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New clinical aspects of cardiac myxomas: A clinical and pathological reappraisal

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Abstract
Easy access to echocardiography and its extensive and repeated use (as is the case in Portugal) now facilitates the early diagnosis of cardiac myxoma (CM).

Objective: To re-evaluate the clinical and pathological profile of CM under current diagnostic conditions.

Methods: We performed a retrospective study of 40 patients consecutively referred for surgery (between January 2003 and January 2010) with a histologically confirmed diagnosis of CM—26 female (F) and 14 male (M), with a mean age of 64 ± 12 years (range 12–81; 53% over 65, 43% over 70); 39 patients were operated (one was not operable due to major neurological deficit). Clinical characteristics, surgical protocols, follow-up records of survivors (range 1–76 months, with serial echocardiograms), and histological data were reviewed.

Results: The apparent incidence was 2.6 cases/million/year; the overall F/M ratio was 1.9:1 (1.3:1 in those aged over 65, similar to the general population). The CM was located in the left atrium (LA) in 92.5%, with insertion in the fossa ovalis of the interatrial septum (IAS) in 53% (only 57% of LA myxomas), and outside the IAS in 30%. The mean size was 4.6 cm × 3.7 cm.

Asymptomatic tumors occurred in 48% of the total population (sessile and/or atypically inserted in 74%; 63% of large size, over 3 cm × 3 cm), 61% were in patients referred in the last 25 months of the study; 23% of patients showed constitutional symptoms (all with very large CMs—mean 6.7 cm × 5.1 cm), 35% had hemodynamic/obstructive symptoms, and 15% presented with embolic events. There was evidence of CM-related mitral valve (MV) disease in 20% of patients, resulting in moderate to severe mitral regurgitation requiring associated MV surgery in 13%.

Significant comorbidities were present in 69%. Surgical procedures included simple excision in 74%; septoplasty/atrioplasty associated with extensive resection of the insertion site in 26%; and combined surgery (CM excision plus other procedures) in 28%. There were significant postoperative complications in 38%. In-hospital mortality was 10%; postoperative mortality was 7.7%. Mean follow-up was 30 months (100% of survivors, 44% for >2 years); late mortality was 5.6% and no CM recurrences were observed.

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Conclusions: (1) CM has a higher incidence than described in the literature and mainly affects patients aged over 65; the reported predominance of female patients disappears after the age of 65. (2) Most CM cases are now asymptomatic at presentation as a result of earlier diagnosis. (3) CM is the cause of MV disease requiring surgical correction in more than 10% of cases, and is associated with significant postoperative mortality, mainly due to the presence of comorbidities. © 2011 Sociedade Portuguesa de Cardiologia. Published by Elsevier España, S.L. All rights reserved.

Introduction

Cardiac myxoma (CM) has conventionally been considered to have an incidence of 0.5 cases/million/year, to be symptomatic in 75–90% of cases (constitutional symptoms in 30–90%, embolic events in 16–50%, and hemodynamic/obstructive symptoms in 40–60%), to be more common in women, and inserted in the fossa ovalis (left atrial side) of the interatrial septum (IAS) in 64–85% of patients. There is some disagreement as to the mean age of patients at diagnosis: in the US, Burke et al. (2001–2007) and McManus et al. (2008) reported that most patients present between the ages of 30 and 60 (mean: 50 years), while in Europe, Thiene et al. (2009) found that the peak occurs in those aged over 60 years.

Easy access to echocardiography and its extensive and repeated use (as is the case in Portugal), particularly in hypertensive and/or diabetic patients, now facilitates the early diagnosis of CM.
Objective

The aim of this study is to re-evaluate the clinical and pathological profile of CM under current diagnostic conditions.

Methods

We performed a retrospective observational study of 40 patients consecutively referred for surgery between January 2003 and January 2010 (85 months), with a histologically confirmed diagnosis of CM - 26 female (F) and 14 male (M), mean age 64 ± 12 years (range 12–81; 53% over 65 and 43% over 70). Twenty-two patients were referred for surgery in the first 60 months of the study, while 18 were referred in the last 25 months. Thirty-nine were operated (18, 45% of the total, in the last 25 months of the recruitment period) and the diagnosis of CM was confirmed by anatomopathological study of the surgical specimens. One case was considered inoperable due to major neurological deficit (the CM was manifested by multiple systemic emboli followed by major stroke and occlusion of the abdominal aortic bifurcation) but the diagnosis was confirmed by anatomopathological study of the emergency aortic embolectomy specimen. Clinical characteristics, surgical protocols and postoperative follow-up records of survivors (range 1–76 months, with serial echocardiographic assessment every one or two years) were reviewed, together with available anatomopathological data.

Fisher's exact test was used to analyze discontinuous variables.

Results

In the period immediately prior to our study (1985–2002), the annual mean number of cases of CM admitted to our cardiothoracic surgery department was 2.3 (range: 0–5). During the study period, this figure rose to 5.6 cases per year (range: 3–9), which is a dramatic increase even bearing in mind that the area from which patients were referred to our department became much larger.

Based on the demographic characteristics of the geographical area currently served by our department (a third of Greater Lisbon and large areas of districts to the north and south of the River Tagus, with a total population of around two and a half million), the apparent overall incidence of CM for the period 2003–2009 was 2.6 cases/million/year. During the first 60 months of the recruitment period, the apparent incidence was 1.8 cases/million/year, but this almost doubled to 3.5 cases/million/year for the last 25 months of the study period.

The overall F/M ratio was 1.9:1, falling to 1.3:1 in those aged over 65 (similar to that reported for the general population – 1.4:1).

Anatomical data

The CM was located in the left atrium (LA) in 37 patients (92.5%), in the right atrium in two (5%), and in the left ventricle (inserted in the posterior papillary muscle of the mitral valve [MV]) in one (2.5%). Insertion was in the fossa ovalis (left atrial side) in 53% of cases (but only 57% of LA myxomas had this typical presentation) and outside the IAS in 30%. The CM stalk was short and wide or nonexistent (sessile) in 16 patients (40%). Macroscopically, the CM presented a villous surface (papillary or pseudopapillary anatomical substrate) in 35% of cases (14 patients) (Figure 1); in the others, the tumor was ovoid or spherical, with a smooth surface (Figure 2). The mean size of the tumors was 4.6 cm × 3.7 cm.

Clinical manifestations

Around half the patients were asymptomatic (19 cases, 48%) at the time of diagnosis. However, the prevalence of asymptomatic patients rose dramatically from 36% (8/22) in the first 60 months of the recruitment period to 61% (11/18) in the last 25 months. The diagnosis was made during routine transthoracic echocardiography in 15 of the 19 asymptomatic patients (confirmed by transesophageal echocardiography in one and by cardiac magnetic resonance imaging in two), by goal-directed transesophageal echocardiography in two (assessment of aortic stenosis in one and investigation of stroke due to paradoxical embolism in the other), and by chest computed tomography in two (during investigation of chronic cough caused by severe gastroesophageal reflux in a 75-year-old patient with asymptomatic chronic atrial fibrillation, previously considered idiopathic, and of chronic obstructive pulmonary disease complicated by hemoptysis in a 60-year-old man). Although asymptomatic, these tumors were large (over 3 cm × 3 cm) in 63% of patients, and were sessile or equivalent.
(non-mobile, with short wide stalks) in 53% of these cases (10 patients); they were pedunculated, with atypical insertion (not in the LA side of the fossa ovalis) in three of these patients (16%); only 26% of asymptomatic patients (5/19) presented mobile pedunculated tumors with typical insertion.

Nine patients (23%) showed constitutional symptoms (fatigue on minimal exertion, weakness, intermittent mild fever, anorexia or weight loss), or equivalent signs (mild normocytic anemia or elevated erythrocyte sedimentation rate and/or C-reactive protein) not explained by comorbidities, that had begun from a few months to around three years previously. All had large CMs (mean of 6.7 cm × 5.1 cm). Fourteen patients (35%) had hemodynamic-obstructive symptoms, beginning between 24 hours (in a patient presenting with paroxysmal atrial fibrillation) and a few days previously (in a patient with acute left ventricular failure resulting from acute severe mitral regurgitation due to chordal rupture) to more than a year. Embolic events occurred in only 15% (6 patients), all with atypical CM insertion; the tumors were large in 83% of these cases (5/6) and had a villous surface in 83% (5/6); in five of these six patients, the embolic event was the first clinical manifestation of CM, and the tumor was large in four of these five cases.

There was evidence or clinical suspicion of arrhythmias in six patients (15%) (included in the group with hemodynamic symptoms), five of whom were aged over 70. Three patients had atrial fibrillation (paroxysmal in one and sustained in two, being considered chronic – over a year’s duration – in one of the latter), all with CM-related valve disease; there was a strong suspicion in three other patients (not documented electrocardiographically) of recurrent salvos of paroxysmal tachyarrhythmia, possibly atrial. In a third of these cases (2 patients), the arrhythmic manifestations were the only symptoms of CM. The atrial electrogram revealed abnormalities (intra-atrial block) in only two of the five patients with baseline sinus rhythm. The CM was inserted in the IAS in four patients and in or near the mitral annulus in the other two.

**CM-related valve disease**

There was evidence of CM-related MV disease in 20% of cases (8 patients, with a mean age of 63 years but a wide range): five due to trauma caused by a mobile CM protruding through the MV into the left ventricle in diastole (Figures 3 and 4), probably weakening the valve itself or the mitral annulus; two, with a CM in or near the mitral annulus, due to deformation of the mitral annulus caused by the drag exerted by the tumor; and one, with CM insertion in the posterior papillary muscle of the MV (mobile and partially obstructing the left ventricular outflow tract during systole), due to deformation of the valve apparatus in systole. All had mitral regurgitation, which was moderate or severe, with...
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Figure 4  Sequence (left to right) of transesophageal echocardiographic video images showing diastolic motion of a very large villous myxoma, protruding into the left ventricle through the mitral valve, causing structural and functional changes to the valve resulting in mild mitral regurgitation.

indication for surgery, in five patients (63% of those with MV dysfunction and 13% of the total study population), and two patients had chordal rupture of the anterior leaflet, representing 5% of cases in our series and 1.6% of all patients with normal coronary arteries operated for chordal rupture of the mitral apparatus during the study period.

Significant comorbidities

There were significant comorbidities in 69% of patients operated, including type 2 diabetes in 31%, chronic renal failure (mild or moderate) in 18% and coronary artery disease in 10%. In one case CM was associated with papillary fibroelastomas, in a 64-year-old woman with a history of chronic pulmonary microthromboembolism admitted for embolic stroke, and diagnosed as paradoxical embolism due to patent foramen ovale, in whom transthoracic echocardiography showed an asymptomatic pedunculated CM, measuring 4 cm \(\times\) 4 cm, inserted in the LA posterior wall, and intraoperative transesophageal echocardiography revealed two small (<1 cm maximum diameter), asymptomatic, papillary fibroelastomas of the left coronary and non-coronary cusps of the aortic valve. The prevalence of hypertension in this population was 60%.

Surgical procedures

Simple excision of the tumor was performed in 74% of patients with atrial CM, while septoplasty or atrioplasty was performed in the other 26%, together with extensive resection of the insertion site (not because of the surgeon’s preference but for technical reasons in cases of sessile or wide-stalked CMs and tumors that were difficult to access). In the case of the CM inserted in the posterior papillary muscle of the MV, tumor excision was accompanied by resection of the papillary muscle. CM excision was combined with other procedures in 28% of cases, including MV surgery in six patients (valve replacement in three, two mechanical and one biological prosthesis, mitral valvuloplasty in two, and mitral commissurotomy in one patient with a history of rheumatic mitral disease), myocardial revascularization in three, foramen ovale closure in four, and aortic valve surgery in two (valve replacement in one case of severe aortic stenosis and asymptomatic CM, and leaflet shaving in the patient with associated papillary fibroelastomas). There were significant postoperative complications in 38% of cases, and overall postoperative mortality was 7.7% (2.6% at 30 days). Nine patients (28%) had arrhythmias in the postoperative period; the incidence of atrial fibrillation was twice as high in patients with CM excision associated with valve surgery compared to those undergoing simple tumor resection (38% vs. 19%), while the combination of septoplasty or atrioplasty with extensive resection of the CM insertion site did not appear to increase the risk of arrhythmias (1/7 patients with postoperative atrial fibrillation).

Overall in-hospital mortality was 10% (four patients, including the inoperable case). Causes of death were: (a) extensive embolic stroke (inoperable patient); (b) staphylococcal sepsis (on the 11th postoperative day in a 63-year-old diabetic patient); (c) multiple organ failure (on the 40th postoperative day, following sepsis complicating acute liver and renal failure in a 66-year-old patient with chronic alcoholic liver disease); and (d) multiple organ failure (on the 89th postoperative day following a series of major complications – sepsis with aortic valve bacterial endocarditis, ischemic stroke and nosocomial pneumonia – in a 75-year-old patient).

Follow-up

Mean follow-up was 30 ± 24 months in survivors discharged from hospital (36 patients), with 44% followed for >2 years. There were no recurrences of CM or suspected cases of familial CM. Late mortality was 5.6% (two patients): one patient died 13 months after surgery following worsening neurological sequelae of a major preoperative stroke; and a kidney transplant patient died three months after undergoing combined surgery (CM resection, aortic valve replacement and myocardial revascularization) as a result of MRSA sepsis. No other cardiovascular events were recorded, with the exception of recurrent atrial fibrillation in the patient who presented with transient sustained atrial tachyarrhythmia.

Histological data

The histological characteristics observed in this series of 40 patients were those usually described for this entity: elongated spindle, stellate, and polygonal mesenchymal cells in a myxoid stroma (Figure 5). Myxoma cells contain...
Figure 5 Usual histopathological characteristics: round, spindle and stellate cells in a soft, edematous myxoid stroma. The cells are concentrated around a few vessels. Presence of mild inflammatory infiltrate (H&E stain).

only a moderate amount of eosinophilic cytoplasm, with oval, round or elongated nuclei, and typically mitosis is rare. Cellularity is variable, with isolated cells in small clusters, cords or rings, the latter frequently surrounding vessels, in single or multiple layers. The most common patterns observed in our population were perivascular or small clusters. There was one case of epithelioid glandular structures, and another resembling multinucleated giant cells, but these may have been cell clusters.

In addition to CM cells, macrophages, lymphocytes, plasmocytes, polymorphonuclear leukocytes, dendritic cells and mast cells are frequently observed in varying numbers, as well as fibroblasts, myofibroblasts and smooth muscle cells. In our series, the inflammatory infiltrate was predominantly lymphocytic/plasmocytic, together with neutrophils in 13 and eosinophils in four patients; inflammation was moderate to severe in 16 cases (40%) and mild or absent in the remainder.

The myxoid stroma is positive for Alcian blue as it contains acid mucin and can include varying amounts of collagen and elastin. There is generally abundant vascularization, and the vessels may lack pericytes or be cavernous. It is common to find extravasation of erythrocytes, hemorrhagic foci (recent or organized), hemosiderin deposits (extra- and intracellular), Gamma-Gandy bodies and cystic areas. In our study population, there was moderate to severe bleeding in 30 cases (75%, extensive in 32.5% of tumors), and mild or no bleeding in the remainder. Two cases had extramedullary hematopoiesis; there were calcifications in four patients and ossification in two.

The tumors are usually covered with a single layer of flat cells, but the outer layer may be stratified with small buds. Thrombi are frequently found adhering to the tumor surface. In our series, an at least partly papillary or villous surface (Figure 6) was observed in 14 cases (35%).

Clinicopathological correlation

There was a significant correlation between embolic complications and a papillary or villous tumor surface (p<0.05), but no association between such complications and CM size, presence and extent of bleeding or inflammatory infiltrate. There was a significant association between...
constitutional symptoms and tumor size (p < 0.05), but not
between these and extent of inflammatory infiltrate.

Extensive bleeding may be the consequence of chronic trauma
caused by the tumor, particularly since 45% of cases
had extremely mobile CMs, protruding into the underlying
ventricular chamber in diastole through an atrioventricu-
lar valve. With a repetitive motion, particularly in the case
of a solid tumor, which on transesophageal echocardiog-
raphy resembles a pilarider, the mass strikes the valve
apparatus, which can cause two-way trauma (the tumor
against the valve and the valve annulus against the tumor).
Nevertheless, no association was found between exten-
sive bleeding and highly mobile atrial CMs protruding into
the ventricle: extensive bleeding was present in only 26%
of such tumors, as opposed to 47% of cases with com-
pletely or relatively immobile CMs (sessile or with short,
wide stalks). Furthermore, extensive bleeding did not occur
more frequently in CMs with a friable (29%) or gelatinous
(18%) appearance. The lack of correlation between major or
extensive bleeding and particular clinical or morphological
characteristics is in fact to be expected since these tumors
have a tendency to bleed due to their high proportion of
angioblasts.6

Discussion

Extrapolating our results to calculate the apparent overall
incidence of CM in Portugal suggests that it has been
greatly underestimated in the past, since there are no new
etiopathogenetic or epidemiological factors that would
lead to a real increase in incidence. Although not impossi-
ble, it is unlikely that the referral rate to our department
increased progressively over the study period, and analy-
sis of the provenance of our CM patients did not reveal
any difference in geographical distribution compared to
patients with coronary or valve disease referred for surgery
to our coronary in the same period. On the other hand,
in parallel with the sharp rise in the annual incidence of
CM in the last two years of the study period there was
also a significant increase in the prevalence of asymp-
tomatic CM. This clearly points to an increase in the number
of cases diagnosed, mainly asymptomatic individuals, in
whom use of cardiac imaging techniques for whatever rea-
son revealed the unexpected finding of an intracardiac
mass. These results are not surprising given that gen-
eral practitioners have increasingly referred patients for
echocardiography in recent years. We therefore believe
that health centers’ relatively easy access to echocardiog-
raphy and its extensive and repeated use, particularly in
hypertensive, diabetic and elderly patients, is the main
reason for the increased number of cases of CM diag-
nosed in recent years. The high prevalence of hypertension
and diabetes in our series and the fact that over half of
patients were over 65 years old tend to support this hypothe-
sis.

We suspect that the clinical course of most undiagnosed
CMs in the past would have been as follows: constitutional
symptoms would have appeared and were not given due
weight and/or hemodynamic/obstructive symptoms were
mistakenly interpreted to be the result of comorbidities,
particularly in elderly individuals, which progressed until
they caused a cardiovascular event (embolic or otherwise)
that was either terminal or presaged a probably fatal recur-
rence. This would be particularly true of elderly patients in
whom, given the overall clinical picture, the cardiovascu-
lar event would not be thoroughly investigated, particularly
in terms of imaging studies (for example, stroke would
not prompt echocardiographic assessment as frequently as
it does today) and the presence of an intracardiac mass
would not be detected or, if it were, the finding would
not necessarily lead to further investigation and refer-
ral for surgery. CM was only sporadically diagnosed on
autopsy.

The increase in the number of cases of asymptomatic
CM over the study period, becoming the most common
form in its last two years, is in stark contrast to the data
found in the literature.2–6 The fact that around half of the
patients in our series were asymptomatic points to gener-
ally earlier diagnosis. As our study shows, early diagnosis
of CM results in a markedly lower number of cases associ-
ated with embolic events, as well as a significant reduction
in the prevalence of constitutional symptoms, as the lat-
ter are caused by the production of cytokines, especially
interleukin-6, by CM cells,1,6 and clearly indicate the pres-
ence of a large longstanding CM. However, if early diagnosis
is used to refer to CMs of recent evolution and hence of rela-
tively small size, the number of asymptomatic cases meeting
this criterion in our series was small, only seven patients
(18%).

CMs are diagnosed with increasing frequency in elderly
patients; the reported predominance of female patients dis-
appears after the age of 65, which may well have a genetic
basis, possibly a specific braking mechanism of CM precursor
cells in men, which no longer functions at advanced ages.

CM-related MV disease, only occasionally mentioned in
the literature,14 was unexpectedly common in our series,
requiring valve surgery together with CM resection in over
10% of cases. Advanced age and concomitant calcific MV
disease do not explain this and it is likely that the cause lies
in fragility of the MV or annulus; ethnicity may be a factor.

Our series included one case, described above, of CM
associated with multiple papillary fibroelastomas of the aor-
tic valve. The association of heterogeneous cardiac tumors
is extremely rare; all cases have been of CM with papillary
fibroelastoma.15 To the best of our knowledge, this is the
sixth reported case.15–18

Documented or suspected tachyarrhythmias in patients
with CM is not a common clinical finding in the preoper-
ative phase. Most involve elderly patients and those with
associated mitral disease.

Typical CM insertion in the left atrial side of the fossa
ovalis was far less common in our series than expected
(onlty around half of cases), insertion outside the IAS being
observed in 30% of patients. The reason for this is unclear.

The diagnosis is usually confirmed histologically after
total surgical excision of the tumor. Differential diagno-
sis can include various entities,15 but focuses mainly on
distinguishing between CM and thrombus, the latter being
characterized by local fibrin deposition and the absence
of myxoma cells. Other conditions that may be confused
with CM include: myxoid sarcoma, which presents pleo-
morphic spindle cells, abundant mitosis and absence of
hemosiderophages; papillary fibroelastoma (on valves, with
vascular papillae covered by endothelium); calcified amorphous tumor (CAT), with extensive calcification and absence of myxoma cells; mesothelial/monocytic incidental cardiac excrecence (MICE), with no myxoid stroma, in patients with a history of cardiac intervention; fibroma (typically located in the ventricle, with abundant collagenous stroma); intracavitary hemangiomia (characterized by absence of myxoid stroma and a lobular arrangement of vessels, surrounded by pericytes positive for actin); and metastatic carcinoma (which can mimic a rare form of CM rich in glandular structures). Immunohistochemical study can also provide useful information for differential diagnosis: CM cells are positive for calretinin in 75–100% of cases, but have variable positivity for vimentin, alpha-1-antichymotrypsin, alpha-1-antitrypsin, S100 protein, smooth muscle actin, desmin, synaptophysin, NSE and endothelial markers; only epithelioloid structures (corresponding to heterologous elements) may be positive for epithelial markers (AE1/AE3, CAM5.2, CK34βE12, CK7, CK20, EMA and CEA).13

Postoperative prognosis is highly variable, depending mainly on the patient’s age, presence of significant comorbidities (in over two-thirds of our patients), preoperative critical status and need to combine additional surgical procedures with CM resection (the case in 30% of our patients). Our population was made up of high-risk patients, reflected in overall postoperative mortality of around 8%, the result of noncardiovascular complications in all cases. The overall prevalence of postoperative atrial tachyarrhythmias in our series was no higher (around 30%) than that reported for isolated coronary surgery in patients of the same age-group; unexpectedly, the combination of septoplasty or atrioplasty with extensive resection of the CM insertion site did not increase the risk of atrial arrhythmias.

Beyond the postoperative period, the medium- to long-term prognosis (in a mean follow-up of 30 months) was good for survivors without serious chronic comorbidities, with no CM recurrences.

Based on all that has been said above, it seems clear that at the time of diagnosis and the predominance of female patients observed in younger individuals disappears in this age-group. Most CMs are now asymptomatic at presentation (a finding on imaging studies), as a result of earlier diagnosis. The classic constitutional symptoms exhibited by patients with large longstanding CMs are now much less frequent.

CM-related MV disease is not uncommon and requires surgical correction together with tumor excision in more than 10% of cases. Postoperative prognosis is strongly influenced by comorbidities and age, with significant postoperative mortality (around 8% in our series).

Conflict of interest
The authors have no conflicts of interest to declare.

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