Papillary Fibroelastomas of the Heart

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Abstract

Cardiac papillary fibroelastomas (CPFs), the second most common primary cardiac tumor, are benign endocardial papillomas predominantly affecting the cardiac valves. Although CPFs are rare and benign tumors, they may result in life-threatening complications. Early diagnosis of this condition is important, since it represents a surgically correctable cause of systemic embolism, myocardial infarction, stroke, acute valve dysfunction, and sudden cardiac death. This review summarizes the significance and clinical approach for the diagnosis of this cardiac entity. The differential diagnosis, histological characteristics of CPF and current treatment strategies are also discussed.

Introduction

Primary cardiac tumors are extremely rare [1]. The frequency of primary cardiac tumors is approximately 0.02%, corresponding to 200 tumors in 1 million autopsies [1,2]. In another series of over 12 000 autopsies, only seven were identified, giving an incidence of less than 0.1% [3]. By comparison, metastatic involvement of the heart is over 20 times more common, and has been reported in autopsy series in up to one in five patients dying of cancer [4].

Cardiac papillary fibroelastomas (CPFs) are benign endocardial papillomas. They are the second most common primary cardiac tumor, but the most common cardiac valve tumor and account for 7.9% of benign primary cardiac tumors [5]. Most CPFs are found incidentally at the time of echocardiography, cardiac catheterization, cardiac surgery, or autopsy [5]. However, the increasing use of echocardiography, and recognition of CPF's echocardiographic features has resulted in a more frequent diagnosis of cardiac papillary fibroelastomas [6,7]. Furthermore, the growing clinical use of cardiac computed tomography (CT) and magnetic resonance imaging (MRI) may lead to an increasing discovery of this tumor entity. Although CPFs occur in all age groups, from the neonate period to the 10th decade of life, they clearly predominate in adults and are particularly frequent between the 4th and 8th decades of life. CPFs are more common in males in most case series. They are generally slow growing tumors but may serve as a nidus, allowing formation of large superimposed thrombi over a short period of time and, therefore, may result in life-threatening complications [8]. Although the CPF is a morphologically distinctive cardiac lesion, its histogenesis remains controversial.

Clinical significance of cardiac papillary fibroelastomas

Although CPFs are rare and histologically benign tumors, they may result in life-threatening complications, i.e., stroke, embolism, and sudden death. Clinically, CPFs present with transient ischemic attack, stroke, myocardial infarction, heart failure, presyncope, syncope, arrhythmias, sudden death, pulmonary embolism, blindness, and peripheral embolism [7,9–11]. The most common clinical presentations are by embolism to the cerebral, systemic or coronary arterial circulations, followed by heart failure and sudden death [7,9–11]. Furthermore, these papillary growths may also obstruct an aortic ostium of a coronary artery, leading to angina pectoris, acute myocardial infarction, and sudden death [12,13]. Clinical symptoms differ depending on the location of the tumor. In patients with aortic valve tumors, sudden death and myocardial infarction were the two most common presentations,

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whereas in patients with mitral valve tumor, stroke was the most common clinical presentation.

Cardiac papillary fibroelastomas are firmly attached to the valvular or mural endocardium and dislodgement of a CPF, therefore, would appear unlikely. Pathologic studies have only rarely found evidence of a fibroelastoma at the site of the arterial occlusion, leading many experts to believe that the true source of the embolization are fibrin strands or thrombin that form on the surface of the tumor [14]. However, embolization may occur from the fragile papillary fronds of the tumor itself or from a thrombus formed on the tumor. Depending on their size and mobility, atrioventricular valve CPFs can cause obstruction to filling of the left or right ventricle resulting in recurrent pulmonary edema and right-heart failure. These features can mimic the clinical picture of mitral or tricuspid valve stenosis [15]. Furthermore, conduction system disturbances and complete atrioventricular conduction block have also been reported [16].

Clinical diagnosis

The majority of patients with CPF are asymptomatic, and the majority of CPF cases have been discovered while patients were being examined for an unrelated problem. Fibroelastoma typically has no clinical findings on physical examination or laboratory workup, whereas the detection of papillary fibroelastomas has increased with the use of echocardiography, CT, and MRI.

Transthoracic echocardiography is a useful tool for the initial evaluation of suspected CPF, but transesophageal echocardiography is frequently required for a more comprehensive and accurate assessment, in order to pinpoint the localization to adjacent structures. With the advent of echocardiography, an *in vivo* diagnosis has become more frequent, since only masses measuring less than 2 mm cannot be clearly visualized, with a sensitivity decreasing from 89 % to 77 % [6]. Echocardiography usually demonstrates a small, mobile, pedunculated or sessile valvular or endocardial mass, which on many occasions flutters or prolapses into the cardiac chambers during systole or diastole. Echodensity of the tumor's central collagen core strongly supports the diagnosis and allows it to be differentiated from other intracardiac tumors, vegetations, or mural thrombi [6]. In contrast to the typical heterogeneous echocardiographic appearance of myxoma, fibroelastoma usually appears as a homogeneous tumor. Although the typical location of fibroelastoma is on the atrial surface of the atrioventricular valves and aortic surface of the semilunar valves, it may be found on any endocardial surface [6]. Fibroelastomas are usually located on the left-sided valves [6,14], and the majority are less than 1 cm in diameter [6,17]. Transesophageal echocardiographic examination is the best diagnostic tool for papillary fibroelastomas. However, it does not reliably reveal multiple lesions.

Since the introduction of multi-slice scanners, CT has become the equal of echocardiography in its depiction of small moving structures [18]. Furthermore, the growing clinical use of cardiac CT may increasingly uncover CPFs in the near future. MRI offers soft-tissue characterization and evaluation of valvular function. After administration of extracellular contrast media, CPFs display no enhancement in the early perfusion phase, but an intense enhancement in the delayed phase. This pattern of delayed enhancement is caused by the content of collagen in fibromas similar to scar tissue after myocardial infarction. Contrast-enhanced MRI offers thus a differentiation between tumor and thrombus. Cine-MRI allows an assessment of myocardial and valvular function comparable with echocardiography. However, the major disadvantage of MRI is the reduced spatial resolution compared with CT and echocardiography.

Electrocardiographic findings are nonspecific, but occasionally patients may have atrial arrhythmias. Invasive cardiac catheterization and selective angiography is usually not necessary in most patients with CPF, especially since it is associated with an added risk to patients because the catheter may dislodge a fragment of the tumor or adherent thrombi, resulting in embolism.

Differential diagnosis

Differential diagnosis of CPF primarily includes other heart tumors, thrombi, vegetations, valvular calcification, semilunar valves strands, and Lambl's excrescences. Myxomas are the most common primary cardiac neoplasm. Approximately 80 % of myxomas originate in the left atrium, and most of the remainder are found in the right atrium [19 – 22]. Rarely, myxomas originate from valvular locations. Myxomas vary widely in size, ranging from 1 to 15 cm in diameter, and weigh between 15 and 180 g [23]. Histologically, myxomas differ from CPFs by the composition of scattered cells within a mucopolysaccharide stroma and blood vessels within papillae [24]. The cells originate from a multipotent mesenchyme that is capable of neural and endothelial differentiation [25]. Cardiac fibromas are benign tumors of fibroblastic origin, which in contrast to rhabdomyomas do not spontaneously regress. Fibromas are usually reported as solitary intramural tumors involving the ventricular septum or left ventricular free wall over the apex. They can be variable in size and may have a focal calcification and occasionally cystic degeneration [26,27]. Cardiac rhabdomyomas are predominantly myocardial neoplasms seen in infants and children [28]. Echocardiographic features of cardiac thrombi differentiating them from CPFs include a laminated appearance, an irregular or lobulated border, microcavitations, and absence of a pedicle. Another lesion that needs to be differentiated from CPF is valvular vegetation. The valvular location and mobility of the infective vegetations can be similar to that of a CPF. However, these vegetations are usually associated with clinical signs of endocarditis and valvular destruction, and may resolve or change in appearance over time with treatment [29]. Mitral annular calcification, one of the most common echocardiographic findings in elderly patients, should be easily differentiated from a CPF, based on its characteristic location and calcification [30]. CPFs can be distinguished from Lambl's excrescences by their composition, size, and location. They are larger and more gelatinous than Lambl's excrescences, and are present on valves, away from the valvular lines of closure, and also on the endocardial surfaces of the atria or ventricles.

Histology

CPFs are small, avascular papillomas, which can arise from virtually any endocardial surface, but they most often originate from the valvular endocardium [24,31,32]. These benign CPF lesions are derived from normal components of the endocardium (fibrous tissue, elastic fibers, and smooth muscle cells) [5]. On histological examination, the fibroelastoma consists of multiple papillary villus fronds radiating from a central stalk [17]. Each frond contains 3 zones and has a characteristic microscopic appearance [17]. They contain a dense, central core of collagen and elastic tissue; a peripheral, myxomatous layer with deposits of acid mucopolysaccharides; and an overlying, hyperplastic layer of endothelial cells [33]. On gross pathologic examination, CPFs resemble a sea anemone, especially when placed in saline [5,6].

Although the CPF is a morphologically distinctive cardiac lesion, its histogenesis remains controversial. Reaction to mechanical trauma, neoplasms, hamartomas or inflammatory nodules have all been considered [24,34]. Furthermore, a fair number of authors believe the lesion to be a reactive phenomenon resulting from persistent valvular endothelial trauma, which ultimately results in Lambl's excrescences [33,35]. Both CPFs and Lambl's excrescences have been shown to contain fibrin and hyaluronic acid, and appear to be present along the valve edge along degeneration planes [36]. However, there are several investigators who disagree with this hypothesis.

Distribution in the heart

The majority of tumors are around 10 mm at their greatest diameter, but tumors as large as 70 mm have been reported [37]. The gross appearance of a characteristic papillary structure may be obscured by attached organizing thrombi [24]. CPFs usually develop on the cardiac valves, but since CPFs are an endocavitary neoplasm, they may arise everywhere from the heart's endocardium. Valvular CPFs may arise from the free edge of the valve, but more commonly they arise from the mid portion of the valve. More than 95% arise in the left heart.

CPFs have been reported to originate from a variety of locations within the heart including the left ventricle [38–40], the ostium of the right coronary artery [41–44], the ostium of the left coronary artery [45,46], the left atrial appendage [37,47], atrial septum [48,49], ventricular septum [7,50,51], right atrium [52,53], right ventricle [54], left ventricular outflow tract [55], Eustachian valve and Chiari network [56,57], the right atrial appendage [58], and right ventricular outflow tract [59]. Recently, Kondo and Tobe described a case of papillary fibroelastoma of the pulmonary artery filling the space over the pulmonary valve [60]. However, a clear differentiation of CPF originating from the coronary ostia and/or the pulmonary artery or arising from the semilunar valves is difficult in some cases.

The majority of CPFs are valvular. In the Armed Forces Institute of Pathology series, only 13% (4/45) were nonvalvular [61]. A comprehensive analysis of 661 patients with CPF revealed that in 44% of cases the tumor was located on the aortic valve, followed by the mitral valve in 35%, the tricuspid valve in 15%, and the pulmonary valve in 8% [62]. In this analysis, the left ventricle was the predominant nonvalvular site of tumor origin in 9%. The other sites involved were the left atrium (1.6%), left atrial appendage (0.3%), atrial septum (1.3%), right atrium (2.0%), right atrial appendage (0.2%), Eustachian valve (0.3%), and right ventricle (1.5%). In 5.8% of patients, multiple tumors in 1 or multiple locations were found. One patient had 8 tumors at various locations in the heart.

CPFs are usually solitary, but can rarely be multiple, involving the same or separate valves or both the left and the right cavities [63]. In most cases, multiple tumor sites were intraventricular or involved separate cardiac leaflets [6]. Recently, we described the coincidence of aortic valve stenosis and regurgitation after prior endocarditis and multiple papillary fibroelastomas in a young male adult [64]. Careful intraoperative inspection revealed multiple gelatin-like tumors toward the aortic valve in the left ventricular outflow tract and the mitral valve apparatus. The true incidence of multiple papillary fibroelastomas may be underestimated, since the diagnosis may be missed on transesophageal echocardiography [65]. In many cases, a second lesion is detected upon surgical inspection [66,67]. Therefore, the entire heart should be assessed as thoroughly as possible during surgery.

Therapy

While some recommend surgery for all patients because of the risk of embolization and associated morbidity [11,31,68–70], others have suggested that careful observation is an acceptable option for asymptomatic patients, as long as the tumor remains small and nonmobile [6].

Twenty-five patients, who did not have surgery but for whom an adverse outcome was reported, were used to determine the independent predictors of adverse outcome (death, non-fatal embolization). Using univariate analysis – including age, sex, tumor location, tumor size, and tumor mobility – aortic valve location and tumor mobility were predictors of CPF-related death or non-fatal embolization. In these patients, tumor mobility was the only independent predictor of death or non-fatal embolization [62].

Therefore, surgery seems to be indicated for patients who have had embolic events, complications which are directly related to tumor mobility (i.e., coronary ostial occlusion), and those with highly mobile or large (≥ 1 cm) tumors [6,62]. However, none of these recommendations are based on data collected from a prospective series because no such data have been reported, and furthermore, there is evidence to suggest that the mechanism of thromboembolism results from a combination of tumor embolization and thrombi formation on the tumor [71], so that a significant change in tumor size can occur over a short interval [8].

When a surgical approach is chosen, surgical excision of the tumor *in toto* including its basis (e.g., atrial septal tissue) can be performed. Surgical excision of a CPF is curative, and in most cases, the tumors can be easily removed because they are pedunculated [31,70,72,73]. The root of the pedicle and the full thickness of the endocardium is excised, and any resulting defects are closed by direct suturing or, if they are too large, with a pericardial or Dacron patch. Furthermore, shaving the tumor from the leaflet is an acceptable surgical approach resulting in a virtually curative procedure. A recently published retrospective study describing the treatment and outcome of patients with CPF demonstrated an 83% rate of shave excision without the need for valvular repair or replacement [74].

However, in addition to shaving the tumor from the leaflet or surgical excision of the tumor, some patients require valve repair or even valve replacement. One may argue that valve replacement is necessary in general due to the worry about thrombus formation at the base of the excised CPF and to ensure that potential regrowth of the CPF is no longer possible. However, CPF recurrence at the site of a previously excised CPF has not been reported [74].

Anticoagulation has been proposed, on the theory that the tumor itself does not embolize, but rather thrombin forming on the surface of the tumor embolizes, leading to the clinical sequelae [14]. Ngaage et al. [74] found no difference in the incidence of thromboembolism between aortic and mitral cardiac papillary fibroelastomas, but rather an equivalent risk of thromboembolism for left-sided valvular tumors (aortic 43%; mitral 43%) and a low risk for nonvalvular tumors (left ventricular outflow tract 6%; all heart chambers 0%). Right heart CPFs are rare and treatment is controversial [75]. Therefore, symptomatic patients who are not candidates for surgical therapy could be treated with long-term oral anticoagulation, although no randomized control data are available on its efficacy [76,77].

Anticoagulation after surgery is not universally recommended [47]. Our above-mentioned patient with multiple cardiac papil-

lary fibroelastomas and the impossibility of resection of the entire intraoperative tumor mass was discharged under oral anticoagulation (phenprocoumon) and had an uneventful postoperative course, in particular without any embolization within the one-year follow-up period [64]. The longest postoperative follow-up of a completely excised CPF is 11 years. No recurrence of cardiac papillary fibroelastomas from the same origin was reported during this period of time. However, the growth of fibroelastomas at new locations after prior successful complete excision of fibroelastomas at different locations in the same patient has been reported.

References

1 *Reynen K.* Frequency of primary tumors of the heart. Am J Cardiol 1996; 77: 107
2 *Goldberg HP, Glenn F, Dotter CT, Steinberg I.* Myxoma of the left atrium; diagnosis made during life with operative and post-mortem findings. Circulation 1952; 6: 762 – 767
3 *Lam KY, Dickens P, Chan AC.* Tumors of the heart. A 20-year experience with a review of 12 485 consecutive autopsies. Arch Pathol Lab Med 1993; 117: 1027 – 1031
4 *Silvestri F, Bussani R, Pavletic N, Mannone T.* Metastases of the heart and pericardium. G Ital Cardiol 1997; 27: 1252 – 1255
5 *Edwards FH, Hale D, Cohen A, Thompson L, Pezzella AT, Virmani R.* Primary cardiac valve tumors. Ann Thorac Surg 1991; 52: 1127 – 1131
6 *Sun JP, Asher CR, Yang XS et al.* Clinical and echocardiographic characteristics of papillary fibroelastomas: a retrospective and prospective study in 162 patients. Circulation 2001; 103: 2687 – 2693
7 *Klarich KW, Enriquez-Sarano M, Gura GM, Edwards WD, Tajik AJ, Seward JB.* Papillary fibroelastoma: echocardiographic characteristics for diagnosis and pathologic correlation. J Am Coll Cardiol 1997; 30: 784 – 790
8 *Joffe II, Jacobs LE, Owen AN, Ioli A, Kotler MN.* Rapid development of a papillary fibroelastoma with associated thrombus: the role of transthoracic and transesophageal echocardiography. Echocardiography 1997; 14: 287 – 292
9 *Fitzgerald D, Gaffney P, Dervan P, Doyle CT, Horgan J, Nelligan M.* Giant Lambl's excrescence presenting as a peripheral embolus. Chest 1982; 81: 516 – 517
10 *Grinda JM, Latremouille C, Berrebi A et al.* [Cardiac fibroelastoma. Six operated cases and review of the literature]. Arch Mal Coeur Vaiss 2000; 93: 727 – 732
11 *Ni Y, von Segesser LK, Dirsch O, Schneider J, Jenni R, Turina M.* Cardiac papillary fibroelastoma. Thorac Cardiovasc Surg 1996; 44: 257 – 260
12 *Boone S, Higginson LA, Walley VM.* Endothelial papillary fibroelastomas arising in and around the aortic sinus, filling the ostium of the right coronary artery. Arch Pathol Lab Med 1992; 116: 135 – 137
13 *Mazzucco A, Bortolotti U, Thiene G et al.* Left ventricular papillary fibroelastoma with coronary embolization. Eur J Cardiothorac Surg 1989; 3: 471 – 473
14 *Roberts WC.* Papillary fibroelastomas of the heart. Am J Cardiol 1997; 80: 973 – 975
15 *Thomas MR, Jayakrishnan AG, Desai J, Monaghan MJ, Jewitt DE.* Transesophageal echocardiography in the detection and surgical management of a papillary fibroelastoma of the mitral valve causing partial mitral valve obstruction. J Am Soc Echocardiogr 1993; 6: 83 – 86
16 *Kawada M, Oda K, Hirose K, Fukutomi T, Yamashiro T, Ogoshi S.* [A case report of surgical treatment for left ventricular papillary fibroelastoma]. Nippon Kyobu Geka Gakkai Zasshi 1996; 44: 1159 – 1162
17 *al-Mohammad A, Pambakian H, Young C.* Fibroelastoma: case report and review of the literature. Heart 1998; 79: 301 – 304
18 *Lembcke A, Meyer R, Kivelitz D et al.* Images in cardiovascular medicine. Papillary fibroelastoma of the aortic valve: appearance in 64-slice spiral computed tomography, magnetic resonance imaging, and echocardiography. Circulation 2007; 115: e3 – e6
19 *Vander Salm TJ.* Unusual primary tumors of the heart. Semin Thorac Cardiovasc Surg 2000; 12: 89 – 100
20 *Kuon E, Kreplin M, Weiss W, Dahm JB.* The challenge presented by right atrial myxoma. Herz 2004; 29: 702 – 709
21 *Keeling IM, Oberwalder P, Anelli-Monti M et al.* Cardiac myxomas: 24 years of experience in 49 patients. Eur J Cardiothorac Surg 2002; 22: 971 – 977
22 *Jelic J, Milicic D, Alfirevic I et al.* Cardiac myxoma: diagnostic approach, surgical treatment and follow-up. A twenty years experience. J Cardiovasc Surg 1996; 37: 113 – 117
23 *Pinede L, Duhaut P, Loire R.* Clinical presentation of left atrial cardiac myxoma. A series of 112 consecutive cases. Medicine 2001; 80: 159 – 172
24 *Burke A, Virmani R.* Papillary fibroelastoma: tumors of the heart and great vessels. AFIP Atlas of Tumor Pathology 1996; 16: 47 – 54
25 *Pucci A, Gagliardotto P, Zanini C, Pansini S, di Summa M, Mollo F.* Histopathologic and clinical characterization of cardiac myxoma: review of 53 cases from a single institution. Am Heart J 2000; 140: 134 – 138
26 *Burke AP, Rosado-de-Christenson M, Templeton PA, Virmani R.* Cardiac fibroma: clinicopathologic correlates and surgical treatment. J Thorac Cardiovasc Surg 1994; 108: 862 – 870
27 *Cho JM, Danielson GK, Puga FJ et al.* Surgical resection of ventricular cardiac fibromas: early and late results. Ann Thorac Surg 2003; 76: 1929 – 1934
28 *Oostenbrug LE, Ottervanger JP, Dompeling EC, Sie TH, Beukema WP.* A bleeding disorder caused by a cardiac tumor: case report. Neth J Med 2001; 58: 232 – 235
29 *Madu E, Myles J, Fraker TD Jr.* Pseudopapillary fibroelastoma of the mitral valve. J Natl Med Assoc 1995; 87: 68 – 70
30 *Nair CK, Aronow WS, Sketch MH et al.* Clinical and echocardiographic characteristics of patients with mitral annular calcification. Comparison with age- and sex-matched control subjects. Am J Cardiol 1983; 51: 992 – 995
31 *Shahian DM, Labib SB, Chang G.* Cardiac papillary fibroelastoma. Ann Thorac Surg 1995; 59: 538 – 541
32 *Lichtenstein HL, Lee JC, Stewart S.* Papillary tumor of the heart: incidental finding at surgery. Human Pathology 1979; 10: 473 – 475
33 *Fishbein MC, Ferrans VJ, Roberts WC.* Endocardial papillary elastofibromas. Histologic, histochemical, and electron microscopical findings. Arch Pathol 1975; 99: 335 – 341
34 *Heath D, Best PV, Davis BT.* Papilliferous tumours of the heart valves. Br Heart J 1961; 23: 20 – 24
35 *Pomerance A.* Papillary "tumours" of the heart valves. J Pathol Bacteriol 1961; 81: 135 – 140
36 *Boone SA, Campagna M, Walley VM.* Lambl's excrescences and papillary fibroelastomas: are they different? Can J Cardiol 1992; 8: 372 – 376
37 *Tsukube T, Ataka K, Taniguchi T, Yokoyama M, Hanioka K.* Papillary fibroelastoma of the left atrial appendage: echocardiographic findings. Ann Thorac Surg 2000; 70: 1416 – 1417
38 *Cha SD, Incarvito J, Fernandez J, Chang KS, Maranhao V, Gooch AS.* Giant Lambl's excrescences of papillary muscle and aortic valve: echocardiographic, angiographic, and pathologic findings. Clin Cardiol 1981; 4: 51 – 54
39 *de Menezes IC, Fragata J, Martins FM.* Papillary fibroelastoma of the mitral valve in a 3-year-old child: case report. Pediatr Cardiol 1996; 17: 194 – 195
40 *Espada R, Talwalker NG, Wilcox G, Kleiman NS, Verani MS.* Visualization of ventricular fibroelastoma with a video-assisted thoracoscope. Ann Thorac Surg 1997; 63: 221 – 223
41 *Rona G, Feeney N, Kahn DS.* Fibroelastic hamartoma of the aortic valve producing ischemic heart disease. Associated pulmonary glomus bodies. Am J Cardiol 1963; 12: 869 – 874
42 *Gunter C, Jenni R.* [What is your diagnosis? Papillary fibroelastoma of the right coronary aortic sinus – embolism with 2 transient cerebral ischemia attacks]. Schweiz Rundsch Med Prax 1998; 87: 1009 – 1011
43 *Prahlow JA, Barnard JJ.* Sudden death due to obstruction of coronary artery ostium by aortic valve papillary fibroelastoma. Am J Forensic Med Pathol 1998; 19: 162 – 165
44 *Rieckmann C, Liebau G, Hellberg K, Seeliger H.* [Papillary fibroelastoma of the aortic valve: primary echocardiography diagnosis in an asymptomatic patient]. Z Kardiol 1990; 79: 208 – 210
45 *Pede S, Vergallo L, Pico C, Renna A, Faggiano C, Faggiano F.* [Papillomatosis of the mitral valve as an unusual cause of myocardial ischemia. Description of a case and review of the literature]. G Ital Cardiol 1988; 18: 76 – 79
46 *Bossert T, Diegeler A, Spyrantis N, Mohr FW.* Papillary fibroelastoma of the aortic valve with temporary occlusion of the left coronary ostium. J Heart Valve Dis 2000; 9: 842 – 843
47 *Howard RA, Aldea GS, Shapira OM, Kasznica JM, Davidoff R.* Papillary fibroelastoma: increasing recognition of a surgical disease. Ann Thorac Surg 1999; 68: 1881 – 1885

48 *Nakao T, Hollinger I, Attai L, Oka Y.* Incidental finding of papillary fibroelastoma on the atrial septum. Cardiovasc Surg 1994; 2: 423 – 424
49 *Watchell M, Heritage DW, Pastore L, Rhee J.* Cytogenetic study of cardiac papillary fibroelastoma. Cancer Genet Cytogenet 2000; 120: 174 – 175
50 *Schuetz WH, Welz A, Heymer B.* A symptomatic papillary fibroelastoma of the left ventricle removed with the aid of transesophageal echocardiography. Thorac Cardiovasc Surg 1993; 41: 258 – 260
51 *Lee KS, Topol EJ, Stewart WJ.* Atypical presentation of papillary fibroelastoma mimicking multiple vegetations in suspected subacute bacterial endocarditis. Am Heart J 1993; 125: 1443 – 1445
52 *Schiller AL, Schantz A.* Papillary endocardial excrescence of the right atrium: report of two cases. Am J Clin Pathol 1970; 53: 617 – 621
53 *Gallas MT, Reardon MJ, Reardon PR, DeFelice CA, Raizner AE, Mody DR.* Papillary fibroelastoma. A right atrial presentation. Tex Heart Inst J 1993; 20: 293 – 295
54 *Bapat VN, Varma GG, Hordikar AA, Sivaraman A, Agrawal NB, Tendolkar AG.* Right-ventricular fibroma presenting as tricuspid stenosis – a case report. Thorac Cardiovasc Surg 1996; 44: 152 – 154
55 *Uchida S, Obayashi N, Yamanari H, Matsubara K, Saito D, Haraoka S.* Papillary fibroelastoma in the left ventricular outflow tract. Heart Vessels 1992; 7: 164 – 167
56 *Wasdahl DA, Wasdahl WA, Edwards WD.* Fibroelastic papilloma arising in a Chiari network. Clin Cardiol 1992; 15: 45 – 47
57 *Shigemitsu O, Hadama T, Mori Y, Miyamoto S, Sako H, Uchida Y.* [Surgical treatment of right atrial papillary fibroelastoma, originated from the Eustachian valve – a case report]. Nippon Kyobu Geka Gakkai Zasshi 1995; 43: 403 – 406
58 *Schwinger ME, Katz E, Rotterdam H, Slater J, Weiss EC, Kronzon I.* Right atrial papillary fibroelastoma: diagnosis by transthoracic and transesophageal echocardiography and percutaneous transvenous biopsy. Am Heart J 1989; 118: 1047 – 1050
59 *Anderson KR, Fiddler GI, Lie JT.* Congenital papillary tumor of the tricuspid valve. An unusual cause of right ventricular outflow obstruction in a neonate with trisomy E. Mayo Clin Proc 1977; 52: 665 – 669
60 *Kondo T, Tobe S.* Images in clinical medicine. Papillary fibroelastoma of the pulmonary artery. N Engl J Med 2007; 356: e1
61 *McAllister HA Jr, Fengolio JJ Jr.* Tumors of the cardiovascular system. In: Rosai J, Sobin LH (eds). Atlas of Tumor Pathology. 2nd series. Washington DC: Armed Forces Institute of Pathology, 1978: 20 – 25
62 *Gowda RM, Khan IA, Nair CK, Mehta NJ, Vasavada BC, Sacchi TJ.* Cardiac papillary fibroelastoma: a comprehensive analysis of 725 cases. Am Heart J 2003; 146: 404 – 410
63 *Alawi A, Kassabian EB, Ashoush R, Jebara VA.* Aortic valve papillary fibroelastoma. Cardiovasc Surg 2002; 10: 65 – 67
64 *Sydow K, Schrepfer S, Franzen O et al.* Coincidence of aortic valve stenosis and regurgitation and multiple cardiac papillary fibroelastomas in a young male adult. J Thorac Cardiovasc Surg 2007; 133: 564 – 565
65 *Touati GD, Carmi D, Sevestre H, Poulain H.* Multiple aortic valve papillary fibroelastoma: do not miss the other one. Eur J Cardiothorac Surg 2002; 21: 596 – 597
66 *Kanarek SE, Wright P, Liu J et al.* Multiple fibroelastomas: a case report and review of the literature. J Am Soc Echocardiogr 2003; 16: 373 – 376
67 *Eslami-Varzaneh F, Brun EA, Sears-Rogan P.* An unusual case of multiple papillary fibroelastoma, review of literature. Cardiovasc Pathol 2003; 12: 170 – 173
68 *Giannesini C, Kubis N, N'Guyen A, Wassef M, Mikol J, Woimant F.* Cardiac papillary fibroelastoma: a rare cause of ischemic stroke in the young. Cerebrovasc Dis 1999; 9: 45 – 49
69 *Colucci V, Alberti A, Bonacina E, Gordini V.* Papillary fibroelastoma of the mitral valve. A rare cause of embolic events. Tex Heart Inst J 1995; 22: 327 – 331
70 *Grinda JM, Couetil JP, Chauvaud S et al.* Cardiac valve papillary fibroelastoma: surgical excision for revealed or potential embolization. J Thorac Cardiovasc Surg 1999; 117: 106 – 110
71 *Grandmougin D, Fayad G, Moukassa D et al.* Cardiac valve papillary fibroelastomas: clinical, histological and immunohistochemical studies and a physiopathogenic hypothesis. J Heart Valve Dis 2000; 9: 832 – 841
72 *Ragni T, Grande AM, Cappuccio G et al.* Embolizing fibroelastoma of the aortic valve. Cardiovasc Surg 1994; 2: 639 – 641
73 *Fiorilli R, Tomasco B, De Sanctis D, Tesler UF.* Aortic valve fibroelastoma: transesophageal echocardiographic diagnosis and surgical excision. G Ital Cardiol 1998; 28: 153 – 157
74 *Ngaage DL, Mullany CJ, Daly RC et al.* Surgical treatment of cardiac papillary fibroelastoma: a single center experience with eighty-eight patients. Ann Thorac Surg 2005; 80: 1712 – 1718
75 *Scalia D, Basso C, Rizzoli G et al.* Should right-sided fibroelastomas be operated upon? J Heart Valve Dis 1997; 6: 647 – 650
76 *Pinelli G, Carteaux JP, Mertes PM, Civit T, Trinh A, Villemot JP.* Mitral valve tumor revealed by stroke. J Heart Valve Dis 1995; 4: 199 – 201
77 *Sastre-Garriga J, Molina C, Montaner J et al.* Mitral papillary fibroelastoma as a cause of cardiogenic embolic stroke: report of two cases and review of the literature. Eur J Neurol 2000; 7: 449 – 453