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CASE REPORT

Pulmonary Embolism Following Incomplete Surgical Resection of a Right Ventricular Myxoma: A Case Report and Review of the Literature

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Abstract: Right ventricular (RV) myxomas are extremely rare, but may have dreadful clinical sequelae including pulmonary embolism (PE). We present a case of a patient who had an RV myxoma that was attached to the tricuspid valve, and therefore could not be resected completely during surgery, and remnants of the tumor were seen on transthoracic echocardiogram during post-operative follow-up. Five months after surgery, the patient had PE, which could be due to tumor emboli or thromboemboli. Since repeat surgical resection was not feasible, the patient was started on warfarin. The patient is doing well and has had no PE recurrence over the past 20 months of follow-up. We have complemented the current case report with a comprehensive literature search and review on RV myxomas associated with PE in order to shed light on this uncommon but potentially lethal disorder. We concluded that right-sided cardiac myxomas, including RV myxomas, should be considered while dealing with PE, particularly in young patients with no risk factors, and that follow-up with echocardiography after surgery is important due to the possibility of recurrence, especially if complete resection was difficult to perform.

Plain Language Summary: Plain language summary available for this article.

Keywords: Myxoma; Pulmonary embolism; Right ventricle; Right ventricular myxoma

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PLAIN LANGUAGE SUMMARY

Myxomas are a type of tumor that may occur inside heart chambers. Myxomas located in the right lower chamber of the heart (right ventricle) are very rare. However, such tumors may fragment and travel to the lung blood vessels.

The patient in our case had a myxoma in the right ventricle. The tumor was attached to a valve in the heart. Partial removal of the tumor was performed so as not to damage the valve. Imaging after surgery showed remaining parts of the tumor. Five months later, the patient had clots in the lung blood vessels (pulmonary embolism). The patient was treated with a blood thinner. He is doing well since then. We searched the medical literature for cases of myxomas in the right ventricle of the heart associated with pulmonary embolism. We present a review of these cases along with our case. We concluded that myxomas of the right ventricle of the heart may be considered as a cause of pulmonary embolism. This is particularly true in young patients who do not have risk factors for pulmonary embolism. Our review also shows that imaging after surgery is important because myxomas may recur.

INTRODUCTION

Primary cardiac tumors are infrequent [1]. Myxoma is the most common type of such tumor in adults [2]. Most myxomas arise in the left atrium. Those located in the right ventricle are rare [3], and they are of a particular concern because of the risk of pulmonary tumor embolism. Right ventricular (RV) myxomas accompanied by pulmonary embolism (PE) are reported only in a limited number of studies in the medical literature [4–14]. Herein, we present a case of a young man who suffered from PE after incomplete surgical resection of an RV myxoma. To the best of our knowledge, this is the first report in the literature of confirmed PE following incomplete surgical resection of an RV myxoma. We also present a review of the literature pertaining to RV myxomas associated with PE in an effort to provide an insightful understanding of such cases.

CASE PRESENTATION

A 28-year-old male physician with no significant past medical history except for asthma, for which he takes albuterol and cetirizine, presented to a cardiology clinic with shortness of breath and palpitations for the last 3 months. The patient reported feeling 'the heart rubbing against the chest while leaning forward'. He denied chest discomfort or other cardiac symptoms. After auscultating his own chest, he heard a murmur for which he sought medical advice. Physical exam was normal except for a low-grade holosystolic murmur best heard at the left lower sternal border, tachycardia and tachypnea with a respiratory rate of 25. Electrocardiogram (ECG) showed sinus tachycardia with a heart rate of 112 beats per minute and right axis deviation. Transthoracic echocardiogram (TTE) revealed an RV mass (approximately 3×2 cm) attached to the interventricular septum by a small pedicle, dilated right heart chambers, moderate tricuspid regurgitation, and severe pulmonary hypertension (systolic pulmonary artery pressure > 60 mmHg) (Fig. 1). Cardiac magnetic resonance (MR) confirmed the presence of a well-circumscribed non-obstructive mass ($2.4 \times 1.9 \times 1.2$ cm) that appeared not to invade the surrounding cardiac structures located in the RV outflow tract, inferior to the pulmonary valve (Fig. 2). The patient denied a family history of cardiac tumors.

The patient underwent open heart surgery with median sternotomy and total cardiopulmonary bypass. Right ventriculotomy was performed, and the incision was extended superiorly and inferiorly. Traction sutures were placed on the right ventricle in order to improve exposure. A large and soft RV mass obstructing the RV outflow tract was identified in the right ventricle attached to the anterosuperior and septal leaflets of the tricuspid valve and partially attached to the interventricular septum. Based on the surgeon's decision, the mass was partially excised without compromising the integrity of the tricuspid valve (Fig. 3). TEE was used to evaluate the valve function and revealed mild tricuspid regurgitation. The patient had uneventful surgical recovery and was discharged following a 5-day hospitalization period.

The pathology report of the resected mass (two specimens) confirmed the diagnosis of myxoma. The first specimen consisted of three

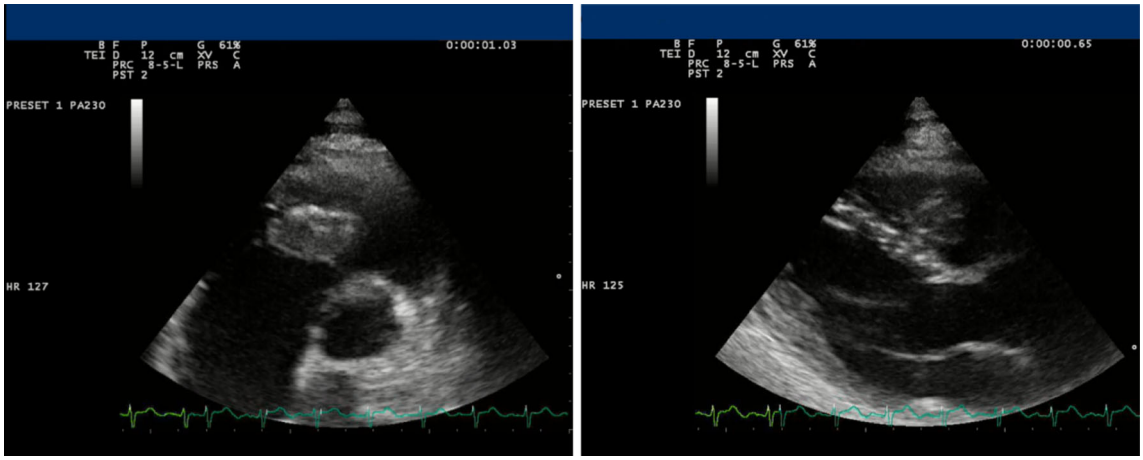

Fig. 1 Transthoracic echocardiogram (TTE) views before surgery showing a right ventricular mass (approximately 3 × 2 cm) attached to the interventricular septum by a small pedicle and dilated right heart chambers

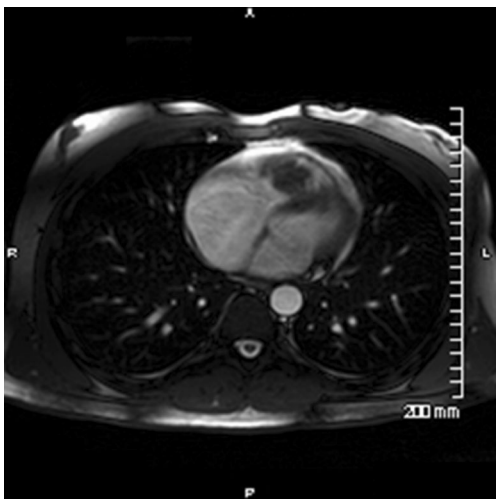

Fig. 2 Cardiac magnetic resonance (MR) before surgery revealing a well-circumscribed non-obstructive mass (2.4 × 1.9 × 1.2 cm) that appeared not to invade the surrounding cardiac structures located in the right ventricular outflow tract, inferior to the pulmonary valve

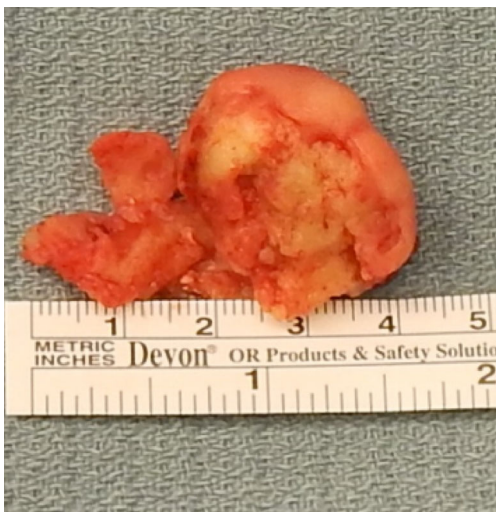

Fig. 3 The resected myxoma (predominantly tan–red with focal yellow tissue measuring about 4 × 3 × 1.5 cm)

fragments of tissue measuring 1.3 × 1 × 0.5 cm in aggregate. One portion of tissue had a tan–white base with tan–red tissue attached and projecting from the base. Another portion of tissue was predominately tan–red with focal yellow tissue, reminiscent of adipose tissue. The third portion of tissue was tan–red. The second specimen was an aggregate of pink–tan to gray–white, rubbery, ragged, and soft tissue fragments measuring 3.5 × 3.5 × 1.5 cm. Sectioning revealed a gray–white to yellow–green, rubbery and friable cut surface. No firm areas were identified. Microscopically, the majority of the first specimen consisted of fibrin clot. There was a fragment of bland polygonal to spindle-shaped cells within a myxoid matrix. Factor VIII showed focal positivity within the bland cells and was positive in capillaries. CD34 was positive in capillaries. No entrapped cores of elastic tissue were seen on Verhoeff-Van Gieson stain (elastin stain). Trichrome stain

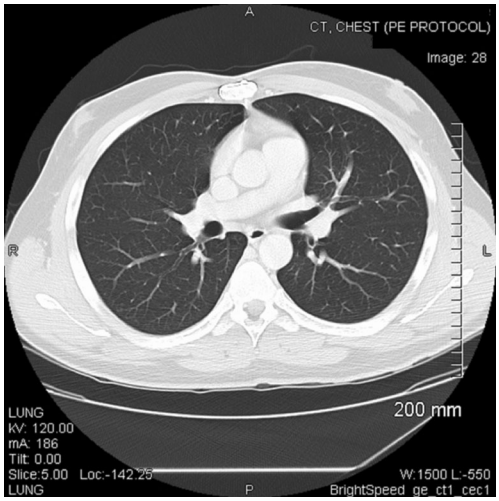

Fig. 4 Chest computerized tomography (CT) after surgery scan showing multiple emboli in the right lower lobe segmental and subsegmental pulmonary arterial branches, as well as peripheral airspace disease in the right lower lobe suggestive of pulmonary infarction

showed no laminated elastic fibers within the matrix. The morphologic and immunohistochemical findings were compatible with cardiac myxoma. The microscopic examination of the second specimen showed myxoma cells with an oval nucleus which were forming ring structures around small thin-walled blood vessels. An accompanying mononuclear inflammatory cell infiltrate was present. Hemosiderin-laden macrophages were also present. A myxoid background was focally present. The majority of the tissue showed secondary changes of fibrosis and calcification which obscured the underlying nature of the lesion. The myxoma was attached to a portion of benign cardiac muscle.

Two weeks after surgery, a follow-up TTE showed a residual RV mass (approximately 2 × 1.5 cm) attached to the interventricular septum.

Five months after surgery, the patient presented to the emergency department with right-sided pleuritic chest pain and upper abdominal discomfort. The patient took 15 airplane flights over the previous 2 months, some of which were very long. He was tachypneic (22 breaths/min), and his ECG showed sinus tachycardia with a heart rate of 118 bpm and right bundle branch block (RBBB). Serum D-dimer was elevated (0.9 mg/l). His chest X-ray was normal. A chest computerized tomography (CT) scan revealed multiple emboli in the right lower lobe segmental and subsegmental pulmonary arterial branches, as well as peripheral airspace disease in the right lower lobe suggestive of pulmonary infarction (Fig. 4). Venous Doppler ultrasound of the legs showed bilateral patent and compressible venous systems and no evidence of thrombus. TTE and transesophageal echocardiogram (TEE) were done and reported dilation of the inferior vena cava (IVC), right atrium and right ventricle and a mass (approximately 2 × 1.5 cm) attached to the base of the RV wall just below the insertion of the anterior tricuspid leaflet (Fig. 5). The tricuspid jet was insufficient to calculate pulmonary pressure. Cardiac MR showed a small residual tissue (9 × 9 mm) adjacent to the interventricular septum and another residual tissue (7 × 9 mm) attached to the RV free wall (Fig. 6). The patient was diagnosed with PE, due to either tumor emboli or thromboemboli, and was started on warfarin. On further follow-up (20 months following PE), he had no recurrent PE.

Informed consent was obtained from the patient for being included in the study.

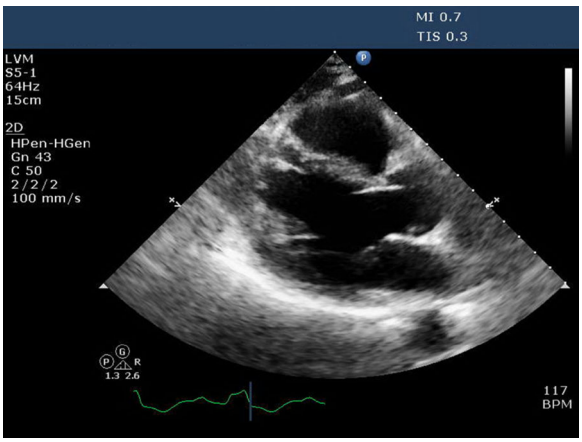

Fig. 5 Transesophageal echocardiogram (TEE) after surgery revealing dilation of the inferior vena cava (IVC), right atrium and right ventricle and a mass (approximately 2 × 1.5 cm) attached to the base of the right ventricular wall just below the insertion of the anterior tricuspid leaflet

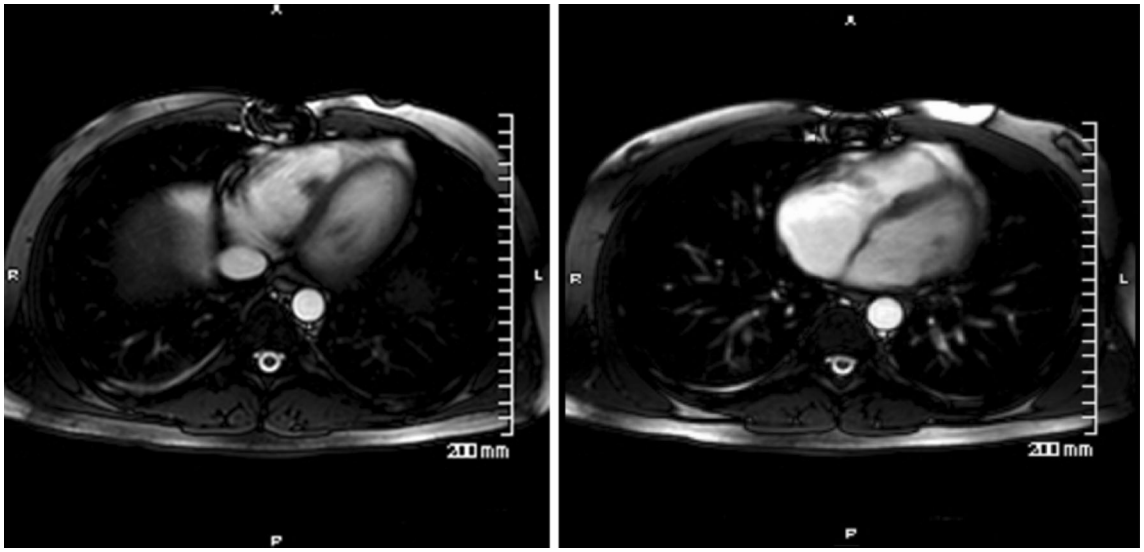

Fig. 6 Cardiac magnetic resonance (MR) views after surgery showing a small residual tissue (9 × 9 mm) adjacent to the interventricular septum and another residual tissue (7 × 9 mm) attached to the right ventricular free wall

DISCUSSION

In the 18th century, the French physician, De-Sénac, stated, "The heart is an organ too noble to be attacked by a primary tumor" [15, 16]. We now know that primary tumors of the heart do exist, although they are rare with a frequency of just about 0.02% [1]. Secondary tumors of the heart are approximately 30-fold more common than primary ones [17]. Around 75% of primary cardiac tumors are benign. Myxomas, which constitute about half of the benign cardiac tumors, are the most common primary tumors of the heart in adults, while rhabdomyomas predominate in children [2, 18]. Myxomas are more common in women and are usually diagnosed between the third and sixth decades of life [19]. Both TTE and TEE play important roles in the initial diagnosis of cardiac myxomas, with CT and cardiac MR being supplemental [18]. It was remarkable that preoperative TTE in our case revealed severe pulmonary hypertension. We believe that could be due to recurrent pulmonary emboli that went unnoticeable. Postoperative TTE in our case revealed dilation of the IVC, right atrium and right ventricle, which we believe could be due to the mild TR revealed on the TEE done during the surgery after excising the mass. We think that the mass was distorting the tricuspid valve.

Most cardiac myxomas are sporadic. Only about 7% of them are hereditary and occur along with skin pigmentation and endocrinopathy in an autosomal dominant disorder called Carney Complex [20]. Our patient denied any family history of cardiac tumors.

Three-quarters of cardiac myxomas are located in the left atrium. Most of the rest occur in the right atrium. RV myxomas were reported in just 3–4% of cardiac myxoma cases [3]. Myxomas range between 1 and 15 cm in diameter weighing between 15 and 180 g [21]. Cardiac myxomas are usually pedunculated and have a smooth, villous or friable surface. Smooth myxomas are known for obstructive complications, whereas villous and friable ones tend to cause embolic complications [22]. The myxoma in the case we are presenting was friable according to the pathology report. This, in addition to the absence of deep vein thrombosis, favors the diagnosis of tumor emboli in our patient.

Location, size, and mobility of cardiac myxomas determine their clinical presentation. Embolism, obstruction, and constitutional symptoms are common manifestations.

Embolism occurs in 30–40% of cases. Systemic embolism is much more common than PE, as most myxomas are predominantly located in the left atrium. Only few cases of RV myxomas associated with PE were reported [4–14].

Once a cardiac myxoma is diagnosed, it should be surgically resected to avoid its associated complications. Recurrence rate is less than 3% in sporadic cases, but ranges between 12 and 22% in familial ones. Factors associated with recurrence include multicentricity, young age, familial cases, and incomplete surgical resection. Follow-up is usually done after surgery using echocardiography [18]. In our case, the tumor could not be completely resected due to its attachment to the tricuspid valve.

Pulmonary tumor emboli and thromboemboli are not easily differentiable. CT scans and pulmonary angiograms are often nonspecific for tumor emboli. Tumor emboli usually display a more peripheral distribution in the subsegmental arteries (as likely occurred in our patient) [23]. On the other hand, thromboemboli are associated with long and multiple airplane flights [24]. Therefore, the fact that the patient in the case we are reporting had taken numerous and long flights before he suffered from PE raises the possibility that thromboembolism contributed to the PE. Thromboemboli are also correlated with elevation of serum D-dimer [25], which was high when the PE was diagnosed in the case we are reporting. Nevertheless, the elevation in D-dimer was slight and lower extremities venous Doppler showed no evidence of thrombi. Pulmonary thromboemboli are more frequently correlated with higher serum D-dimer levels [26].

Confirmation of pulmonary tumor emboli require a lung biopsy procedure, which can be done with either open-lung or transbronchial approaches [27]. A definitive diagnosis of pulmonary tumor emboli through invasive procedures was not pursued in our patient since surgery was already done, and the patient was started on warfarin. The fact that no recurrence of PE happened during the follow-up may favor but does not confirm that the emboli were thrombotic in origin.

Echo-guided percutaneous trans-catheter biopsy of intracardiac masses, especially in the right-sided chambers, is safe and can accurately provide histopathological diagnosis. Such an approach may therefore mitigate the need for surgical excisional biopsy and potentially alter clinical management in a large number of patients [28].

We conducted a search of published cases describing RV myxomas associated with PE in PubMed using the following search terms: pulmonary embolism, myxoma, ventricular, right ventricular myxoma. The search yielded 29 articles, 11 of which were pertaining to RV myxomas associated with PE. We present a review of these 11 cases along with the case we are presenting (Table 1).

The oldest case was published in 1971 [14], and the most recent one, apart from ours, in 2016 [4]. Singh el al. reported two cases of cardiac masses in his article, however only one of them was confirmed as a myxoma and included in our review [10]. Eight of the 11 cases were reported in English language [4–8, 10, 12, 13]. Urina Triana et al. reported their case in Spanish language. We included it since we could translate the entire article [11]. The case reported by Vernant et al. was in French language. We translated and included the abstract of that article as it was the only part we found [14]. Tatebayashi et al. reported their case in Japanese language. We only included the abstract of that article since it was available in English language [9].

The number of male and female patients was equal. The mean age of patients was approximately 33 years, and while the youngest patient was 12 years old [13], the oldest one was 76 years old [9]. However, most patients were in their 20 or 30s.

Although the presentation was not the same for all the cases, eight cases showed that pulmonary embolism could be the first presentation of RV myxomas [4–9, 11, 12]. This indicates the significance of performing echocardiography in cases of unexplained PE especially in young patients who do not have risk factors of PE.

A summary of the most frequent findings of the cases in our review, including our case, is shown in Table 2.

Table 1 Review of the literature related to right ventricular myxomas associated with pulmonary embolism including the case we are presenting

Case no.	Authors, year of publication	Age in years, sex	Presentation	Vital signs	Physical examination	ECG	Abnormal labs	Echocardiogram	Follow-up	Recurrence after surgery	Notes
1	Singh et al., 2016 [4]	26, F	Dyspnea and left precordial pain	Normal BP, tachycardia, and tachypnea	Narrow split of S2 with loud P2 and a pan-systolic grade III/VI murmur along LSB	Sinus tachycardia and right axis deviation	Leukocytosis	2 RA myxomas and 1 RV myxoma	Yes, echocardiogram 6 months after surgery was normal	No	Elevated JVP with prominent 'v' wave
2	Ahmad-Zarghami et al., 2007 [5]	26, M	Episodes of brisk hemoptysis	NA	Normal	NA	NA	2 RV myxomas and tumoral posterior cusp of the tricuspid valve	NA	NA	All areas affected by the tumor were removed
3	Moyassakis et al., 2005 [6]	21, M	PE and palpitations	NA	Murmur	NA	NA	RA myxoma and RV myxoma	Yes, normal	Yes, two recurrences in multiple locations	Possible 'pretumoral tissue foci'
4	Segal et al., 2000 [7]	34, M	Episodes of pleuritic chest pain	NA	NA	NA	NA	RV myxoma	NA	Yes	Mass was densely adherent to the RV wall
5	Zuber et al., 1997 [8]	27, F	PE, weight loss, fatigue, exertional dyspnea, and recurrent supraventricular arrhythmias	High BP	A grade III/VI systolic murmur and a thrill with maximum intensity over the pulmonary region	Incomplete RBBB	NA	RV myxoma	Yes, follow-up of 1 year was normal	No	Long work-up and multiple presentations till myxoma was diagnosed
6	Tatebayashi et al., 1993 [9]	76, F	Cough, dyspnea, and constitutional symptoms of myxoma	NA	NA	NA	High serum IL-6	RV myxoma	NA	NA	Surgery showed clear RV cavity
7	Singh et al., 1992 [10]	30, F	Breathlessness on exertion	Normal BP, normal HR, and tachypnea	Wide split of S2 with a loud P2, a grade II/VI ejection systolic murmur along the LSB and an RV heave	Right-axis deviation and RVH	NA	RV myxoma and ASD	NA	NA	
8	Urina Triana et al., 1987 [11]	17, F	Pleuritic chest pain sometimes with dry cough, fever, chills, profuse sweating and palpitations	Normal HR and fever	Slightly loud P2 and a grade II/IV systolic ejection murmur in the second and third left intercostal space	Sinus tachycardia and incomplete RBBB	Microcytic hypochromic anemia, leukocytosis, and high ESR	RV myxoma	NA	No	

Table 1 continued

Case no.	Authors, year of publication	Age in years, sex	Presentation	Vital signs	Physical examination	ECG	Abnormal labs	Echocardiogram	Follow-up	Recurrence after surgery	Notes
9	Boulafendis et al., 1984 [12]	46, M	Left-sided chest pain and SOB	NA	Loud S3, a systolic murmur with a thrill along LSB, and a very prominent RV impulse	Sinus tachycardia and RVH	NA	RV myxoma	NA	NA	
10	González et al., 1980 [13]	12, M	SOB, tachypnea, and cyanosis, and episodes of fever, anorexia, and general malaise	Normal BP, tachycardia, tachypnea and fever	Wide split of S2 with loud P2, a midsystolic murmur along the LSB and an RV heave	Sinus tachycardia and incomplete RBBB	Microcytic hypochromic anemia, leukocytosis, and high ESR	RV myxoma	Patient died	No	
11	Vernant et al., 1971 [14]	49, F	PE	NA	NA	NA	Eosinophilia	NA	Yes, follow-up of 20 months was normal	No	
12	Current study	28, M	SOB, palpitations, pleuritic chest pain and upper abdominal discomfort	Tachycardia and tachypnea	A low-grade holosystolic murmur best heard at the left lower sternal border	Sinus tachycardia and right-axis deviation and RBBB	Elevated serum D-dimer	RV myxoma	Yes	Yes, 2 residual masses after incomplete surgical resection	Myxoma was attached to the tricuspid valve

F female, *M* male, *PE* pulmonary embolism, *SOB* shortness of breath, *BP* blood pressure in mm Hg, *HR* heart rate in beats per minute, *T* temperature in Celsius, *S2* second heart sound, *P2* pulmonic component of the second heart sound, *LSB* left sternal border, *RBBB* right bundle branch block, *RA* right atrial, *RV* right ventricular, *RVH* right ventricular hypertrophy, *IL-6* interleukin-6, *ESR* erythrocyte sedimentation rate, *ASD* atrial septal defect, *JVP* jugular venous pressure, *NA* data not available

Table 2 Most frequent findings of the cases in the review of literature including our case

Finding	No. of cases that reported the finding
Signs and symptoms	
SOB	7 [4, 8–10, 12, 13][a]
CP	5 [4, 7, 11, 12][a]
Palpitations	3 [6, 11][a]
Vital signs	
Tachypnea	4 [4, 10, 13][a]
Tachycardia	3 [4, 13][a]
Fever	2 [11, 13]
Physical examination	
Murmur	8 [4, 6, 8, 10–13][a]
Loud P2	4 [4, 10, 11, 13]
RV heave	3 [10, 12, 13]
Wide split of S2	2 [10, 13]
ECG	
Sinus tachycardia	5 [4, 11–13][a]
RBBB	4 [8, 11, 13][a]
Right axis deviation	3 [4, 11][a]
RVH	2 [10, 12]
Labs	
Leukocytosis	3 [4, 11, 13]
Microcytic hypochromic anemia	2 [11, 13]
High ESR	2 [11, 13]

SOB shortness of breath, *S2* second heart sound, *P2* pulmonic component of the second heart sound, *RBBB* right bundle branch block, *RVH* right ventricular hypertrophy, *ESR* erythrocyte sedimentation rate

[a] Including our case

Echocardiography was remarkable in four cases [4–6, 10]. It revealed two right atrial masses and one RV mass in the first one [4], two RV masses and tumoral posterior cusp of the tricuspid valve in the second one [5], one right atrial mass and one RV mass in the third one [6], and one RV myxoma and atrial septal defect in the fourth one [10].

Recurrence of myxoma after surgical resection happened in the case reported by Moyassakis et al. Therefore, the patient underwent a second surgical resection, after which recurrence happened again [6]. Segal et al. reported a case in which the mass was densely adherent to the wall of the right ventricle. Surgical resection was performed, however recurrence occurred [7]. These two cases in addition to the case we are presenting show that recurrence of myxomas may happen. Recurrence seems to occur particularly when complete resection of the mass is not possible. This emphasizes the importance of the follow-up including echocardiography after surgery. It was notable that only four of the 11 cases we reviewed reported follow-up [4, 6, 8, 14].

Zuber et al. reported a patient who presented with PE several times after a ligament reconstruction surgery. At first, the patient was only treated with anticoagulation. Echocardiography, which showed RV myxoma, was not performed until the patient presented for the third time [8]. The case reported by Boulafendis et al. also shows that echocardiogram was performed during a second presentation after only giving anticoagulation therapy during the first one [12]. González et al. reported the death of a 12-year-old boy after failing to diagnose the myxoma early [13]. These cases show that the diagnosis of myxomas can be easily missed in case of not suspecting them.

Singh et al. reported an RV myxoma seen on echocardiogram. Nonetheless, the RV cavity was clear during surgery. Severe right heart failure occurred in the immediate postoperative period, and embolism of the tumor was suspected [10].

CONCLUSIONS

Despite being rare, cardiac tumors including RV myxomas should be included in the differential of the occasional patient with unexplained PE. This is particularly important when there are no risk factors or predisposing etiologies for PE and

the patient is young. The presentation of RV myxomas does not seem to be specific, and the diagnosis is usually accidentally made on a TTE obtained to examine RV strain or failure. Furthermore, following up patients with echocardiography after surgery is important since recurrence, which seems to be related to incomplete resection, could happen.

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Compliance with Ethics Guidelines. Informed consent was obtained from the patient for being included in the study.

Data Availability. Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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