Cardiac masses: a teaching tour with ultrasound and MRI.

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Learning objectives

To describe the MRI findings that help to characterize intracardiac tumors and compare the usefulness of ultrasound compared to MRI.

Traditionally, echocardiography has been used as a screening technique in patients with suspected intracardiac mass. Transthoracic echocardiography (TTE) is an inexpensive, easily accessible technique, and allows detecting and localizing cardiac masses. However, it has the disadvantage of being operator-dependent, sometimes the study quality is not optimal due to inadequate acoustic window, and has a limited ability to characterize tissues. When the TTE does not provide enough information, there is the possibility of a transesophageal echocardiography (TEE), being this an invasive method that also will require patient sedation, and has a limited field of view.

On the contrary, magnetic resonance imaging (MRI) is able to suggest the etiology of the mass, defining its extent and its relations with adjacent structures and the presence of hemodynamic effects or associated extracardiac lesions.
Background

Until 1950, cardiac tumors were a curiosity. With the advent of cardiopulmonary bypass, the surgical treatment became possible, particularly of intracavitary masses. Subsequently, the development of echocardiography, computed tomography and magnetic resonance imaging, have greatly contributed to the preoperative diagnosis.

Cardiac tumors are rare, representing between 0.001 and 0.1% according to autopsy series. Secondary tumor involvement is most commonly seen, 1% of autopsies, and usually in the context of disseminated malignancy. Benign tumors are the most common primary cardiac tumors, accounting for 80% of them.

TTE is the technique of choice for detection and analysis of their functional repercussions. Using two-dimensional echocardiography (2D), assesses the size and location of the tumor, while Doppler technique is used to assess its hemodynamic effects. However, it is an operator-dependent scanning and image quality can be low in obese patients with an inadequate acoustic window, or with pulmonary disease (e.g. COPD).

TEE, which has no acoustic window limitations, is sometimes used as an alternative to TEE, but nevertheless, it is an invasive technique with a limited size scanning window, especially in the assessment of aortic arch, the inferior vena cava and the left ventricular apex.

MRI is a noninvasive technique; its multiplanar capability allows for better localization of cardiac masses and also because of its wide field of view, is capable of evaluating the entire mediastinum and adjacent lung structures. Therefore permits an optimal assessment of myocardial infiltration, pericardium and extracardiac structures. In addition, the use of contrast media, such as gadolinium, improves the characterization of tumors and helps to define normal anatomic variants or "pseudotumors" detected by echocardiography.

Their main disadvantage includes long time of immobilization (45 - 90 minutes) and the need for synchronization, which in case of cardiac arrhythmias will lead to acquisition artifacts.

There are several clinical features that could be seen in patients with a cardiac tumor:

• Embolism: either the tumor itself or from a thrombus attached, which fragments and migrate. Right-sided tumors, embolize to the lungs, producing pleuritic symptoms and right heart failure. While those located in the left cavities and depending on the size of the embolus, can produce a stroke or even mimic vasculitis or infectious endocarditis.
• Obstruction: Atrial tumors can obstruct the flow intermittently, depending on body position, mimicking an atrioventricular valve stenosis. Ventricular tumors can obstruct the outflow tract, causing chest pain, shortness of breath or syncope.

• Arrhythmia: both intramyocardial and intracavitary masses can affect the heart rhythm, either by infiltration of conduction tissue, or by irritation of the myocardium itself. Occasionally, they may be associated with sudden cardiac death, although it is more frequent, the development of ventricular tachycardia or atrioventricular block.
Imaging findings OR Procedure details

We conducted a retrospective review of cardiac tumors diagnosed in our hospital from 2004 to 2010.

We present 42 cases of cardiac masses, 24 males and 18 females, aged between 17 and 91 years (mean age 58 years). Our series is composed by 2 leiomyosarcomas, 7 myxomas, 2 fibromas, 4 fibroelastomas, 1 bacterial vegetation, 2 lipomas, 1 hydatidosis, 1 semiinvasive aspergillosis, 3 cases of tumor invasion by contiguity and 19 thrombosis, 7 of them having a tumoral origin (Table 1 on page 16).

The 42 patients were studied with TTE. TTE was performed using a 3 MHz transducer (Sequoia and CV70 models, Siemens, Munich Germany; and Vivid 7 model, General Electric, Fairfield, Connecticut, U.S.A), obtaining images in the following levels: long and short parasternal axis and subcostal apical two and four chambers views. When at the standard planes, a mass was found, we obtained complementary planes: using subxiphoid and suprasternal views. In 11 patients, TEE was also performed with a 7 MHz transducer (Sequoia equipment, Siemens,Munich,Germany), obtaining images in short axis, long and four cameras, from the middle esophageal and transgastric positions.

The 42 patients underwent MRI on a 1.5 Tesla (Intera, Philips, Amsterdam, The Netherlands), none of them required anesthesia. The study protocol consisted of:
• Cine SSPF (Balanced®) Sequences in two-chamber, four-chamber and short axis, allowing to assess the relationship of cardiac masses with valves and obstructions of the input and output tracts of the cavities.

• Double inversion-recovery (IR) fast SE sequence with nulling of blood pool signal, T1 or T2 weighted.

• Spectral presaturation IR black blood sequence in axial plane.

• Sequences of perfusion, myocardial viability and "black blood" after gadolinium administration (dose of 0.2 mmol / kg body weight).

BENIGN TUMORS:

MYXOMA:

It is the most common cardiac tumor, accounting for up to 50% of all cardiac masses. They are more common in women, between the fourth and seventh decades.
They are usually solitary and atrial in location (75% left and 20% right), being the atrial septum around the fossa ovalis the most frequent point of origin. However, 7% of cases show an atypical behavior, with a familiar predisposition or as a part of an autosomal dominant syndrome known as Carney complex, characterized by myxomas, hyperpigmented skin lesions and extracardiac tumors (pituitary adenomas, breast fibroadenomas and psammomatous melanocytic schwannomas). In these cases, patients affected are usually young males, the myxomas are often multifocal and tend to recur after excision.

Presenting symptoms depend on tumor location, conditioning embolic events or intermittent valvular obstruction. Sometimes, a constitutional syndrome is associated, which may be secondary to an autoimmune reaction initiated by the tumor, or to the release of vasoactive products from the tumor itself.

It is thought that cardiac myxomas originate from endocardial neural tissue or pluripotential mesenchymal primitive cells. They are characterized by having a polypoid shape, are generally soft, gelatinous-looking with grayish-white colour. They may contain cystic or necrotic areas, hemorrhage foci and calcium.

The diagnosis can usually be done with echocardiography; both TTE and TEE will demonstrate a tumor that is related to the atrial septum. Its main distinguishing feature, apart from its characteristic location, is its pedunculated and mobile appearance. Its echotexture is usually heterogeneous according to the presence of cystic, necrotic, hemorrhagic and calcic foci (Fig. 1 on page 16).

Ultrasonography raises differential diagnosis with:

- Blood clots: differential diagnosis with other intracardiac masses is usually easy and the combination of ultrasound findings, location of the mass and the clinical context is sufficient to make a correct diagnosis in most cases. Non-mobile myxomas and those with a broad base implantation, pose greater confusion with thrombus.

- Valvular vegetations.

In MRI, the majority of myxomas show a heterogeneous signal due to the heterogeneity of the underlying tissue. Myxomatous tissue is hypointense to myocardium on T1 and hyperintense on T2, whereas the fibrous component, show low signal on both T1 and T2 weighted images. Postcontrast enhancement is usually heterogeneous, although sometimes it is quite homogeneous. Cine sequences show the characteristic mobility of myxomas and eventual prolapse through the mitral valve annulus. In these sequences, its signal is predominantly hypointense relative to the circulating blood, due to signal drop, resulting from the magnetic susceptibility effect which produces the high iron content.
MRI, sometimes have more difficulty than echocardiography to demonstrate the tumor pedicle anchors to the wall (Fig. 2 on page 17).

Differential diagnosis is posed with:

- Blood clots: they are much more frequent and usually occur in dyskinetic or aneurysmal areas. When seated in the atrium, they are usually found in the posterior wall. By contrast, myxomas generally depend on the anterior aspect of the interatrial septum. Gadolinium also helps the differential diagnosis, since the thrombus should not enhance.

- Papillary fibroelastoma: they tend to be smaller and show different signal characteristics.
- Sarcomas: usually invade adjacent structures and metastasize to the lung and mediastinum.

The treatment of myxomas is urgent surgical resection. MRI is useful when planning surgery, providing accurate information on the size, location and the anchor point of the lesion. Surgical mortality is very low, with excellent long-term prognosis, although they require echocardiographic monitoring for recurrence screening.

**PAPILLARY FIBROELASTOMA:**

Represents approximately 10% of all cardiac tumors and 90% of cases originate from the valves, more frequently in the mitral followed by the aortic. It is more common in older patients, usually detected incidentally, around the seventh decade of life.

They are small tumors of less than 2 cm, attached to the endocardium by a short thin stalk. They arise from the atrial surface of the atrioventricular valve or the aortic surface of the semilunar, usually away from the free edge, so rarely produce valve dysfunction. 16% of these tumors arise from non valvular surfaces.

Histologically, these tumors are composed by avascular connective tissue, lined by endothelium.

**Echocardiography** demonstrates a small pedunculated tumor, of mottled appearance, which vibrates in systole and shows finger-like extensions that resemble a "sea anemone". It can be difficult to distinguish from valvular vegetations, but unlike these, fibroelastomas, often settle on the atrial surface.

Given the small size of these tumors and their mobility, it is difficult to detect them on **MRI**, especially in static sequences, as they are attached to a moving valvular leaflet. Therefore, the technique of choice for its detection is echocardiography, being MRI useful when large or unusual in location. Cine sequences, detect a hypointense and mobile
mass and sometimes reveal the presence of turbulent flow around the tumor. No contrast uptake is usually observed (Fig. 3 on page 18).

The differential diagnosis arises with:

- Thrombus
  - Vegetation: usually associated with destruction of the valve leaflets and valvular incompetence.
  - Myxoma: are rare in the valves and generally larger, with signal characteristics described above.
  - Lamble excrescences: they are small filiform processes, which are observed in the aortic valve in elderly patients.

Surgery is the treatment of choice, especially when it presents with repeated embolic episodes.

**LIPOMA:**

It is the second most frequent benign tumor. They can settle in endocardium, myocardium and epicardium, although most of them are subepicardial. They are more frequently found in the left ventricle, right atrium and atrial septum.

They can reach a large size without causing symptoms, however those with intracavitary growth may produce obstructive clinic, while the pericardial ones, may compress the ventricles and even cause dyspnea due to lung compression. They can also associate different types of arrhythmia.

Macroscopically, these tumors are encapsulated and homogeneous masses composed of mature adipose tissue.

In echocardiography, intracardiac lipomas are homogeneous and hyperechoic masses, while the pericardical ones are usually hypoechoic. The interatrial septal lipomas, can pose differential diagnosis with myxomas, however, lipomas have a wide base of implantation and are not as mobile.

**MRI** shows a homogeneous and hyperintense signal on T1 and T2, equal to mediastinal or subcutaneous fat, and shows no uptake of gadolinium (Fig. 4 on page 19). Fat suppression T1 sequences demonstrate signal loss of the tumor.

The main differential diagnosis is with lipomatous hypertrophy of the interatrial septum. This is not a true neoplasm and is characterized by an infiltration of adipocytes, reaching a thickness of 2 cm in the transverse axis and sparing the ovalis fossa, giving an "hourglass"
image. They are usually seen in overweighted elderly and may debut with atrial fribillation (Fig. 5 on page 20).

**FIBROID:**

It is the second most common tumor in children after rhabdomyoma, and it is rare in adults. In Gorlin's syndrome, the prevalence of cardiac fibromas is increased, associated with basal cell carcinomas, odontogenic keratocysts of the jaw, and skeletal abnormalities with tendency to develop malignancies.

The point of origin of this tumor is usually in the ventricles and more specifically in the ventricular septum and left ventricular free wall.

The most frequent clinical presentations are arrhythmias or sudden death, although up to one third of cases are asymptomatic. Like lipomas, it doesn’t cause systemic embolism.

Pathologically, are solid tumors with myocardial origin, composed of fibroblasts, with multiple foci of calcification.

In **echocardiography**, they are solid usually large masses, (approximately 5 cm), located in a ventricular wall, and sometimes obstructive. Occasionally they may be confused with focal hypertrophic cardiomyopathy.

In **MRI**, they are hypointense on T1, iso-or hypointense and homogeneous on T2, usually with poor or no uptake of contrast medium, although different behaviors have been described with gadolinium (Fig. 6 on page 21).

In children, the first differential diagnosis arises with a rhabdomyoma, which tends to be multiple and associated with tuberous sclerosis. The low signal of fibroid and dystrophic calcifications are other distinguishing features.

The treatment of choice is surgical.

**HEMANGIOMA:**

It is a benign vascular tumor that can occur in any cardiac chamber and even in the pericardium. It represents 5-10% of benign cardiac tumors. Patients usually complain of dyspnea during exercise, but a proportion is asymptomatic.

Microscopically, are classified as capillary, cavernous or arteriovenous.

In MRI they are isointense with the myocardium on T1 and hyperintense on T2, enhancing intensely but generally in an inhomogeneous way, after administration of gadolinium.

Surgical excision is difficult because of its vascular nature.
OTHER BENIGN TUMORS:

Paraganglioma: they are very rare tumors that originate from neuroendocrine cells that normally arise in the left atrium, but can also be related to the coronary arteries. They occur in young adults, who tend to be symptomatic due to the production of catecholamines by the tumor.

They are echogenic masses on echocardiography, with a strong and broad base of implantation, suggesting differential diagnosis with myxomas and sarcomas.

In MRI, they are iso-hypointense on T1 and hyperintense relative to myocardium on T2, and given to its vascularity, enhance intensely but heterogeneously after contrast administration.

PRIMARY MALIGNANT TUMORS:

The most common malignant cardiac tumors are metastases. Primary malignant cardiac tumors are rare and of them, 95% are sarcomas and 5% lymphomas.

The clinical course is rapidly progressive, with death occurring as a result of local infiltration, obstruction of the cardiac chambers or metastasis.

Sarcomas are more frequent between the third and fifth decades and in the right atrium.

ANGIOSARCOMA:

It is the most common primary malignant tumor in adults. It has a clear preference for the right atrium and can be intracavitary and polypoid or diffuse and infiltrating.

Hemorrhagic pericardial effusion is a common manifestation and should raise suspicion.

They are masses macroscopically large, hemorrhagic and infiltrative, with necrotic areas. Histologically these tumors consist of mesenchymal cells with ill-defined vascular spaces lined by atypical endothelial cells.

Echocardiography demonstrates a right atrial mass with a broad-based implantation, next to the inferior vena cava. Although TTE is a reasonable screening technique, the TEE may reveal information suggesting a malignant nature, such as the intramyocardial extension or invasion of the inferior vena cava. In addition, it allows transvenous endomyocardial biopsy of the tumor.

MRI shows a heterogeneous signal mass on T1, due to the presence of necrotic and hemorrhagic foci and predominantly hyperintense on T2. It can also detect signal void foci on T1 and T2 sequences and bright signal on FFE sequences, corresponding to vascular structures. They show a heterogeneous pattern of gadolinium uptake, which
has been described as a "sunshine" appearance (marked superficial uptake and necrotic central areas).

It is also capable of showing pericardial infiltration signs, such as hemorrhagic effusions, thickening or nodularity of the pericardium and fat planes obliteration.

Even when the diagnosis is made early, most of the patients have already developed metastasis, especially to the lung. Thus, despite surgical treatment, the prognosis is ominous, with a median survival of 3 to 6 months.

**LEIOMYOSARCOMA:**

It is a malignant tumor originating from smooth muscle and represents 8-9% of cardiac sarcomas. It has a predilection for the left atrium, although it can occur in any cardiac chamber and 30% of cases are multiple. Frequently invade the pulmonary veins or mitral valve.

Its gross appearance is of a gelatinous and sessile mass. They may originate from subendocardial smooth muscle bundles, or from smooth muscle of the veins and pulmonary arteries, and then spread to the atria.

In MRI, they are usually iso-or hypointense on T1 and hyperintense on T2, showing intense avidity for the contrast media (Fig. 7 on page 22).

They pose differential diagnosis with cardiac myxomas and unlike these, are often attached to the posterior wall of the left atrium.

**PRIMARY LYMPHOMA:**

They are rare tumors, 5% of primary malignancies, being much less common than secondary cardiac involvement by systemic lymphoma. However, its incidence has increased over the past 20 years, by developing in patients with acquired immunodeficiency syndrome, transplantation or receiving immunosuppressive therapy.

They are B cells non-Hodgkin lymphomas, confined to the heart or pericardium, and preferably affect the right atrium, with frequent involvement of more than one camera and pericardial invasion.

Clinically, they course with congestive heart failure, arrhythmias, pericardial effusion or superior vena cava syndrome.

**Echocardiography:** imaging findings are nonspecific, being TEE useful for transvenous tumor biopsy. Biopsy may be indicated to reach the diagnosis, as lymphoma doesn’t always presents with pericardial effusion and its cytological examination has low diagnostic yield.
In MRI they are isointense on T1, hyperintense and heterogeneous on T2-weighted images, enhancing heterogeneously with gadolinium. It is useful to determine the precise location and for detecting nodularity of the pericardium.

Treatment is usually surgical, chemotherapeutic and radiotherapeutic, with little success, usually due to delayed diagnosis.

OTHER SARCOMAS:

Undifferentiated sarcoma: is the second primary malignant tumor of the heart. It is most common between the fourth and fifth decade and is usually found in the left atrium, but can also affect the heart valves.

It doesn’t show distinguishing features, and can present as a polypoid myocardial mass or as an infiltrating intracardiac mass.

METASTATIC TUMOR AFFECTATION:

It is 20-40 times more common than primary cardiac neoplasms. In oncological autopsy series they are detected in 10-12% of cases. The involvement may be epicardial, myocardial or endocardial, although most are epicardial. Primary tumors that more frequently metastasize to the heart are lung, breast, melanoma, esophagus, and lymphoma.

Possible routes of spread are:

• Lymphatic: particularly frequent in carcinomas of the lung, breast and hematological malignancies. It typically, manifests as pericardial effusion (Fig. 8 on page 23).

• Hematogenous: melanomas, which affect the heart as much as 50% of cases, and occasionally sarcomas (Fig. 9 on page 24).

• Direct invasion: it is characteristic of lung carcinomas, and can also be found in breast, esophagus, lymphoma and thymoma (Fig. 10 on page 25).

• Transvenous extension: in patients with carcinoma of the lung through the superior vena cava and pulmonary veins and in patients with renal cell carcinoma, hepatocellular carcinoma, cholangiocarcinoma, and adrenal carcinomas, via inferior vena cava and suprahepatic veins (Fig. 11 on page 26).

The development of tachycardia, arrhythmia, cardiomegaly or heart failure in a tumoral patient can be indicative of metastatic involvement. Death usually occurs due to cardiac tamponade, congestive heart failure or coronary artery invasion.
The myocardial and epicardial tumor involvement can be better assessed with MRI than with echocardiography. Furthermore, in cases of transvenous extension, the use of gadolinium can help to differentiate soft thrombus adhere to tumoral thrombus, since uptake is not observed in the case of soft thrombus. Metastases do not have a characteristic appearance on MRI. In general, malignant tumors are hypointense on T1 and hyperintense on T2, except for metastatic melanoma, which are hyperintense on T1 and T2. Pericardial effusion is often hemorrhagic or serosanguineous, showing a shortening of the T1 signal.

**PEUDOTUMORAL LESIONS:**

**INTRACARDIAC THROMBUS:**

They are the main simulators of malignancy. They may be found in the right chambers, corresponding to venous thrombi that have embolized from the extremities to the heart or related to central catheters. However, they are much more frequent in left chambers. In the left ventricle, they often settle in the apex, especially in patients with ventricular aneurysm, dilated cardiomyopathy or patients in its first week after myocardial infarction. In the left atrium, they are usually located in the appendage and are associated with atrial fibrillation or atrial flutter, mitral stenosis or mitral valve prosthesis.

Echocardiography is an excellent technique for the detection of thrombi, being TTE the method of choice to locate the left ventricle thrombus and TEE for those who sit in the left atrium and right chambers (Fig. 12 on page 27).

However, MRI, especially postcontrast images, allows a better detection of a larger number of thrombi and the very small ones, compared to cine sequences and to ETT. The presence of turbulent flow in slow and dyskinetic segments, and similar signal between the thrombus and the adjacent myocardium, explain the difficulty to detect thrombi in the cine sequences.

The thrombus signal will depend on its age and on the degradation hemoglobin process. Acute thrombi will be hyperintense on T1 and T2, subacute thrombi hyperintense on T1 with areas of low signal on T2, and chronic ones show low signal on both T1 and T2. Generally they don’t enhance, although organized thrombi may have a faint peripheral ring enhancement (Fig. 13 on page 28).

**BACTERIAL VEGETATION:**

Endocarditis represents an endothelial damage associated with thrombosis of the endocardial surface. Usually refers to inflammation of the valves, but atrial and ventricular endocardial lining can also be compromised. The process usually begins where the pressure is higher, that is, in the atrial surface of the atrioventricular valves and ventricular
surfaces of the semilunar valves. It infects more often left valves with a similar incidence of aortic and mitral endocarditis. Right valves involvement, should suggest intravenous drug abuse, but can also be secondary to the infection of intravascular devices. The approximate incidence is 4-10 / 100,000 inhabitants, being somewhat more frequent in males.

Predisposing factors are congenital valvular malformations, acquired valvular disease and prosthetic valves. In the presence of bacteremia, these situations facilitate infection of small microthrombi when they adhere and colonize thrombotic surfaces.

Microorganisms usually involved in this process are gram-positive cocci, both streptococci and staphylococci.

Fever is the most common presenting symptom. Diagnosis is mainly clinical, based on the presence of blood cultures, together with clinical and physical examination. Imaging studies allow to demonstrate valvular vegetations, perivalvular complications, such as abscesses, and estimates the severity of heart failure.

**Echocardiography** is able to demonstrate vegetations on heart valves, valvular regurgitation and abscesses, and is the technique of choice for suspected infective endocarditis (Fig. 14 on page 29). It is also a useful technique for monitoring patients on antibiotic therapy and to predict complications such as peripheral embolization.

**MRI** is not as sensitive in detecting vegetations, though it seems to be useful in the evaluation of complicated cases and those cases that raise diagnostic doubts.

Treatment requires intensive long term antimicrobial therapy and sometimes it is necessary to remove the vegetation, replace the damaged valve or even resort to cardiac transplantation.

**HYDATIDOSIS:**

Hydatidosis is a parasite infestation caused by the encysted larvae of Echinococcus. Cardiac involvement occurs when the Echinococcus reaches the right heart through the portal venous or lymphatic system and then, after passing through the left chambers and coronary circulation, is lodged in the myocardium. This occurs at a frequency of 0.5-2% of hydatid disease. It has a predilection for the interventricular septum and the left ventricular free wall, being less frequent the pericardial and paracardiac involvement. When seated in the right ventricle, usually are subendocardic located, with the consequent risk of intracavitary rupture and pulmonary embolization.

Clinically, it can manifest with anaphylactic reactions, including fever, rashes and even circulatory collapse and systemic or lung embolism. It can also cause conduction
disturbances, valvular disease and chest pain, either pericardial or ischemic in origin, when coronary arteries become blocked.

**Echocardiography** is the initial procedure of choice, by showing the cystic nature of a lesion with sharp outlines and internal trabeculations. The presence of a cystic lesion in the myocardium is almost pathognomonic of a hydatid cyst (Fig. 15 on page 30).

The differential diagnosis is considered, with masses with cystic degeneration, pericardial cysts, abscesses, or hematomas.

**MRI** shows an intramyocardial mass containing small cystic structures corresponding to daughter vesicles within the liquid contents, and is more useful than ultrasound in the assessment of extracardiac extension.

The treatment should be surgical, due to the risk of complications such as rupture, tamponade and anaphylactic shock.

**SEMIINVASIVE ASPERGILLOSIS:**

Aspergillus is a ubiquitous fungus capable of causing severe disease in both healthy and immunocompromised patients. There are predisposing factors like underlying heart disease, prosthetic valves, central venous catheters, prolonged use of antibiotics and intravenous drug use. It is more common in males, with the highest incidence between the third and fourth decade. It has a predilection for the left heart valves, affecting the aortic more often than the mitral.

Clinically it presents with fever, peripheral embolism, and less frequently with dyspnea and heart failure. Aspergillus encocarditis occurs in severely immunocompromised patients and has a fatal course due to the difficulty to diagnose it early and treat it.

Often, fungus, balls are formed with potential to embolize to the brain, skin, eyes, limbs, mesenteric and coronary arteries, delaying the diagnosis due to mimicking of other diseases. This finding is present in up to 83% of Aspergillus endocarditis.

**Echocardiography** is a useful tool to identify an endocavitary mass and in the context of an immunocompromised patient, Aspergillus endocarditis may be suspected. The case reported in our series showed no vegetations, but a solid heterogeneous echotexture tumor within the right ventricular free wall (Fig. 16 on page 31). Initially, this possibility was not provided and therefore diagnostic **MRI** was performed, which suggested an infectious etiology and the possibility of a semiinvasive aspergillosis, with origin from an anterior mediastinal inflammatory "mass" secondary to median sternotomy.
Table 1

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Fig. 1: Myxoma

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Fig. 2: Myxoma

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Fig. 3: Fibroelastoma

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Fig. 4: Lipoma

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**Fig. 5:** Lipomatous hypertrophy

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Fig. 6: Fibroma

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Fig. 7: Leiomyosarcoma

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Fig. 8: Lymphatic infiltration

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**Fig. 9:** Hematogenous spread

33 year old male with retroperitoneal germ cell tumor. There is a 2 cm mass anchored to the posterior wall of the right atrium and posterior portion of the tricuspid ring. Surgery confirmed that it was a metastasis. Pulmonary metastatic nodules were also observed (bottom right image).
Fig. 10: Direct invasion

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**Fig. 11:** Transvenous extension

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Fig. 12: Thrombus

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**Thrombus.** 65 year old woman with mitral stenosis, who had a mass attached to the roof and posterior wall of the left atrium. After administration of gadolinium (right images) there is no early or late enhancement.

**Fig. 13:** Thrombus

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Fig. 14: Vegetation

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Fig. 15: Hydatid cyst

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**Fig. 16:** Semi-invasive Aspergillosis

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Conclusion

Some cardiac masses as papillary fibroelastoma or myxoma can be characterized by echocardiography. However, this technique is limited in the evaluation of nonmobile masses or tumors located in the right chambers. In addition, ultrasound is a blind technique in assessing the mediastinum and extracardiac structures.

Therefore, and because of its availability, echocardiography should be the technique of choice in the initial assessment of a patient with suspected cardiac mass, individually analyzing the need to expand the study by MRI.

MRI has a clear advantage over the combination of TTE and TEE in the evaluation of cardiac masses. It is able to suggest the etiology of the mass, define its extent and its relation to adjacent structures as well as the presence of hemodynamic effects or extracardiac associated lesions. This is especially important, since intracardiac masses often are non-neoplastic, and many will not require surgery. Another advantage of MRI is that it provides information in three planes of the space and creates contrast between soft tissues and vascular spaces without the need for contrast media.

MRI allows tissue characterization in the case of myxomas, fibromas, thrombi and adipose tissue. Signal characteristics of malignant tumors do not allow characterizing them. However, some features indicative of malignancy on MRI are aggressive behavior, right chambers or pericardial compromise, heterogeneous signal, diameter larger than 5 cm and contrast uptake.

There is a clear overlap between the presenting symptoms and imaging findings of benign and malignant neoplasms. The location of the masses can help to approximate the diagnosis (Fig. 17 on page 34).

Primary cardiac tumors, although rare, are fatal cancers, so they must be reported and studied in order to know enough to predict their presentation, clinical and biological evolution. This will allow further advance in the knowledge of more accurate diagnostic methods and the most appropriate therapy, in order to improve morbidity and mortality.
**Fig. 17:** Cardiac masses location

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