

# A concealed carcinoid cardiac metastasis uncovered by comprehensive cardiovascular magnetic resonance-based tissue characterization: a case report

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## Background

Cardiac metastases of carcinoid tumours are extremely rare, and their diagnosis poses a significant challenge. A variety of techniques has been reported in the literature for this purpose, ranging from echocardiogram to the Indium-111 Octreotide, positron emission tomography using specific tracers, and biopsy. Occasionally, the diagnosis is only made post-mortem. Recently, CMR (cardiovascular magnetic resonance) has been added to the diagnostic toolkit. This case report describes the CMR sequences that can be used to characterize cardiac metastases of carcinoid tumours.

## Case summary

A 55-year-old woman with an antecedent history of resected carcinoid tumour of the ileocecal junction underwent whole-body In-111 Octreoscan single-photon emission computed tomography in the context of her follow-up. This raised the suspicion of pericardial involvement, which prompted a CMR study. Comprehensive CMR findings were consistent with isolated carcinoid tumour metastasis embedded within the anterior papillary muscle. We describe the CMR sequences that were used to characterize the metastasis.

## Discussion

The rarity of cardiac metastasis of carcinoid tumour makes its diagnosis challenging and warrants a high level of clinical suspicion. Cardiovascular magnetic resonance imaging proves to be an indispensable tool in the tissue characterization of such tumours.

## Keywords

Carcinoid tumour • Neuroendocrine tumour • Cardiac metastasis • Cardiac magnetic resonance imaging • CMR • SPECT/CT • Case report

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## Learning points

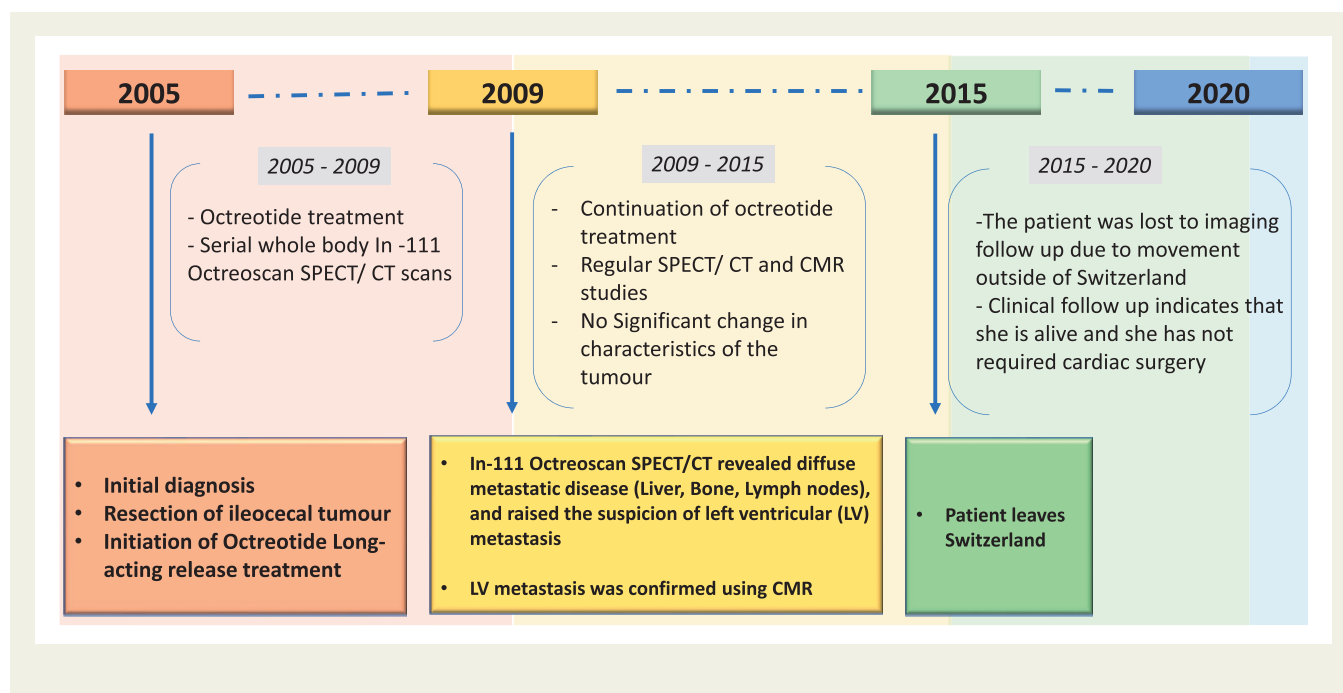
- Cardiovascular magnetic resonance (CMR) may allow the early identification of myocardial tumours of small size and uncommon location secondary to neuroendocrine tumours, especially when they present low density of somatostatin receptors.
- A combination of pre- and post-contrast multiparametric CMR imaging is paramount to achieve the correct diagnosis. Relying on standard techniques, including late gadolinium enhancement, may overlook the diagnosis of small metastatic lesions particularly when embedded into the myocardial walls or papillary muscles.
- Good spatial resolution, in-depth tissue characterization, high soft-tissue contrast alongside functional assessment poised the CMR as the forefront technique for monitoring disease progression or response to treatment.

## Introduction

Neuroendocrine tumours (NETs) represent a heterogeneous group of rare neoplasms, which originate from enterochromaffin cells. They are found in the gastro-entero-pancreatic system in ~70% of all cases, while other locations of primary tumours include most frequently the bronchopulmonary system, and very rarely mediastinum, thymus, and ovary among others. These tumours are relatively uncommon, with an annual incidence of 6.98 per 100 000 persons in the general population, although this varies in different registries.<sup>1,2</sup>

such as the lung, pancreas, stomach, or ovary.<sup>3</sup> Carcinoid syndrome typically comprises of flushing, diarrhoea, bronchoconstriction, and congestive heart failure secondary to valve lesions of the right heart.<sup>4</sup> Solid cardiac metastases from carcinoid tumours are seldomly reported.

## Timeline



Carcinoid tumours are a subset of NETs. They are typically found to contain numerous membrane-bound neurosecretory granules that contain a variety of hormones and biogenic amines, serotonin being one of the best-characterized of them.<sup>3</sup>

The most common cardiac manifestation of these tumours is carcinoid syndrome. This is a paraneoplastic syndrome, which is caused by vasoactive substances secreted mainly by NETs of the gastrointestinal tract which have metastasized to the liver with subsequent release of hormones directly into the systemic circulation. Less frequently, it is seen with primary tumours arising from other organs,

## Case presentation

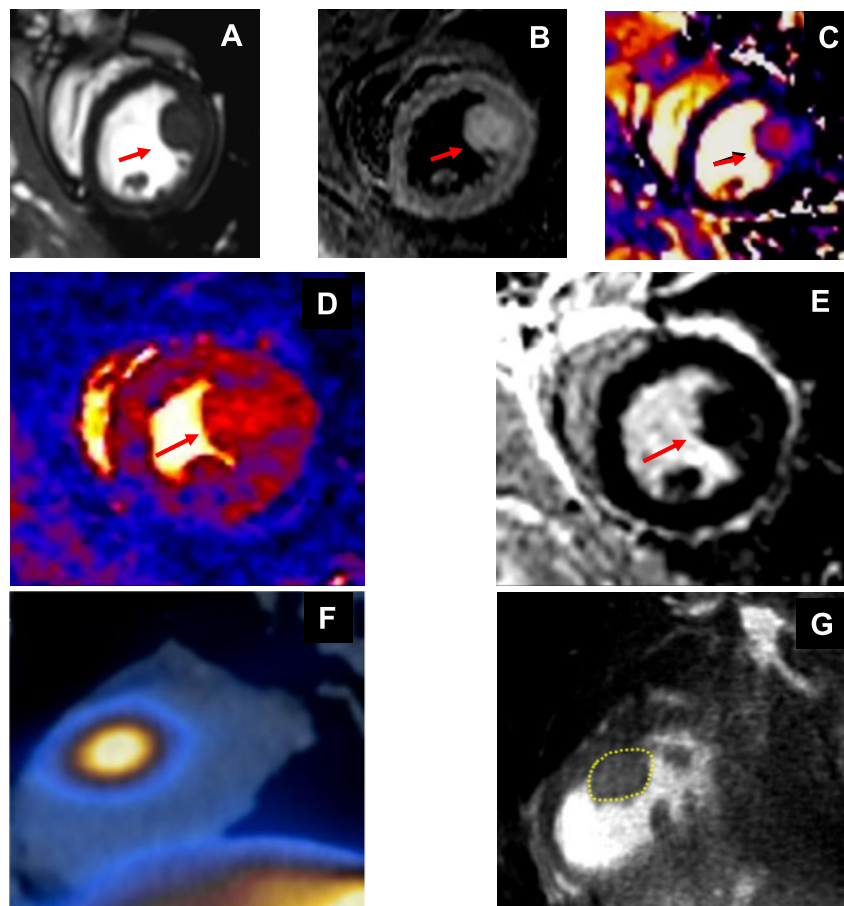
A 55-year-old woman with an antecedent history of resected carcinoid tumour of the ileocecal junction (surgical resection in December 2005) underwent whole-body Indium-111 Octreoscan SPECT/CT (single-photon emission computed tomography) in the context of her follow-up in 2009. This exam revealed diffuse metastatic lesions of the liver, bone, and lymph nodes and raised the suspicion of pericardial involvement prompting cardiovascular magnetic resonance (CMR) referral. The patient was completely asymptomatic. Clinical

examination at the time was normal, her blood pressure was 143/87 mmHg, and her heart rate was 80 b.p.m. Her transthoracic echocardiogram was unremarkable. CMR findings were consistent with an isolated metastatic lesion embedded in the anterior papillary muscle. Biotherapy with Octreotide® long-acting release was started, and the patient underwent regular clinical and imaging follow-up including In-111 Octreoscan SPECT/CT and CMR.

Cardiovascular magnetic resonance was performed using a 1.5 T scanner (Magnetom AERA, Erlangen, Germany). Balanced-steady state free-precession (SSFP) cine images disclosed an apparent hypertrophy of the anterior papillary muscle (maximal diameters 18 × 17 mm) without other left ventricular (LV) abnormalities or right-sided valvular heart disease (Figure 1A). The LV ejection fraction was 63%. A comprehensive tissue characterization of the anterior papillary muscle was carried out. On a T2-weighted short-inversion recovery image the papillary muscle showed a strong increase of signal intensity relative to LV walls, in keeping with high water content (Figure 1B). This finding was confirmed by T2-mapping, which yielded an increased T2 value (66 ms; as reference the T2 value of the adjacent anterior wall was 45 ms) (Figure 1C). The metastatic lesion was

well perfused at first-pass perfusion imaging acquired during intravenous bolus of gadobutrol (0.1 mmol/kg) (Figure 1D). Fifteen minutes after contrast agent injection, no hyperenhancement of the papillary muscle was detected on phase-sensitive inversion recovery late gadolinium enhancement (LGE) images (Figure 1E). A self-navigated whole-heart angiography was acquired and the three-dimensional CMR images were compared with the corresponding images of In-111 Octreoscan SPECT/CT showing a good match between the pathological molecular signature and the anterior papillary muscle (Figure 1F and G). Altogether, the multiparametric CMR coupled with molecular imaging by In-111 Octreoscan SPECT/CT enabled a thorough assessment of the tissue features of the anterior papillary muscle leading to the correct final diagnosis of highly vascularized metastasis of the primary gastrointestinal carcinoid tumour. In addition, the serial cine SSFP measurements allowed us to monitor the growth of the metastasis and its functional impact on mitral valve.

We followed up this patient with yearly whole-body In-111 Octreoscan SPECT/CT and CMR for 6 years (between 2009 and 2015), until she left Switzerland in 2015, when she was lost to imaging follow-up (echocardiographic follow-up was not felt necessary and



**Figure 1** Mid-ventricular short-axis cine (A), T2-w short-inversion recovery turbo spin echo (TSE) (B), T2-mapping (C), perfusion map (D), post-contrast phase-sensitive inversion recovery late gadolinium enhancement (E), Indium-111 Octreoscan single-photon emission computed tomography (F), and three-dimensional whole-heart imaging (G).

the decision-making was guided mainly by CMR). The tumour characteristics did not change significantly over this follow-up period, and there was no evidence of significant mitral regurgitation. The patient remained asymptomatic from a cardiac perspective, and surgical resection of the metastasis was not deemed necessary. Clinical follow-up at the beginning of 2020 indicates that the patient remains well and has not required surgery. She is being treated with regular doses of intravenous octreotide. The only symptoms she reports are occasional nausea and morning headaches (which are well-recognized side effects of octreotide).

## Discussion

Our case highlights the importance of in-depth tissue characterization through multiparametric CMR coupled with molecular signature by In-111 Octreoscan SPECT/CT for the early diagnosis of cardiac metastasis of carcinoid tumour. Data on cardiac metastases originating from this neoplasia are sparse in the literature. Jann *et al.*<sup>5</sup> reviewed published evidences, and found 45 cases of cardiac metastases in patients with NETs. Cardiac involvement was right ventricular only ( $n = 10$ ), LV only ( $n = 11$ ), or biventricular ( $n = 10$ ), while clinical presentation ranged from no symptoms to cardiac arrest.

To date, different imaging techniques have been employed for the diagnosis of cardiac metastases of carcinoid tumours. Several works have provided insights on the use of different imaging modalities to this end, varying from the readily available echocardiogram,<sup>6</sup> to the traditional In-111 Octreotide<sup>7</sup> or positron emission tomography<sup>8</sup> to CMR,<sup>9</sup> or combinations thereof.<sup>10–12</sup> Occasionally, biopsy of the mass is necessary for the diagnosis,<sup>13</sup> or the diagnosis is made post-mortem. We report here on multiparametric CMR approach, which in combination with by In-111 Octreoscan SPECT/CT, allowed us to achieve the final diagnosis. The T2 sequences unveiled a high water content lesion embedded in the papillary muscle and this finding was complemented by first-pass perfusion signal which confirmed that the lesion in the papillary was indeed highly vascularized. Late gadolinium enhancement imaging excluded the presence of intra-tumour necrosis or fibrosis, and cine SSFP imaging allowed to monitor the growth of the metastasis throughout the follow-up and its impact on LV and mitral valve function. By combining high-resolution whole-heart CMR angiography and In-111 Octreoscan SPECT/CT was possible to integrate the molecular readout of the nuclear technique with the cardiac anatomy.

One of the characteristics of NETs is the high density of somatostatin receptors (SSTR) on the cell surface, especially SSTR2. This enables visualization of NETs using radiolabelled somatostatin analogues, such as 111In-octreotide or 68Ga-DOTA-octreotate (DOTATATE).<sup>14</sup> In order to detect tumours with low receptor density, CMR may prove helpful. This case report illustrates the versatility of novel CMR pulse sequences which allows for a precise and comprehensive tumour characterization, even when located in a small structure such as a papillary muscle.

Surgical resection of cardiac metastases of carcinoid tumours has been described in the literature.<sup>15</sup> In the case of our patient, multidisciplinary team discussion concluded that surgical treatment was not appropriate at that time; the long-term follow-up was based on CMR

to assess progression of the disease and monitor for possible new indications for surgery in the future.

## Conclusion

Cardiovascular magnetic resonance offers a high diagnostic yield for detecting and monitoring metastatic lesions of the heart at relatively low cost and wider availability as compared to nuclear techniques. A combination of pre- and post-contrast multiparametric CMR imaging is paramount to achieve the correct diagnosis. Relying solely on standard techniques such as LGE may overlook the identification of small metastatic lesions particularly when embedded into the myocardial walls or papillary muscles. Overall, good spatial resolution, in-depth tissue characterization, and comprehensive functional assessment have poised CMR as the forefront technique for monitoring disease progression or response to treatment.

## Lead author biography



Georgios Georgiopoulos is an EACVI (European Association of Cardiovascular Imaging) fellow at the School of Biomedical Engineering & Imaging Sciences, King's College London. After board certification in Cardiology, he worked as a postdoctoral fellow on the clinical value of noncoding RNAs as determinants of human atherosclerosis (National & Kapodistrian University of Athens). His PhD work was the effect of sex

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## Supplementary material

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

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**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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