CASE REPORT

Primary cardiac angiosarcoma arising from the interatrial septum: magnetic resonance imaging appearances

^{1,2}S PUPPALA, FRCSEd, FRCR, CBCCT, ¹E T D HOEY, MRCP, FRCR, ¹K MANKAD, MRCP, FRCR and ²A M WOOD, MRCP, FRCR

¹Department of Radiology, Leeds Teaching Hospitals, Leeds, UK and ²Department of Radiology, University Hospital of Wales, Cardiff, UK

ABSTRACT. We present a case of primary cardiac angiosarcoma arising from the interatrial septum that had imaging features overlapping with those of right atrial myxoma. The mass was initially discovered on a thoracic CT study. Further evaluation with echocardiography was limited by poor acoustic windows and cardiac magnetic resonance (CMR) imaging was performed prior to surgical resection. CMR provided a detailed morphological assessment; imaging features included a frond-like surface architecture, a narrow attachment point at the interatrial septum, mild signal hyperintensity compared with that of myocardium on T_1 weighted sequences, patchy foci of delayed gadolinium enhancement and a haemorrhagic pericardial effusion. To the best of our knowledge, this is the first reported case of angiosarcoma arising from the interatrial septum that has undergone evaluation with CMR.

Received 3 September 2009
Revised 12 November 2009
Accepted 4 January 2010

DOI: 10.1259/bjr/29501513

© 2010 The British Institute of Radiology

Case History

A 41-year-old female with no significant medical history presented to her general practitioner with a 24 hour history of intermittent central chest pain and breathlessness. The pain was sharp in nature, non-radiating and exacerbated by deep inspiration. She described a similar episode 5 months previously that had subsided spontaneously. Physical examination was unremarkable and the patient was prescribed a course of broad-spectrum antibiotics on suspicion of a respiratory tract infection. One week later the patient's symptoms were persisting and she was referred to her local hospital for further investigation. A blood panel showed that haemoglobin, white cell count, electrolytes and coagulation were within normal ranges. An electrocardiogram showed sinus rhythm at a rate of 85 beats per min with no ST-segment changes or other abnormalities, and a chest radiograph was also normal. A CT pulmonary angiogram excluded central and segmental pulmonary emboli but identified a well-circumscribed low-attenuation mass, measuring 3 cm in maximal dimension, in the vicinity of the interatrial septum. Other relevant findings included a small pericardial effusion and a 1 cm subpleural soft-tissue nodule at the left lung base (Figure 1).

Transthoracic echocardiography was somewhat limited by poor acoustic windows but demonstrated a mobile echogenic mass within the right atrium. Cardiac magnetic resonance (CMR) imaging was undertaken to

provide further assessment of lesion extent and composition. Sequences included dynamic steady state free precession (SSFP) "bright blood" imaging in transverse and short axis planes (to provide functional information), complimented by static T_1 weighted "black blood" prepared fast spin-echo images (to provide tissue characterisation). Repeat T_1 weighted fast spin-echo images were acquired 10 min after administration of 0.1 mmol kg⁻¹ gadolinium (without a tailored inversion recovery pulse).

SSFP sequences showed the mass to be of low signal intensity in comparison with the adjacent blood pool and with a "frond-like" surface architecture. It had a relatively narrow attachment point (over approximately 5 mm) to the inferior aspect of the interatrial septum. On review of cine loops, the mass was seen to be mobile, contacting the septal leaflet of the tricuspid valve in systole with mild associated regurgitation (there was no prolapse through the valve orifice). The mass was of slightly increased signal intensity compared with myocardium on T_1 weighted sequences, and tissue planes were preserved at its insertion point on the septum with no features to suggest infiltration. The pericardial effusion contained foci of high signal, suggesting a haemorrhagic component, although slow flow within the effusion that remains "in-plane" could also have accounted for this high signal. Delayed images following gadolinium administration demonstrated subtle patchy enhancement (Figure 2).

Catheter coronary angiogram was performed prior to surgical resection and showed the coronary arteries to be unobstructed. There was no demonstrable enhancement in the vicinity of the mass to suggest macroscopic neovascularisation.

Address correspondence to: E T D Hoey, Radiology Academy, Clarendon Wing, Leeds General Infirmary, Leeds LS1 3EX, UK. E-mail: edwardhoey1@gmail.com

Figure 1. Transverse images from the initial CT pulmonary angiogram. (a) Low-attenuation mass in the region of the interatrial septum (arrows). (b) 1 cm sub-pleural soft-tissue nodule in the left lower lobe (arrow). LV, left ventricle; RV, right ventricle.

Figure 2. Selected images from the cardiac magnetic resonance examination. (a) Transverse steady state free procession (SSFP) image (TR/TE, 40/1.2; flip angle 55°) showing a low-signal right atrial mass arising from the interatrial septum (arrow). The mass contacts the septal leaflet of the tricuspid valve (curved arrow). (b) Short axis SSFP image (TR/TE, 40/1.2; flip angle 55°) at the level of the mitral valve orifice showing the right atrial mass and its attachment to the inferior aspect of the interatrial septum (arrow). (c) Transverse T_1 weighted fast spin-echo image (TR/TE, 1000/35) showing the mass to be of slightly increased signal compared with the adjacent myocardium. High-signal elements are seen within the pericardial effusion (arrows) in keeping with a haemorrhagic component. (d) Transverse T_1 weighted fast spin-echo image acquired 10 min following administration of 0.1 mmol kg⁻¹ gadolinium (TR/TE, 1000/35), showing subtle patchy enhancement (arrow). LV, left ventricle; RA, right atrium; RV, right ventricle.

Differential diagnosis

The main differential considerations were right atrial thrombus, metastasis, myxoma and primary malignant tumours such as angiosarcoma, undifferentiated pleomorphic sarcoma and lymphoma.

Right atrial thrombus is unusual in the absence of a central venous catheter (which acts as a nidus). Furthermore, a thrombus would not be expected to display enhancement following administration of contrast media, although chronic thrombi can occasionally accumulate gadolinium peripherally if there is a fibrinous pseudocapsule [1]. Cardiac metastasis could not be ruled out on the basis of the imaging appearances, but would be very unusual in the absence of a known underlying primary malignancy; even in this setting, metastases are found predominately in the epicardium with only 5% being endocardial [2].

Approximately 18% of myxomas have a right atrial location [3]. The majority have a narrow attachment point at the interatrial septum near the fossa ovalis, which accounts for their frequently mobile nature [4]. They can have a smooth or frond-like surface architecture, and a heterogeneous CMR signal and enhancement pattern is typical [4, 5]. Right atrial myxoma is prone to fragmentation and embolisation into the pulmonary arterial tree [6] and has also been reported as the cause of a haemorrhagic pericardial effusion (which was attributed to bleeding from small penetrating pericardial arteries) [7, 8].

Angiosarcoma usually manifests as a large (>5 cm) lobulated mass arising from the right atrial free wall, which encases and invades adjacent structures including the right coronary artery, tricuspid valve and pericardium [4, 5, 9]. Sparing of the interatrial septum has been described as a fairly characteristic feature of these tumours [4, 10, 11]. Occasionally angiosarcoma can present as an ill-defined infiltrative pericardial mass [5]. A tumour "blush" at catheter coronary angiography is frequently observed and indicates neovascularisation [10, 12]. CMR appearances are typically heterogeneous on all pulse sequences, reflecting areas of necrosis and haemorrhage [4, 5, 13]. Delayed heterogeneous gadolinium enhancement is invariably present and a haemorrhagic pericardial effusion is also found frequently [4, 5, 13].

The other primary cardiac sarcomas predominate in the left atrium and display slow infiltrative growth patterns and heterogenous CMR signal characteristics [13, 14]. Primary cardiac lymphoma invariably occurs in immunocompromised individuals and appears as a lobulated right atrial mass [4, 5].

The presumptive diagnosis on imaging grounds was right atrial myxoma, but the pericardial effusion was recognised as being an atypical feature of this disease entity. The pulmonary nodule was of uncertain significance, and the differential for this included an embolised tissue fragment or thrombus, a metastasis or a primary lung tumour.

Diagnosis

Surgical resection was undertaken via a right atrial approach. The mass had a firm consistency and a villous blood-stained surface texture, with a fine network of

superficial vessels. It "peeled" away from the atrial septum with relative ease and a 5 mm margin of tissue was also resected. The haemorrhagic pericardial effusion was drained. Visually, there was no discernable residual tumour tissue at the resection site and inspection of the tricuspid valve and right ventricle was unremarkable. Manual palpation of the right ventricular outflow tract was, however, concerning because it had a "nodular" texture. Post-operative recovery was uneventful and a follow-up thoracic CT study performed 2 weeks later showed the septum to be macroscopically clear of disease (Figure 3). The left lower lobe nodule remained unchanged in size and appearance.

Histological examination of the resected specimen revealed an abundance of spindle-shaped cells arranged in a sheet-like fashion. These cells demonstrated a moderate degree of nuclear pleomorphism and a high mitotic rate. Evidence of a vascular origin was suggested by focal vasoformative features including vacuolation. Immunohistochemistry showed strong positive reactivity for the endothelial cell marker CD34. Staining by pancytokeratin, an epithelial cell marker, was negative. These findings were consistent with a diagnosis of primary cardiac angiosarcoma (Figure 4).

Chemotherapy was scheduled but declined by the patient. Six months later she presented in extremis and died shortly thereafter (no further imaging was performed).

Discussion

Primary cardiac tumours are rare, with an estimated incidence of 0.002–0.2% from surgical series [15, 16]. Approximately 75% are benign with nearly 50% of these being myxomas [14].

Figure 3. Transverse images from the post-operative thoracic CT study showing the interatrial septum (arrows) to be macroscopically clear of disease. LV, left ventricle; RA, right atrium; RV, right ventricle.

Figure 4. Histopathology sections from the resected specimen (original magnification, $\times 100$). (a) Haematoxylin-eosin stain showing multiple spindle cells (arrow). (b) Haematoxylin-eosin stain showing areas of vacuolation (arrow). (c) Immunoperoxidase staining for CD34 shows positive reactivity (arrow).

Angiosarcoma is the most frequent primary malignant cardiac tumour and accounts for more than a third of reported cases [14]. It is a tumour of endothelial and mesenchymal origin, comprising numerous vascular channels lined by anaplastic epithelial cells [10]. Peak incidence is in the third to fifth decades and it has a strong male predominance [9, 10]. Metastases are present at time of diagnosis in 66–89% of cases and are most often to the lungs [17]. Prognosis is dire, with few patients surviving 12 months beyond diagnosis despite aggressive surgical management [18]. Clinical diagnosis is challenging because the symptoms are non-specific and may include chest pain, palpitations and congestive heart failure [18]. Invariably, the disease has reached an advanced stage by the time of symptom onset. Complete surgical resection, which confers the best long-term outcome, is often precluded by anatomical considerations [9].

Echocardiography is the first-line imaging technique for detection of a suspected cardiac mass but carries several well-described limitations, including a restricted field of view, heavy operator dependence and limited soft-tissue characterisation. CMR has become a reference technique for the evaluation and characterisation of a cardiac mass as it provides an unrestricted field of view, gives unparalleled soft-tissue contrast and permits assessment of invasion into paracardiac structures, thereby enabling a comprehensive assessment [4, 5, 13, 19, 20]. Electrocardiographically gated multidetector CT is emerging as a rival technique for the assessment of cardiac morphology and offers a number of advantages over CMR, including improved spatial resolution (0.5–0.6 mm

vs 1.0–2.0 mm), extremely fast acquisition times and definitive characterisation of calcifications. CT cannot, however, rival the soft-tissue contrast that can be achieved with CMR and currently has inferior temporal resolution (75–80 ms *vs* 30–40 ms).

Angiosarcoma usually exhibits a number of overtly malignant imaging features, making confident distinction from benign entities straightforward on the most part [4]. CMR features that suggest a malignant cardiac mass include a broad-based attachment, size >5 cm, lack of tissue homogeneity, the involvement of more than one cardiac chamber, pericardial effusion and extension into the mediastinum or great vessels [4, 5]. It should be noted, however, that none of these features are both sensitive and specific for a diagnosis of malignancy [13, 21]. As highlighted by the present case, benign and malignant tumours can have overlapping features. Angiosarcoma originating from the interatrial septum has been reported previously in the echocardiographic literature [22], but as far as we are aware, this is the first such case depicted with CMR.

This case highlights the importance of reviewing the interatrial septum on thoracic CT studies; radiologists should be aware that angiosarcoma can on occasion arise from the interatrial septum and that its CMR imaging features are not always characteristic.

References

1. Vogel-Claussen J, Rochitte CE, Wu KC, Kamel IR, Foo TK, Lima JA, Bluemke DA. Delayed enhancement MR imaging: utility in myocardial assessment. *Radiographics* 2006;26: 795–810.

2. Grebenc ML, Rosado de Christenson ML, Burke AP, Green CE, Galvin JR. Primary cardiac and pericardial neoplasms: radiologic-pathologic correlation. *Radiographics* 2000;20:1073-103.
3. Grebenc ML, Rosado-de-Christenson ML, Green CE, Burke AP, Galvin JR. Cardiac myxoma: imaging features in 83 patients. *Radiographics* 2002;22:673-89.
4. O'Donnell DH, Abbara S, Chaithiraphan V, Yared K, Killeen RP, Cury RC, Dodd JD. Cardiac tumors: optimal cardiac MR sequences and spectrum of imaging appearances. *AJR Am J Roentgenol* 2009;193:377-87.
5. Sparrow PJ, Kurian JB, Jones TR, Sivananthan MU. MR imaging of cardiac tumors. *Radiographics* 2005;25:1255-76.
6. Araoz PA, Mulvagh SL, Tazelaar HD, Julsrud PR, Breen JF. CT and MR imaging of benign primary cardiac neoplasms with echocardiographic correlation. *Radiographics* 2000;20:1303-19.
7. Ciliberti D, Savini E, Capone PL. Cardiac tamponade due to a right atrial myxoma. *Cardiologica* 1998;43:1101-3.
8. McCoskey EH, Mehta JB, Krishnan K, Roy TM. Right atrial myxoma with extracardiac manifestations. *Chest* 2000;118:547-9.
9. Neragi-Miandoab S, Kim J, Vlahakes GJ. Malignant tumours of the heart: a review of tumour type, diagnosis and therapy. *Clin Onc* 2007;19:748-56.
10. Best AK, Dobson RL, Ahmad AR. Best cases from the AFIP: cardiac angiosarcoma. *Radiographics* 2003;23:S141-5.
11. Janigan DT, Husain A, Robinson NA. Cardiac angiosarcomas: a review and a case report. *Cancer* 1986;57:852-9.
12. Economides EG, Singh A. Case of tumor neovascularization demonstrated by cardiac catheterization. *Cathet Cardiovasc Diagn* 1998;43:451-3.
13. Luna A, Ribes R, Caro P, Vida J, Erasmus JJ. Evaluation of cardiac tumors with magnetic resonance imaging. *Eur Radiol* 2005;15:1446-55.
14. Burke A, Jeudy J Jr, Virmani R. Cardiac tumours: an update. *Heart* 2008;94:117-23.
15. Centofanti P, Di Rosa E, Deorsola L, Dato GM, Patanè F, La Torre M, et al. Primary cardiac neoplasms: early and late results of surgical treatment in 91 patients. *Ann Thorac Surg* 1999;68:1236-41.
16. Elbardissi AW, Dearani JA, Daly RC, Mullany CJ, Orszulak TA, Puga FJ, Schaff HV. Survival after resection of primary cardiac tumors: a 48-year experience. *Circulation* 2008;118:S7-15.
17. Tazelaar HD, Locke TJ, McGregor CG. Pathology of surgically excised primary cardiac tumors. *Mayo Clin Proc* 1992;67:957-65.
18. Pigott C, Welker M, Khosla P, Higgins RS. Improved outcome with multimodality therapy in primary cardiac angiosarcoma. *Nat Clin Pract Oncol* 2008;5:112-5.
19. Syed IS, Feng D, Harris SR, Martinez MW, Misselt AJ, Breen JF, et al. MR Imaging of Cardiac Masses. *Magn Reson Imaging Clin N Am* 2008;16:137-64.
20. Deetjen AG, Conradi G, Möllmann S, Hamm CW, Dill T. Cardiac angiosarcoma diagnosed and characterized by cardiac magnetic resonance imaging. *Cardiol Rev* 2006;14:101-3.
21. Hoffmann U, Globits S, Schima W, Loewe C, Puig S, Oberhuber G, Frank H. Usefulness of magnetic resonance imaging of cardiac and paracardiac masses. *Am J Cardiol* 2003;92:890-5.
22. Rodrigues AG, Tardif JC, Petitclerc R, Mercier LA, Paquet E, Leung TK, Delorme F. Angiosarcomas of the interatrial septum mimicking atrial myxomas. *J Am Soc Echocardiogr* 1996;9:209-12.