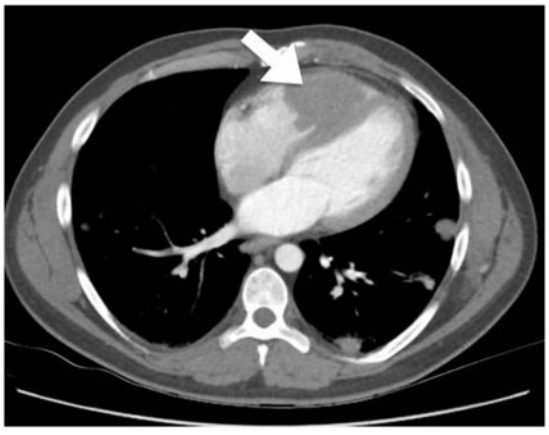

Figure 1 Chest computed tomography at presentation demonstrating a large right ventricular mass (white arrow). Additionally, several pulmonary metastases of the lung are displayed.

Cardiac magnetic resonance (CMR) imaging confirmed the finding of a 5.5 cm × 3.5 cm lesion without free-floating appendage or obstruction of the right ventricular outflow tract. Tissue characterization by T1- and T2-weighted black blood imaging revealed a signal behaviour comparable to the pulmonary metastases (*Figure 3*). Additionally, positron emission tomography (PET) with 250 MBq induced 18-fluorodeoxyglucose (^{18}F-FDG) as part of a re-staging showed significant FDG-uptake (*Figure 4*).

The patient underwent the first cycle of cisplatin, etoposide, and bleomycin (PEB) chemotherapy at reduced dosage in order to avoid tumour lysis syndrome.[5] In addition, he was therapeutically anticoagulated due to the high tumour burden. A repeat trans-thoracic echocardiogram (TTE) performed 2 weeks later already demonstrated a significant reduction of the metastasis with a diameter of 3.3 cm × 3.0 cm (*Figure 2B*). The patient will receive a total of four cycles of PEB chemotherapy according to the current guidelines. Afterwards, a re-staging with ^{18}F-FDG-PET/CT will be performed and—depending on the residual findings—a metastasis resection vs. conservative approach with sustained aftercare and CT diagnostics will be discussed. Anticoagulant treatment can be reduced to a prophylactic approach during the course of chemotherapy. However, due to the prementioned coagulation disorder of the patient, the additional application of Octanine 3.000 IE (Factor IX) biweekly is necessary.

Discussion

Primary tumours of the heart are very rare, with an autopsy incidence rate of less than 1%.[6] However, in three quarter of all cases, they are of benign aetiology. Myxoma represents the most frequent benign primary cardiac tumour, followed by lipoma, and fibroelastoma, which are predominantly located in the left or right atrial cavities. In contrast to this, sarcomatous lesions, in particular angiosarcoma, are the most common primary malignant entities.[7]

Secondary cardiac tumours, which are mostly metastases, are much more frequently encountered and were found in about 10% of cancer patients in autopsy studies.[6] They generally derive from

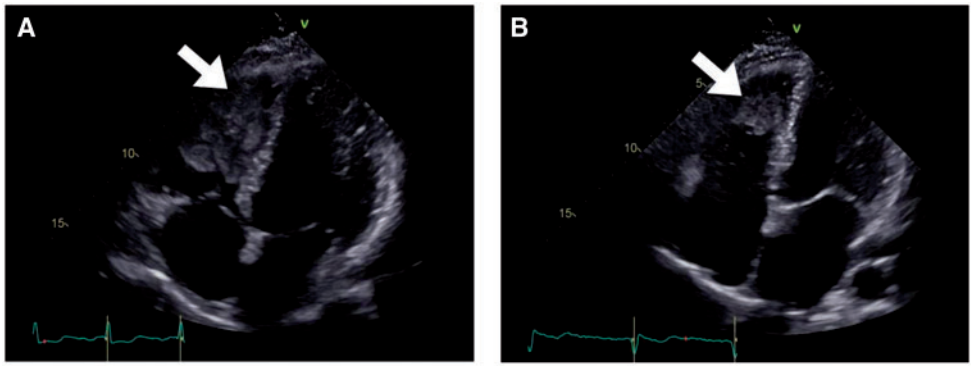

Figure 2 Transthoracic echocardiography before and after treatment. There is a large space-occupying mass in the right ventricle with adhesion on the apex and septum (white arrow) with a maximum expansion of 4.0 cm × 4.5 cm × 5.5 cm before chemotherapy (*A*). The lesion declined considerably under treatment (*B*) with a residual expansion of 3.3 cm × 3.0 cm (white arrow).

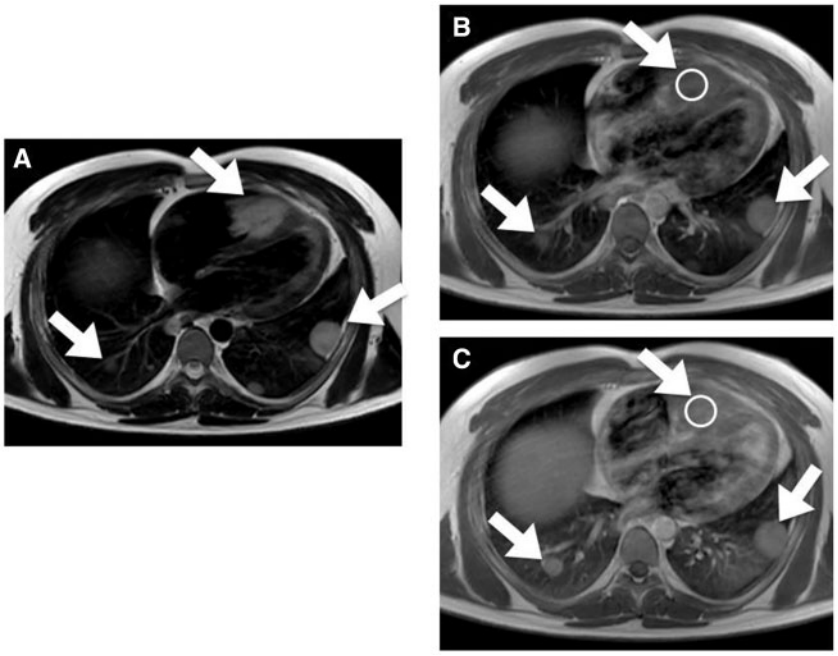

Figure 3 Magnetic resonance imaging in four chambers. T2-weighted turbo spin echo black blood sequence (*A*) showing a hyperintense signal of the right ventricular mass (upper white arrow). Additionally, metastases of both the left and right lung are displayed (lower white arrows). The T1-weighted turbo spin echo black blood sequence before (*B*) and after (*C*) contrast media application demonstrates a considerable signal increase (signal intensity 680 vs. 981) of the lesion (upper white arrows).

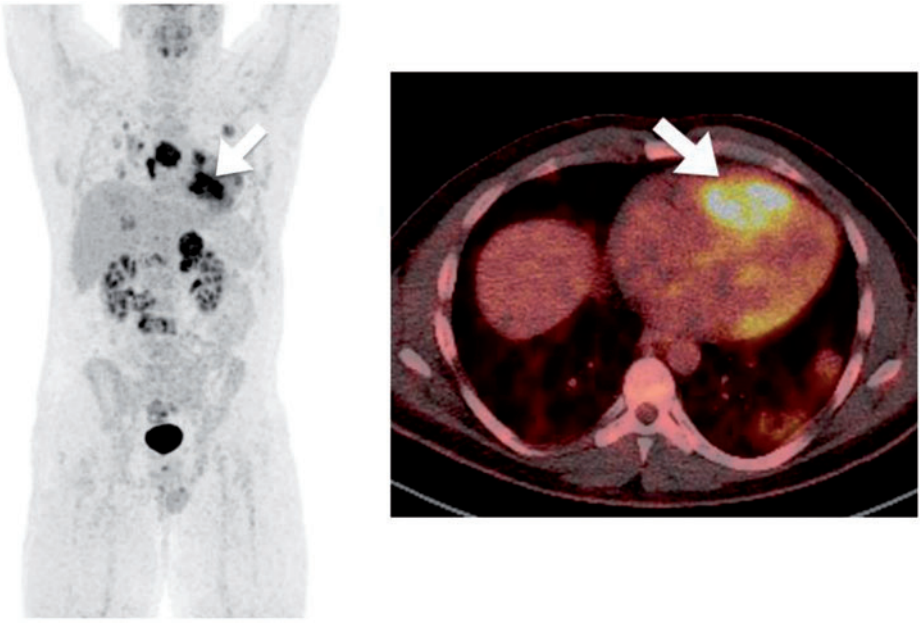

Figure 4 18-fluorodeoxyglucose positron emission tomography before treatment. A hypermetabolic mass is present in the right intracardiac cavity (white arrow).

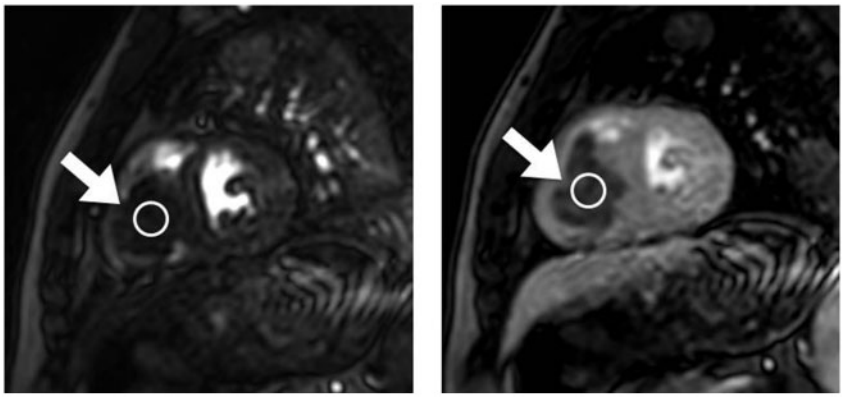

Figure 5 First pass magnetic resonance perfusion imaging with images at early (*A*) and late (*B*) timepoint. While on pure visual assessment contrast enhancement of the right ventricular mass might appear only marginal (left-sided white arrow), signal intensity measurements confirmed a substantial increase from 200 to 400 during first pass perfusion (right-sided white arrow).

malignant tumours of the lungs and breast as well as haematological malignancies.[8] Metastatic spread can occur by both the haematogenous or lymphatic route, transvenous extension, and direct extension. Regarding the localization, the pericardium and myocardium are most frequently affected, whereas endocardial or intracavitary metastases are a rarity. Among cavitary masses, the formation of an intracardiac thrombus is relatively frequent and represents the most relevant differential diagnosis.

In the past few years, multimodality imaging has become essential in the diagnostic evaluation of cardiac disease.[9] However, to the present day, there is no routinely performed diagnostic algorithm for the determination of intracardiac lesions. Transthoracic echocardiography represents the primary imaging modality for the assessment of intracardiac masses. Computed tomography and magnetic resonance imaging can depict several morphologic characteristics for differentiating between benign and malignant masses. Through its unique soft tissue contrast, CMR imaging in particular may help to differentiate between various types of intracardiac masses including intraventricular thrombosis based on signal intensities on T1- and T2-weighted images as well as contrast enhancement on first pass perfusion and contrast-enhanced inversion recovery images in early and late phase.

Molecular imaging methods such as ^{18}F-FDG-PET/CT can assess metabolic activity, and hereby depict tumour metabolism. In the past, with help of ^{18}F-FDG-PET/CT, a differentiation of malignant and benign cardiac masses was feasible with a sensitivity of more than 90%.[10] For correct differentiation, the appropriate combination of cardiovascular imaging techniques plays a pivotal role. In order to improve the diagnostic accuracy, a modern approach should preferably contain the integration of different imaging modalities. Hence, the exact diagnostic procedure should be geared to the individual patient and his medical history. On this occasion, an interdisciplinary cooperation between cardiologists, radiologists and if necessary oncologists should be aimed.[11]

Nonetheless, sometimes it can be challenging to differentiate one mass from another; especially in case of rare and extremely rare findings. To our knowledge, this is the first case report exhibiting such large metastatic spread to the right ventricle caused by a classic testicular seminoma. As the occurrence of tumour diseases generally predisposes also to coagulum, our differential diagnostic deliberations have centred around intraventricular thrombus and metastasis.

In our case, transthoracic echocardiography was not sufficient to differentiate between the entities. The superior tissue characterization capability of CMR imaging is useful in analysing the composition of lesions and generally performs well in the differentiation between tumour and thrombus.[12] However, against the background of acute and chronic thrombi and their different tissue composition, there are some overlaps for both entities in CMR imaging signal characteristics. As thrombi are avascular masses, they typically do not enhance on first pass perfusion.[13] Conversely, as in our case, tumours or metastases exhibit a signal increase on first pass contrast perfusion imaging as well as on post-contrast T1-weighted turbo spin echo images (*Figures 3* and *5*). Comparison of the signal intensity with the pulmonary metastases further helped us reach the aetiological diagnosis and initiate prompt treatment.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: none declared.

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