Blood cysts of the cardiac valves in adults: Review and analysis of published cases

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Abstract

Background and aim: Blood cysts of cardiac valves are generally seen in newborns and infants and very rarely in adults. Although in most cases they are incidental findings they may be associated to severe cardiac or systemic complications. This study analyzes incidence, presentation, and treatment of valvular blood cysts in adults.

Methods: A review of the pertinent literature through a search mainly on PubMed and Medline was performed.

Results: In patients ≥18 years of age, our search disclosed 54 patients with mitral blood cysts (mean age, 48 ± 18 years), 9 with a tricuspid valve cyst (mean age, 67 ± 15 years), 3 with a blood cyst on the pulmonary valve (age 31, 43, and 44 years), and 1 aortic valve cyst in a 22-year-old man. Most patients were asymptomatic while stroke, syncope, or myocardial infarction occurred in six patients with a mitral valve cyst. Blood cysts were removed surgically in 70% of patients with a mitral cyst, in 55% with a tricuspid cyst, and in all those with a pulmonary or aortic cyst. At histology, the cyst wall was composed mainly by fibrous tissue and with the inner surface lined with typical endothelium.

Conclusions: Blood cysts of cardiac valves are rare in adults but may cause life-threatening complications, particularly when located on the mitral valve. For such reason, surgical removal appears advisable, with low-risk procedures. Widespread use of multimodality imaging techniques will most likely increase the number of valvular blood cysts diagnosed also in adults.

Keywords

cardiovascular pathology, valve repair/replacement
1 | INTRODUCTION

Benign cardiac neoplasms are substantially rare and among these intracardiac cysts filled with blood are even more uncommon; indeed, they have not even been mentioned in a recent review of cardiac tumors reported by Tyebally et al.\(^1\) However, mainly owing to advancement in diagnostic techniques, with a widespread use of and accessibility to multimodality imaging, an increase in the diagnosis of cardiac or pericardial masses has been observed recently and is expected to further grow in the future.\(^2\) Intracardiac blood cysts (BCs) are commonly found in newborns and infants being rare after the first year of life, they mainly involve the cardiac valves and generally disappear during growth.\(^2\) In adults they may occasionally be diagnosed, are usually located on all cardiac valves and chambers, the mitral valve (MV) being the most frequently involved; despite absence of histological malignancy BCs of the heart valves have been reported to cause life-threatening complications with even severe sequelae.

There is still uncertainty on the origin of BCs and controversy on whether medical treatment with continuous clinical and echocardiographic patient follow-up should be preferred to immediate surgical removal. The present review, analyzing the published cases, was undertaken with the aim of assessing the incidence, evaluating the clinical presentations, and discussing the treatment of BCs involving the cardiac valves in adults.

2 | METHODS

We have performed a search of the English literature, through PubMed and Medline, to identify all cases of BCs involving the MV, MV apparatus, and tricuspid, aortic and pulmonary valves (AV and PV) that have been so far reported. Articles in textbooks and meeting abstracts were excluded, as well as cases included in general reviews of cardiac tumors or clinical reports, when detailed clinical and pathological information on BCs, when present, was lacking. Cases of valvular cysts but with the uncertain histological diagnosis were excluded. The reference sections of pertinent articles were also evaluated as well as personal files and the archives of journals available on the CTSNet website. All reported cases observed in the pediatric population were excluded, considering only those occurring in patients ≥18 years of age.

Main terms used in the literature search, alone or in combination, were intracardiac cyst, valvular cyst, BC, blood-filled cyst, pedunculated cysts, MV, MV apparatus, MV leaflet, tricuspid valve (TV), papillary muscle, chordae tendineae, AV, PV, semilunar valve, valve cusps, atrio-ventricular valve, and semilunar valve.

Approval by the Ethical Committees was not required for this kind of study, as well as informed patient consent, provided that all relative data were treated anonymously.

3 | RESULTS

3.1 | BCs of the MV

Our literature search has documented a total of 50 articles considered eligible for analysis and reporting a total of 54 patients; 36 (72%) are reports of a single case,\(^3\)\-\(^36\) 12 (24%) images in cardiovascular disease,\(^39\)\-\(^50\) 1 case series reporting 5 patients (2%),\(^51\) and 1 letter to the editor (2%),\(^52\) all published from 1960 to 2021 (Tables 1 and 2).

3.1.1 | Patient characteristics

There were 29 males (55%) and 25 females (45%) with an age ranging from 18 to 87 years (mean, 48 ± 18 years). The majority of patients was asymptomatic and the cyst was disclosed at routine controls for other pathologies. Symptoms related to the presence of MV BCs, in the absence of any other intracardiac abnormality, included predominantly palpitations, chest discomfort, and exertional dyspnea. In three patients, BCs caused severe left ventricular outflow tract (LVOT) obstruction,\(^5\)\(^,\)\(^11\)\(^,\)\(^50\) two patients presented with hemiparesis,\(^4\)\(^,\)\(^43\) two with syncopal episodes,\(^32\)\(^,\)\(^50\) two had a stroke,\(^15\)\(^,\)\(^18\) two a myocardial infarction,\(^9\)\(^,\)\(^21\) and in one the BC caused severe MV regurgitation.\(^22\) Except for the first two BCs cases described, diagnosed either by cineangiography\(^2\) or M-mode echocardiogram,\(^5\) in all other cases transthoracic 2D echo was used for evidencing the presence of an MV mass (Figure 1). The diagnosis was confirmed by supplemental transesophageal echo in many cases and more recently by multimodality imaging, including angio-computed tomography, nuclear magnetic resonance, contrast real-time echocardiography, and 3D echo.\(^23\)\(^,\)\(^24\)\(^,\)\(^36\)\(^,\)\(^38\)\(^,\)\(^44\)\(^,\)\(^45\)\(^,\)\(^49\)\(^,\)\(^51\)

3.1.2 | Surgical data

Cyst removal was performed in 37 patients (70%) while in 16 (30%) medical treatment and serial follow-up was recommended; in one patient AV and ascending aorta replacement were performed leaving in place a small BC on the MV.\(^20\) Surgery was generally performed through a standard median sternotomy while in three cases a minimally invasive, endoscopic technique was used.\(^22\)\(^,\)\(^36\)\(^,\)\(^45\) Two patients had previous open heart operations and required repeat sternotomies,\(^22\)\(^,\)\(^42\) while one had a previous liver transplantation.\(^10\) The BC was approached through a trans-aortic incision in 7 cases, through the left atrium in 6, trans-septal in 4, while in 20 cases it was not specified. Beside cyst removal, 27 patients (73%) had associated procedures: mitral valve replacement (MVR) in 12, mitral valve repair (MVR) in 9, coronary artery bypass grafting in 3, and combined MVR and AV replacement in 1. In addition, in two patients, with associated cor triatriatum, resection of the intraatrial band was performed.\(^14\)\(^,\)\(^24\) No operative deaths are reported.
| Author, ref. no. | Year | Age, sex | Location | Max. dimension, mm | Surgical approach | Operation |
|-----------------|------|----------|----------|-------------------|------------------|-----------|
| Leatherman et al.³ | 1968 | 39, F | AML | 30 | Transaortic | Cyst removal |
| Hauser et al.⁴ | 1983 | 27, M | APM | 25 | LA incision | Cyst removal, MVR |
| Arnold et al.⁵ | 1990 | 46, M | AML | 32 | Transaortic | Cyst removal, MVR |
| Xie et al.⁶ | 1992 | 41, F | PML | 13, ³ | Transseptal | Cysts removal |
| Ohmoto et al.⁷ | 1993 | 57, M | APM | 40 | Transaortic | Cyst removal |
| Pelikan et al.⁸ | 1999 | 50, M | AML | 22 | No surgery | - |
| Sharma et al.⁹ | 2000 | 68, M | APM | 20 | Transaortic | Cyst removal, CABG |
| Kuvin J et al.¹⁰ | 2004 | 45, F | AML | 25 | LA incision | Cyst removal |
| Minneci et al.¹¹ | 2004 | 44, F | AML | 20 | Transaortic | Cyst removal, MVR |
| López-Pardo et al.¹² | 2008 | 34, M | AML | 22 | No surgery | - |
| Tsutsui et al.¹³ | 2008 | 47, F | AML | 15 | No surgery | - |
| Denker et al.¹⁴ | 2009 | 65, F | AML, PML | 10, 10³ | NA | Cysts removal, MVR, LA band resection¹⁵ |
| Lodha et al.¹⁵ | 2009 | 74, F | AML | NA | No surgery | - |
| Park et al.¹⁶ | 2009 | 22, M | APM | 21 | No surgery | Cyst removal, MVR |
| Migliore et al.¹⁷ | 2010 | 18, F | AML | 22 | No surgery | - |
| Khan et al.¹⁸ | 2012 | 87, F | AML | 17 | No surgery | - |
| Park et al.¹⁹ | 2012 | 47, M | APM | 18 | NA | Cyst removal, MVR |
| Bhatt et al.²⁰ | 2013 | 45, F | PML | NA | - | No removal |
| Donndorf et al.²¹ | 2013 | 55, M | PM (n.s.) | 20 | Transaortic | Cyst removal, CABG |
| Ansari et al.²² | 2015 | 55, M | AML | 26 | LA incision | Cyst removal, CABG |
| Halim et al.²³ | 2015 | 23, M | AML | 20 | Transseptal¹ | Cyst removal, MVR |
| Madhavan et al.²⁴ | 2015 | 70, F | AML | 16 | NA | Cyst removal, MVR |
| Özmen et al.²⁵ | 2015 | 19, F | AML | 17 | NA | Cysts removal, RA band resection²⁶ |
| Yilmaz et al.²⁶ | 2015 | 63, M | AML | 17 | No surgery | - |
| Ahmad et al.²⁷ | 2016 | 25, M | PPM | 20 | NA | Cyst removal, MVR |
| Okamoto et al.²⁸ | 2016 | 41, F | PPM | 29 | LA incision | Cyst removal, MVR |
| Akutsu et al.²⁹ | 2017 | 57, M | AML | 15 | Transseptal | Cyst removal, MVR |
| Pavsic et al.³⁰ | 2017 | 44, F | AML | 23 | NA | Cyst removal, MVR |
| Bagheri et al.³¹ | 2018 | 62, M | PPM | 21, 19³ | NA | Cysts removal, MVR |
| Ludhwani et al.³² | 2019 | 47, F | MVA | 15 | No surgery | - |
| Ma et al.³³ | 2019 | 32, M | AML | 46 | NA | Cyst removal |
| Cerik et al.³⁴ | 2020 | 42, F | AML | 17 | No surgery | - |
| Ramirez-Mesias et al.³⁵ | 2020 | 57, F | AML | 10 | No surgery | - |
| Wang et al.³⁶ | 2020 | 30, M | AML | 17 | NA | Cysts removal |
| | | 45, M | AML | 25 | NA | Cyst removal, MVR |
| | | 57, F | AML | 11 | NA | Cyst removal, MVR |
| | | 58, M | AML | 19 | NA | Cyst removal |
| | | 57, M | MV chordae | 12 | No surgery | - |
There are nine articles on BCs of the TV, six case reports,53–59 two images in cardiovascular disease,57,60 and one letter to the editor,61 published from 1991 to 2021 (Table 3).

### 3.2.1 | Patient characteristics

Of the nine patients, five were females and four males with an age ranging from 35 to 88 years (mean, 67 ± 15 years). Symptoms at presentation were generally not specific except for few cases with moderate-severe tricuspid regurgitation, with congestive heart failure or symptoms related to other concomitant cardiac pathology. One patient had an associated muscular ventricular septal defect without hemodynamic significance.55

### 3.2.2 | Surgical data

Cyst removal was performed in six cases (55%) while in the remaining three, surgery was considered not indicated. All patients were operated through a median sternotomy using a right atriotomy for cusp excision; in one case even a combined left atrial-transseptal approach is reported. In four patients, BCs removal was associated with various techniques of TV repair; in one patient myocardial revascularization was also performed.
3.3 | BCs of the PV

3.3.1 | Patient characteristics

Our search yielded three papers on BCs of the PV, two case reports, and one image in cardiovascular disease (Table 4). All were females, 31, 43, and 44 years of age. Auscultation of a cardiac murmur, associated to fatigue and dyspnea, prompted further evaluation with angiographic or echocardiographic disclosure of the BC. In two cases, the pulmonary trunk had an aneurysmal dilatation and in one the PV was severely dysplastic.

3.3.2 | Surgical data

Cyst removal was performed in all cases, by a transpulmonary approach. In one patient, PV valvuloplasty was required associated to reduction of the pulmonary trunk size.

3.4 | BCs of the AV

We found only a case of a BC, on an image in cardiovascular medicine paper, found on a bicuspid AV in a 22-year-old male with aortic stenosis. The cyst had a maximum diameter of 21 mm with a broad base of implant; it was excised during AVR.

3.5 | BC pathology

BCs of the cardiac valves are usually described as round or oval-shaped masses, either bluish or yellowish in color, at times pedunculated and of variable sizes.

Mean maximum size of MV BCs was 20 ± 8 mm, ranging from 3 to 46 mm; in four cases the cyst was considered as "giant" despite a large variability of sizes. The most frequent location of the cysts was the anterior mitral valve leaflet (AML) occurring in 33 cases, followed by the anterior papillary muscle in 8, the posterior mitral leaflet (PML) in 5, and the posterior papillary muscle in 4. The cyst was described to be attached to the chordae tendinae in one, to the mitral annulus in one, and to an unspecified papillary muscle in one; in

![Figure 1](image-url)  
(A) Transthoracic 2D echocardiographic four-chamber view, in a 61-year-old asymptomatic man showing the intracardiac mass (asterisk) attached to the anterior mitral leaflet (AML) and (B) moderate mitral regurgitation. LA, left atrium; LV, left ventricle.

Table 3 | Characteristics of reported cases of blood cysts of the tricuspid valve

| Author, ref. no. | Year | Age, sex | Location | Max. dimension, mm | Surgical approach | Operation |
|-----------------|------|----------|----------|-------------------|------------------|----------|
| Paşaoğlu et al.53 | 1991 | 35, M | STL | 30 | RV | Cyst removal |
| Timperley et al.60 | 2004 | 80, F | STL | NA | RA | Cysts removal |
| Michelena et al.64 | 2007 | 55, M | ATL | 30 | RA | Cysts removal, TVr |
| Agac et al.55 | 2009 | 72, F | STL | 20 | No surgery | - |
| Grapsa et al.56 | 2011 | 88, F | STL | 25 | No surgery | - |
| Butler et al.57 | 2015 | 66, M | NA | NA | RA | Cysts removal, TVr |
| Kaļčik et al.58 | 2015 | 65, M | PTL | 18 | LA-Transseptal | Cysts removal, TVr, CABG |
| Aydin et al.59 | 2019 | 68, F | STL | 23 | No surgery | - |
| Taylan et al.61 | 2021 | 74, F | ATL | NA | RA | Cyst removal, TVr |

Abbreviations: ATL, anterior tricuspid leaflet; CABG, coronary artery bypass grafting; F, female; M, male; NA, not available; PTL, posterior tricuspid leaflet; RA, right atriotomy; RV, right ventriculotomy; STL, septal tricuspid leaflet; TVr, tricuspid valve repair.

*Unless specifically indicated, cyst removal was considered performed though a right atriotomy.
one patient with two BCs both AML and PML were involved.14 In three patients, two BC were found.6,14,30 Some BCs have been described as multilobulated.9,12,17,50

The maximum size of TV BCs ranged from 18 to 33 mm (mean, 24 ± 5 mm); in three cases the size of the BC was not indicated.57,60,61 BCs were located on the septal TV leaflet in four, anterior TV leaflet in two, and the posterior TV leaflet in one case; in one patient location of the BC was not reported.57

The maximum size of the three PV BCs was 8, 30, and 40 mm, respectively; according to the authors’ description BCs were located on the posterior PV cusp in one case and on the right PV cusp in one; in one patient location of the BC was not reported.57

Histology of the excised tissue has not been reported in all surgical cases. When available histologic data, regardless of BC location, have been substantially uniform in describing the BC wall as composed mainly by fibrous tissue of various thickness (Figure 2A), at times with a myxoid stroma. In many cases, the inner BC wall was lined with typical endothelium while smooth calcific spots were occasionally seen.19,49 The fibrous nature of the BC wall is also confirmed by immunohistochemistry (Figure 2B). Interestingly, no ultrastructural images have been reported in BCs excised from cardiac valves of human beings.

4 | DISCUSSION

The first description of an intracardiac BC was reported by Elsässer as late as 1844,66 while Houser and colleagues are credited with the first use of echocardiography to identify such peculiar lesions.4 In 1968, the first surgical removal of an MV BC was reported by Leatherman et al.3; as described by the authors “The cyst was attached to the septal leaflet at the point where the leaflet was joined by chordae tendineae. During excision the cyst was opened and blood drained out. Extracorporeal circulation lasted 18 min, and recovery was uneventful.”3 Intracardiac BCs are usually incidental necropsy findings or are diagnosed clinically predominantly in children, being extremely rare after the first year of life and particularly in adults.1,2 They are considered benign tumors, nevertheless, while benign from the histologic point of view, they have been associated to relevant complications such as LVOT obstruction and coronary or systemic embolization with consequent severe sequelae such as stroke or myocardial infarction.4,5,9,11,15,18,20,48

Table 4: Characteristics of reported cases of blood cysts of the pulmonary valve

| Author, ref. no. | Year | Age, sex | Location | Max. dimension, mm | Surgical approach | Operation |
|------------------|------|----------|----------|--------------------|-------------------|-----------|
| Liese et al.62   | 1963 | 31, F    | PPC      | 40                 | Transpulmonary     | Cyst removal |
| Minato et al.63  | 1997 | 43, F    | RPC      | 8                  | Transpulmonary     | Cyst removal |
| Zhang et al.64   | 2021 | 44, F    | NA       | 30                 | Transpulmonary     | Cyst removal, PV repair, reduction PA plasty

Abbreviations: F, female; PA, pulmonary artery; PPC, posterior pulmonary cusp; PV, pulmonary valve; RPC, right pulmonary cusp.

*This patient had a dysplastic pulmonary valve.
others have considered formation of microbubbles inside the cyst, when using contrast real-time echocardiography, as pathognomonic of the presence of a BC.12,17 However, sometimes solid cardiac tumors, such as myxomas, may present with similar echocardiographic features, therefore, being difficult to be differentiated from a benign BC.7,8 Furthermore, it must be underlined that other intracardiac masses must be ruled out such as fibroelastomas or infectious vegetations, which also frequently involve the cardiac valves and, therefore, the diagnosis of a BC is not always straightforward and needs histology to be confirmed. The potential role of magnetic resonance imaging has also been stressed in the diagnostic assessment of such patients particularly because of its specificity in ruling out signs of myocardial infiltration and, therefore, to exclude the presence of a malignant lesion.20

From this review, it appears that management of patients with a BC is still controversial.21 Many advocate surgical excision while according to others serial clinical and echocardiographic surveillance can be adequate especially in the presence of masses of small size to monitor the rate and degree of growth.15 Indeed, in 30% of the patients analyzed surgery was not considered either for BC small size, clinical stability, patient refusal, or advanced age. However, due to the potential for embolization of even small cardiac masses, including BCs, we believe that surgical removal should always be indicated not only to prevent the risk of complications but also to determine or confirm the exact diagnosis.

The origin of BCs of the cardiac valves is still unknown. The first hypotheses were formulated in the early 1900 by Bayne-Jones, studying the blood vessels of the heart valves.67 Large studies on hearts of dogs and mainly cows and calves obtained from slaughter houses, have demonstrated the presence of valvular BCs in almost 20% of hearts; the results of histological and ultrastructural evaluations support the hypothesis that BCs most likely derive from dilation of the thin-walled valvular arteries due to the mechanical stresses induced by the pressure gradient when the atrio-ventricular valves are closed with consequent cyst formation.68,69 This theory, however, does not explain the occurrence of BCs in low-pressure structures such as the PV.24 Furthermore, it is not clear whether what observed in animal studies can also be completely applied to human beings. According to Tsutsui et al., BCs could derive by blood trapped in valvular crevices or microscopic invaginations during development12; this might explain the finding of BCs in children but not BCs in adults with previously normal echocardiograms. Other consider BCs to derive from valvular hematomas,24 or being secondary to endocardial inflammation; accordingly, the few cases observed following previous open heart surgery might indicate an additional risk factor of cardiac surgery in the development of BCs, although this most likely is just an occasional association.22

This review has some limitations. Since we have excluded from our analysis cases possibly contained in specific textbooks or pathological reviews and those with an uncertain diagnosis, the number of MV BCs may be underestimated. Even if the American Academy of Pediatrics has identified the upper age limit as 21 years for pediatric patients,70 we arbitrarily considered 18 years as the lowest age for this review; elevating this limit would have further reduced the number of recognizable cases. Although some of the data which could be obtained from single cases were not complete, this review provides enough evidence to assess the clinical presentation, diagnostic modalities, and management of patients with a cardiac valve BC found in adult patients.

In conclusion, BCs are rarely found in patients ≥18 years of age and predominantly affect the MV. Although in most cases they represent an incidental finding, sometimes they are heralded by serious acute complications such as syncope and stroke. For such reason, surgical removal, which is a low-risk procedure and can be performed with minimally invasive techniques, should be advisable for BCs of the MV, even if of small size; on the other hand, BCs in the right heart may be treated conservatively unless they cause TV regurgitation or obstruction to blood flow. The origin of valvular BCs is still quite uncertain but since their histological benign nature is well known further studies on pathogenesis would have only a speculative interest. It is likely that the current widespread use of multimodality imaging will increase the number of intracardiac BC detected and hopefully the present review will help to improve the management of such patients.

CONFLICT OF INTERESTS
The authors declare that there are no conflict of interests.

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How to cite this article: Bortolotti U, Vendramin I, Lechiancole A, et al. Blood cysts of the cardiac valves in adults: Review and analysis of published cases. J Card Surg. 2021;36:4690-4698. https://doi.org/10.1111/jocs.15992