

Received: 2017.05.23
Accepted: 2017.06.21
Published: 2017.12.31

Surgical Treatment of Cardiac Tumors: Insights from an 18-Year Single-Center Analysis

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Source of support: Departmental sources

Background: The aim of this study was to investigate the clinical presentation, operative data, and early and late outcomes of a large patient cohort undergoing surgical treatment for cardiac tumors in our institution.





Material/Methods: A total of 181 patients underwent surgery because of suspected cardiac tumor in our institution between 1998 and 2016. In 162 cases, the diagnosis was confirmed postoperatively and these patients were included in this study. Preoperative baseline characteristics, operative data, and postoperative early and long-term outcomes were analyzed.

Results: Mean age at presentation was 56.6±17.6 years, and 95 (58.6%) patients were female. There were 126 (77.8%) patients with benign cardiac tumors, while the remaining patients had malignant tumors (primary and metastasized). The mean follow-up time was 5.2±4.7 years. The most frequent histologically verified tumor type was myxoma (63%, n=102). In terms of malignant tumors, various types of sarcomas presented most primary malignant cardiac tumors (7.4%, n=12). The mean ICU length of stay was 1.7±2.2 days and overall in-hospital mortality was 3.1% (n=5). Frequent postoperative complications included mediastinal bleeding (5.8%, n=9), wound infection (1.3%, n=2), acute renal failure (5.6%, n=9), and major cerebrovascular events (n=7, 4.6%). The overall cumulative survival after cardiac tumor resection was 94% at 30 days, 85% at 1 year, 72% at 5 years, and 59% at 15 years.

Conclusions: Surgical treatment of cardiac tumors is a safe and highly effective strategy associated with good early and long-term outcomes.

MeSH Keywords: **Cardiac Surgical Procedures • Heart Neoplasms • Patient Outcome Assessment**

Full-text PDF: <https://www.medscimonit.com/abstract/index/idArt/905451>

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Background

Primary cardiac tumors are very rare, with incidence rates ranging from 0.0017% to 0.02% [1]. Approximately one-fourth of all cardiac tumors are malignant [2]. Myxomas are benign; they are the most common type of primary cardiac tumors and are predominantly found on the left side, especially in the left atrium [3]. Sarcomas are the most common type of primary malignant cardiac tumor, with undifferentiated sarcomas and angiosarcomas as the most common subtypes [4,5]. Cardiac metastases predominantly originate from lung and breast cancer. Peripheral sarcomas, melanomas, lymphomas, and leukemias are more frequently diagnosed than are primary malignant cardiac tumors [6], and melanomas have the highest propensity for cardiac metastases [7]. The incidence of cardiac metastases ranges from 10% to 25% of all heart tumors [4]. Over the years, clinical value of cardiac metastases has significantly increased due to considerably improved detectability and diagnosis of malignant underlying diseases and better imaging techniques [8,9].

Benign cardiac tumors may be diagnosed at any age, but myxomas are more likely to be detected between the fourth and sixth decades of life; both are associated with excellent survival after surgical treatment [10]. In contrast, primary malignant cardiac tumors often affect younger patients [5], and these tumors are associated with dismal prognosis and survival, despite extensive multimodal therapy [11,12]. Median survival is 3–12 months for sarcomas, up to 5 years for lymphomas, and 6 months for cardiac metastases [10,13–15]. In general, the clinical course of malignant cardiac tumors is characterized by aggressive growth and fatal outcome [12,16].

The clinical presentation of cardiac tumors is diverse and depends on the size and site of the tumor [6]. Cardiac tumors can be clinically silent or may cause various nonspecific symptoms [8]. While symptoms such as dyspnea, angina pectoris, cerebral or peripheral embolisms, and arrhythmias are more frequently seen in patients with cardiac tumors, systemic manifestations in the form of weight loss, fever attacks, and arthralgia can also occur, mimicking endocarditis [17–19].

Due to the high risk of embolization, sudden cardiac death, and hemodynamic compromise, immediate surgical treatment is often indicated [7,20,21]. Patients with primary malignant diseases or metastases may undergo surgery for symptomatic and palliative consideration [11].

In this article, we report our 18-year, single-center experience with surgical treatment of cardiac tumors at our institution. Our aim was to examine clinical and operative data, as well as early and long-term survival, including postoperative complications of a contemporary patient collective undergoing cardiac tumor surgery.

Material and Methods

Study population

After obtaining Institutional Review Board approval, all data for this study, including patient medical history, diagnostic and operative reports, and histological findings, were obtained from our clinical software system and analyzed. A total of 181 patients underwent surgery for suspected cardiac tumor in our institution between 1998 and 2016. In 19 of them, the preoperative diagnosis was not confirmed histologically and these patients were excluded from the study. The 162 patients with confirmed cardiac neoplastic disease were included into our analysis. Preoperative baseline characteristics, intraoperative data, and postoperative early and long-term outcomes were analyzed. The obtained surgical data were not complete in 11 cases, but the postoperative course and follow-up of these patients were completely analyzed.

Surgical techniques

Most (91.7%, n=143) surgical tumor resections were performed through standard median sternotomy, and 4.3% and 3.1% were performed through lateral thoracotomy or via clamshell thoracotomy, respectively. Most operations were performed using cardio-pulmonary bypass (CPB). The site of cannulation depended on the location of the tumor. In most cases, intraoperative transesophageal echocardiography was performed to verify the site and size of the cardiac tumor and to check postoperative functional status of the heart.

Statistical analysis

All data were analyzed using the Statistical Package for Social Sciences (IBM Corp. Released 2016. IBM SPSS Statistics for Mac, Version 24.0. Armonk, NY: IBM Corp) and are presented as continuous and categorical variables. Continuous variables are described as mean \pm standard deviation or as median in cases of asymmetrical distribution. Categorical variables are presented as absolute numbers and percentages. The percentages were not always calculated by the total of 162 patients due to absence of some surgical data in 11 cases.

Long-term survival was calculated and graphically presented using the Kaplan-Meier method. Log-rank and Breslow tests were used to confirm the statistical significance of the survival differences. Cox regression was used to determine risk factors for mortality. Odds ratio (OR) and 95% confidence interval (CI) are given for each analyzed feature. A value of $p < 0.05$ was considered to be statistically significant.

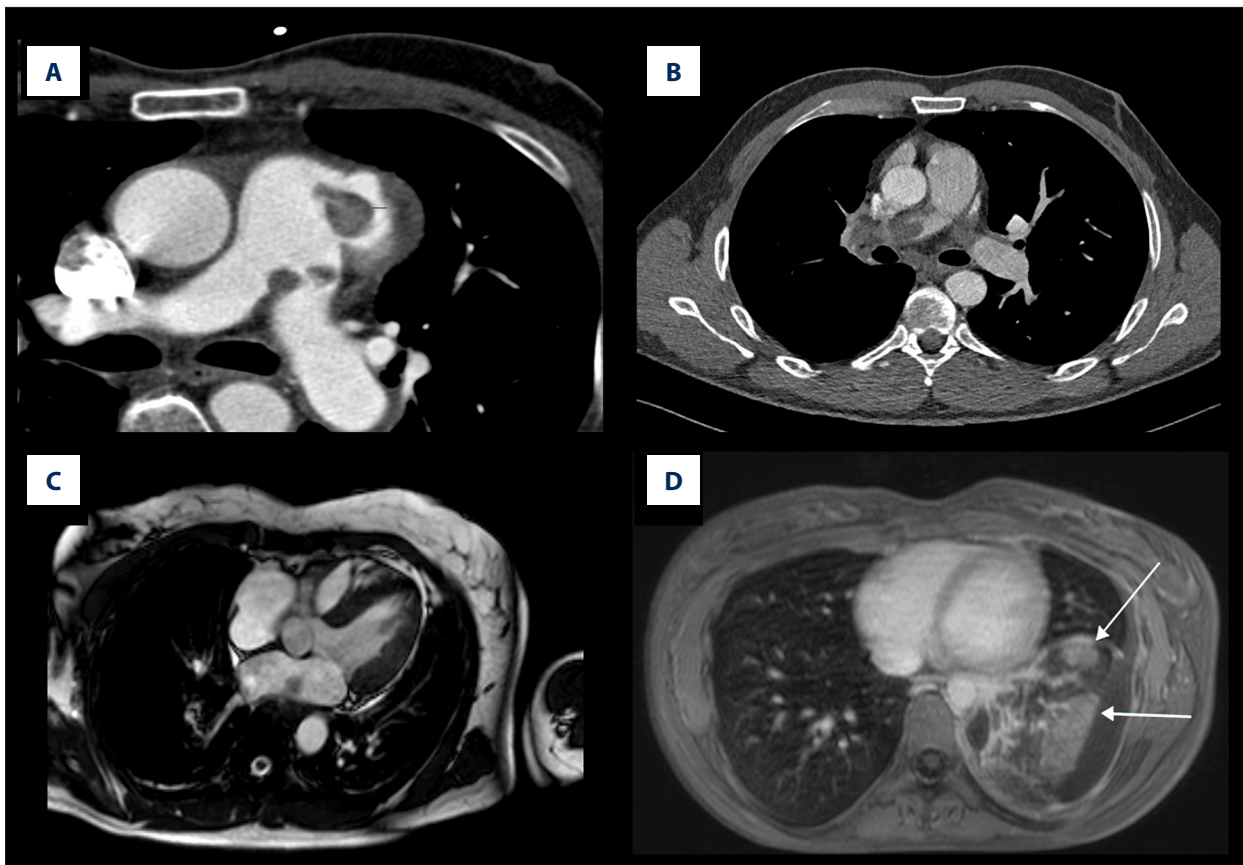


Figure 1. (A) A 63-year-old patient with angiosarcoma of the main and left pulmonary artery; computed tomography. (B) Rhabdomyosarcoma of the right lung with infiltration of the right pulmonary artery; computed tomography. (C) Left atrial metastasis of skin melanoma in a 56-year-old patient; magnetic resonance imaging. (D) Metastasis of osteosarcoma in the lower lobe of the left lung with infiltration of the left atrium through the left inferior pulmonary vein in a 23-year-old patient; magnetic resonance imaging.

Results

Tumors

The most common benign tumor was cardiac myxoma (n=102, 63%), followed by cardiac papillary fibroelastoma (n=11, 6.8%). Cardiac sarcomas (n=12; 7.4%) formed the largest group in the category of primary malignant tumors (Figure 1A, 1B); they included angiosarcomas (n=5) followed by undifferentiated sarcomas (n=4). Lymphoma was found in only 1 case. The majority of cardiac metastases (n=14; 8.6%) originated from peripheral sarcomas (gluteal soft tissue sarcoma, calcaneal chondrosarcoma, femoral osteosarcoma, and undifferentiated soft tissue sarcoma) and lung cancer (n=3). Further metastases originated from melanoma (Figure 1C), as well as anal and neuroendocrine testicular cancer. Another group had infiltrations of non-Hodgkin lymphomas and plasmocytomas (n=6, 3.7%) (Figure 1D).

In cases of benign tumors, the left side was more frequently involved, and the left atrium was the most frequent location of all benign tumors (77.8%, n=98). In 73 cases, cardiac myxomas (73% of the myxomas) originated from the interatrial septum (Figure 2A), whereas cardiac papillary fibroelastomas were predominantly found on the valve apparatus of the aortic (Figure 2B) and mitral valves (n=7; 64% of fibroelastomas). Table 1 shows location sites and histological differentiation of cardiac tumors in detail. The mean diameter of benign cardiac tumors was 33 ± 21 mm compared to 52 ± 42 mm in primary malignant tumors. The mean largest dimension of cardiac metastases (when possible to determine) was 61 ± 55 mm, and these were frequently found in the left atrium. However, in these cases, multiple secondary cardiac and mediastinal tumors were often observed.

All 181 patients underwent surgery because of suspicion of cardiac tumors. However, in 19 cases (11%) the diagnosis of primary or secondary cardiac tumor could not be confirmed. Histological examination showed endocarditis in 7 patients

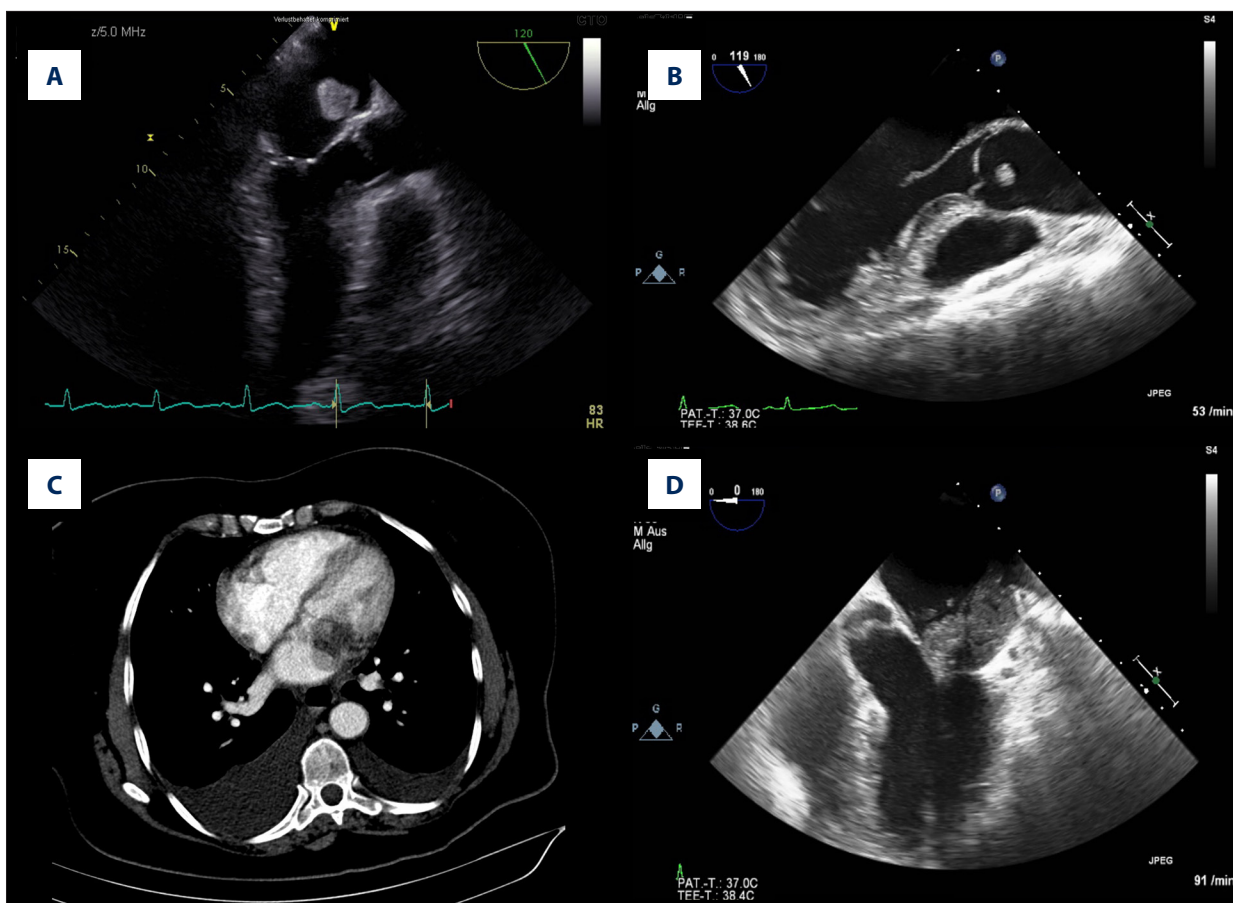


Figure 2. (A) Left atrial cardiac myxoma in a 59-year-old patient; transesophageal echocardiography. (B) Aortic valve papillary fibroelastoma in a 53-year-old patient; transesophageal echocardiography. (C) Cardiac myxoma located in the posterior leaflet of the mitral valve in a 64-year-old female patient; computed tomography. (D) The same case (C); transesophageal echocardiography.

Table 1. Characteristics of the heart tumors.

Tumor characteristics	Number of patients (valid %)
Primary intracardiac tumor	142 (87.7%)
Tumor location	
Left atrial	106 (65.8%)
Right atrial	14 (8.7%)
Pericardial	2 (1.2%)
Mediastinal	14 (8.7%)
At the atrial septum	78 (54.9%)
Ventricular	14 (9.9%)
Involvement of heart valves	22 (15.5%)
Infiltrative	5 (3.5%)

Tumor characteristics	Number of patients (valid %)
Tumor prolapse through the tricuspid valve	1 (0.6%)
Tumor prolapse through the mitral valve	7 (4.3%)
Histology	
Total resection	141 (88.7%)
Malignancy	36 (22.2%)
Myxoma	102 (63%)
Fibroelastoma	11 (6.8%)
Other benign tumors	13 (8%)
Sarcoma (primary and secondary)	19 (11.7%)
Other malign tumors	17 (10.5%)

Table 2. Patients' demographics and preoperative baseline characteristics.

Characteristics	Value	Characteristics	Value
Demographic data		Struma nodosa	
Number of patients	162		4 (2.5%)
Age (yrs)	56.6±17.6	Graves-Basedow disease	
Female	95 (58.6%)		3 (1.9%)
Body mass index (BMI)	26.3±4.8	Hashimoto disease	
Comorbidities			2 (1.2%)
Chronic obstructive pulmonary disease (COPD)	36 (23.7%)	Euthyroid struma	
Diabetes mellitus	33 (20.7%)		1 (0.6%)
Stroke	27 (17.4%)	Thyroid adenoma	
TIA	11 (7.1%)		2 (1.2%)
Peripheral thromboembolism	3 (1.9%)	Malign thyroid tumor	
Arterial hypertension	102 (67.5%)		1 (0.6%)
Coronary heart disease	86 (56.9%)	Left ventricular function	
Previous PTCA	11 (6.9%)	>55%	112 (72.7%)
Previous cardiac surgery	19 (11.9%)	45-55%	26 (16.9%)
Atrial fibrillation (chronic or paroxysmal)	24 (15.9%)	30-45%	9 (5.8%)
Preoperative sinus rhythm	138 (91.4%)	<30%	7 (4.5%)
Current smoker	48 (30.2%)	NYHA Class (1-4)	
Former smoker	26 (16.4%)	1	9 (5.8%)
Thyroid disease (also, in various combinations)		2	20 (12.9%)
Thyroidectomy or radioiodine ablation	10 (6.2%)	3	11 (7.1%)
Hypothyroidism	14 (8.6%)	4 or cardiac decompensation	11 (7.1%)
Hyperthyroidism	4 (2.5%)	Symptoms	
		None	38 (28.8%)
		Dyspnea/Angina Pectoris/Palpitations	55 (34%)
		Cerebral ischemia	17 (10.5%)
		Fever	10 (6.2%)
		Syncope	5 (3.8%)
		Dizziness	2 (1.5%)
		Peripheral embolism	2 (1.5%)

and valvular degeneration in 6 patients. These 19 patients were excluded from the statistical analysis.

Patients and symptoms

The baseline characteristics of patients are summarized in Table 2. Overall, the mean age at the time of surgery was 56.6±17.6 years and females were predominantly affected (n=78, 58.6%). In contrast, malignant tumors were mainly found in male patients (n=19, 52.8%). There were no symptoms in 38 patients (28.8%). The most frequently observed symptoms of cardiac tumors were unspecific, such as dyspnea, palpitations, and angina pectoris (34%, n=55), followed by cerebral ischemia (n=17, 10.5%), recurrent fever attacks (n=10, 6.2%), and syncope (n=5, 3.8%). Additional symptoms included dizziness and peripheral embolisms.

Functional status and comorbidities

At the time of surgery, 11 patients (7.1%) had NYHA IV and NYHA III status. In terms of heart pump function, left ventricular ejection fraction was good in 112 (72.7%) patients, and only 7 (4.5%) patients had poor ejection fraction. A total of 19 (11.9%) patients had already undergone cardiac surgery and underwent redo surgery for tumor resection. Common comorbidities were arterial hypertension (67.5%, n=102), chronic obstructive pulmonary disease (COPD) (23.7%, n=36), and diabetes mellitus (20.7%, n=33). Of the 38 (24.5%) patients who had cerebral embolism preoperatively, 27 (17.4%) had stroke and 11 (7.1%) had TIA. Only 3 (1.9%) patients had peripheral thromboembolism in their previous medical history. A total of 28 (20.1%) patients had a positive family history of tumor disease, 19 patients had other benign tumors, and 33 had other malignant tumors (Table 3). The frequency of thyroid pathology in cardiac tumor patients is remarkably high (n=35, 22.2%). Detailed characteristics of these patients are described in Table 2.

Table 3. Oncological characteristics of our patients with heart tumors.

Tumor in other locations	50 (30.9%)	
Malignant	33	(20%)
Breast cancer	4	(2.5%)
Prostate cancer	4	(2.5%)
Anal cancer	4	(2.5%)
Lymphoma	4	(2.5%)
Multiple myeloma	4	(2.5%)
Melanoma	3	(1.9%)
Colon cancer	3	(1.9%)
Sarcoma	2	(1.2%)
Cervical cancer	2	(1.2%)
Renal cancer	1	(0.6%)
Lung cancer	1	(0.6%)
Leukaemia/myeloproliferative syndrome	1	(0.6%)
Thyroid cancer	1	(0.6%)
Histiocytoma	1	(0.6%)
Benign	19	(11.7%)
Liver haemangioma	6	(3.7%)
Thyroid adenoma	4	(2.5%)
Liver cyst	2	(1.2%)
Meningioma	1	(0.6%)
Undefined lung tumor	1	(0.6%)
Uterus leiomyoma	2	(1.2%)
Cerebral haemangioma	1	(0.6%)
Acoustic nerve neuroma	1	(0.6%)
Teratoma	1	(0.6%)
Intestinal adenoma	1	(0.6%)

Surgical strategy and intraoperative variables

The operative data are presented in Table 4. Bicaval cannulation was used in 129 (79.6%) cases, followed by two-stage cannulation in 12 (7.4%) cases, and femoral cannulation in 10 (6.2%) patients. The mean CPB time was 95.8±58.9 min (n=151) and the mean cross-clamp time was 55.3±39.7 min (n=133). For myocardial protection, crystalloid cardioplegia was used in 126 (77.8%) patients and blood cardioplegia in 7 (4.3%). The mean intraoperative body temperature was 33.4±3°C. Pericardial or

Dacron patches were needed in 58.4% (n=94) of cases for reconstruction purposes. A total of 26 (16%) patients underwent concomitant cardiac surgery in addition to tumor resection. The most frequently performed concomitant procedures were valve replacement (n=11, 6.8%) and coronary artery bypass grafting (n=20, 12.4%). All valve replacements were only indicated due to tumor location involving heart valves and were not based on any other clinical indication (Figure 2C, 2D).

Postoperative outcome

The mean ICU length of stay of patients with primary cardiac tumors was 1.7±2.2 days.

Early postoperative complications included stroke (n=5; 3.3%), intracranial bleeding (n=2; 1.3%), wound infection (n=2; 1.3%), acute renal failure (n=9; 5.6%), and rethoracotomy for bleeding (n=9; 5.8%). In 1 case, extracorporeal membrane oxygenation (ECMO) was used. Another 2 patients were temporarily supported with an intraaortic balloon pump (IABP).

Sex had no influence on the outcome (p=0.138). Patients with diabetes mellitus had a higher mortality rate (OR=2.1, 95% CI from 1.2 to 3.6, p=0.009). Preoperative congestive heart failure was also a risk factor of mortality (OR=1.2, 95% CI from 1 to 1.5, p=0.03). Subtotal tumor resection was associated with higher mortality (OR=3.0, 95% CI from 1.4 to 6.3, p=0.003).

Cumulative survival was compared based on tumor malignancy and is presented in Figure 3. Early survival (30 days after surgery) was 99% in the group with benign tumors vs. 77% in patients with malignant tumors. After 1 year, the survival rates were 96% vs. 49%, respectively. In terms of long-term survival, 83% and 75% in the benign tumor group vs. 32% and 26% of the malignant tumor collective were alive at 5-year and 10-year follow-up, respectively. The differences in survival rates between these groups were highly statistically significant (log-rank p=0.000, Breslow p=0.000).

In long-term follow-up, 7 patients from the present cohort underwent redo surgery due to endocarditis (n=1), valve failure (n=1), recurrence of myxoma (n=1), and recurrences of various types of sarcomas (n=4) (left atrial synovial sarcoma, right atrial synovial sarcoma, mediastinal undifferentiated sarcoma, and rhabdomyosarcoma of the left atrium).

Cardiac tumors in children

A total of 7 children who underwent resection surgery for cardiac tumors were analyzed. Two female patients (17 years and 10 months old) had cardiac fibromas. One of them was located in the left ventricle without obstruction and had no recurrence in the follow-up time. Another fibroma caused right

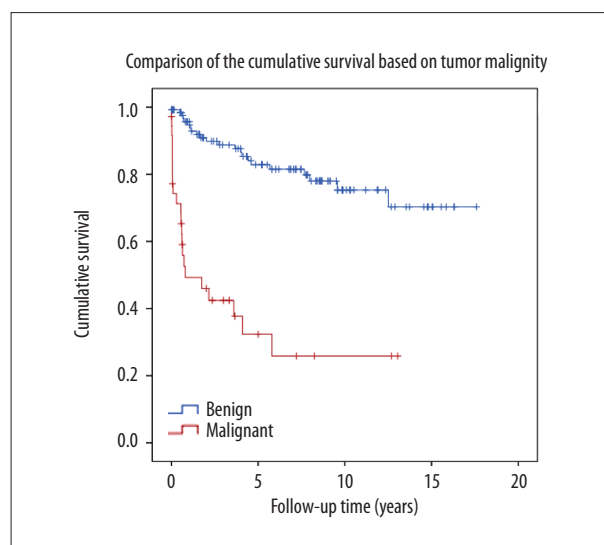
Table 4. Intraoperative data and postoperative outcomes.

Characteristics	Value
Intraoperative data	
Sternotomy	143 (91.7%)
Lateral thoracotomy	7 (4.3%)
Clamshell thoracotomy	5 (3.1%)
Bicaval cannulation	129 (79.6%)
Two-stage cannulation	12 (7.4%)
Femoral vessel cannulation	10 (6.2%)
Operation time [min]	198±100
Cardiopulmonary bypass (CPB) time [min]	95.8±58.9, n=151
Cross-clamp time [min]	55.3±39.7, n=133
Intraoperative body temperature [°C]	33.4±3
Tumor diameter [mm]	37±27
Use of patch	94 (58.4%)
Simple tumor extirpation	118 (72.8%)
Concomitant procedures	26 (16%)
CABG	20 (12.4%)
Aortic valve replacement	5 (3.1%)
Mitral valve replacement	5 (3.1%)
Tricuspid valve replacement	1 (0.6%)
Mitral valve reconstruction	3 (1.9%)
Tricuspid valve reconstruction	1 (0.6%)
Tumor removal from a valve	3 (1.9%)
Multiple valve operation	5 (3.1%)
Orthotopic autotransplantation	1 (0.6%)

ventricular outflow tract obstruction prior to surgery. Another 5-week-old boy had multiple cardiac rhabdomyomas with left ventricular outflow tract obstruction, but only 3 of them could be resected. Two pediatric patients were operated on for cardiac myxomas. One of them was a 15-year-old girl who presented with thrombotic embolism in basal ganglia. She underwent successful surgery with no recurrence during follow-up. The second case of cardiac myxoma in our pediatric population was a female patient, also with thrombotic embolism, who underwent her first surgery at the age of 17 years. Redo

Figure 3. Comparison of the cumulative survival based on tumor malignancy. Breslow p=0.000, log-rank p=0.000

Characteristics	Value
Total artificial heart	1 (0.6%)
Intraoperative transfusions	
Autotransfusion [ml]	136±341
Packed Red blood cells (RBC) [ml]	859±2049
Platelets [ml]	128±364
Fresh frozen plasma (FFP) [ml]	314±1136
Postoperative outcomes	
ICU length of stay, LOS (days)	1.7±2.2, Median=1.0
Total hospital LOS (days)	15±12, Median=13
In-hospital death	5 (3.1%)
Death after hospital discharge	44 (27.2%)
Follow up time (years)	5.2±4.7
Postoperative adverse events	
Extracorporeal membrane oxygenation (ECMO)	1 (0.6%)
Intraaortic balloon pump (IABP)	2 (1.2%)
Revision due to bleeding	9 (5.8%)
Revision due to wound infection	2 (1.3%)
Acute renal failure	9 (5.6%)
Neurological complications	
Ischemic	5 (3.3%)
Hemorrhagic	2 (1.3%)



surgery had to be performed 10 years after the primary operation due to recurrence of cardiac myxoma. A 9-year-old boy had an infected cyst in the mediastinum, which was resected completely. A 17-year-old girl underwent surgery for thoracic osteosarcoma after she had been operated on for thoracic paravertebral chordoma complicated with paraparesis. One year later, she was reoperated on for intravascular recurrence and embolism of the superior vena cava. Following this, she received chemotherapy and radiotherapy and died on day 199 after the last surgery.

Discussion

While primary cardiac tumors are very rare, metastatic tumors within the heart have been found in up to 20% of autopsies after cancer deaths. Nevertheless, very few patients are operated on due to cardiac tumors, both primary or metastatic. In our patient population, 162 patients underwent such surgery in a period of 18 years. However, up to 2500 patients/year are operated on for all cardiac surgical indications in our department. Echocardiography was our main diagnostic tool, aiding in determining tumor size and location. A small number of patients preoperatively received CT, MRI, or transesophageal echocardiography. The decision to use advanced diagnostic tools was dependent on the suspected tumor type and clinical manifestation. In cases with suspected malignancy, computed tomography or magnetic resonance imaging can improve the diagnostic approach. In recent recommendations and guidelines, there are specific characteristics of various tumor types in the diverse diagnostic tools [22–26].

Not surprisingly, myxomas were the most common primary cardiac tumor we encountered. In terms of primary malignant tumors, cardiac sarcomas were the most common malignant cardiac tumors, either primary or metastatic. Malignant tumors accounted for 22.2% of all tumors. These findings agree to a great extent with those of other groups [3–5]. The same also was true for patient age. However, in our small 7-patient group of pediatric patients, the incidence of cardiac fibroma was as high as that of myxoma, suggesting a different distribution among children. This is, however, of no statistical significance due to the small number of children in this study. In another small series with 16 pediatric patients, rhabdomyoma occurred most frequently, followed by myxoma and fibroma [27]. In the overall relatively large patient series, we found that benign tumors were more common in women, while malignant tumors were more common in men.

Neoplastic pathologies elsewhere were found in 50 patients. Even after disregarding the patients with malignant tumors, the remaining 19 patients represent 11.7% of our patient group; therefore, we speculate that people with other benign

neoplasms are more likely to develop cardiac tumors. On the other hand, of all 11 patients that had concomitant valve replacement, none had other valve pathology requiring surgery, suggesting that heart valve pathologies do not increase risk of developing cardiac tumors. In general, an attempt should always be made to preserve the valvular structure. When an extensive resection is necessary, the affected valve should be replaced. In our series, some patients had valve replacement as part of the tumor surgery.

Another interesting observation was the high prevalence of relevant thyroid disease in the study population, which was double that of the general German population [28]. This phenomenon should be examined in further studies for establishing screening recommendations.

The surgical approach (incision, cannulation for CPB, and concomitant procedures) depended on the location and size of the tumor. The use of blood or crystalloid cardioplegia, as well as cooling the patients on the CPB was according to the surgeon's preferences and did not seem to have an effect on the outcome. We tried to excise the tumors completely, with an acceptable safety margin. By virtue of the high incidence of myxomas and their abundance in the left atrium with the stalk in the interatrial septum, the approach typically used was transatrial with bicaval cannulation.

Patients with benign tumors showed better outcome with less complicated postoperative course and significantly better survival. This was due to the overall worse general condition of the patients with malignant tumors, as well as systemic involvement of neoplastic disease. Adjuvant therapy (radiation therapy or/and chemotherapy) is used in some cases of malignancy. Habertheuer and other authors showed that patients with malignant cardiac tumors who underwent adjuvant chemotherapy or/and radiation had a statistically significant survival advantage [29,30]. In fact, the therapy of almost all malignant tumors is interdisciplinary and should not be carried out by the surgeon alone.

Noticeably, performing concomitant procedures during tumor resection did not have a negative effect on the outcome. Overall, the patient group presented in this study showed acceptable disease course with results comparable to other non-tumor cardiac surgical patients treated in our department.

Nevertheless, given the rarity of all tumors involving the heart and the lack of symptom specificity, a high degree of suspicion during diagnosis is needed. Up to 12% of cases are asymptomatic and discovered incidentally, which was the case in 28.8% of our patients [31]. This is of special importance in pediatric patients, in whom cardiac tumors are especially rare. Moreover, a differential diagnosis must be kept in mind, as shown by 19

patients in our series in whom postoperative histological examination showed non-neoplastic pathology. This can account for up to 62% of all cardiac masses [32]. Despite extensive development of various diagnostic modalities, ongoing research on cardiac imaging cannot conclusively differentiate intra-cardiac masses preoperatively [33]. In our case series, fever was also noticed in patients without confirmed endocarditis, and did not help to differentiate cardiac tumors from infection. Other symptoms of cardiac tumors may include fatigue, weight loss, and joint pain. The cause of these symptoms is not well known, but is believed to be immune-mediated [34].

The relatively large and contemporary case series presented in this article demonstrates good surgical results regarding low recurrence and acceptable postoperative complications, with no or minimal effect on overall operative outcome. Diagnosis

is still a challenge, but, at least in our case series, most of the retrieved masses were confirmed as neoplasms.

Conclusions

Cardiac tumors are challenging because they are rare and it is difficult to differentiate various intra-cardiac masses preoperatively. Better diagnostic modalities should be investigated. However, in terms of therapy, surgical excision remains the best option, given the good outcome and acceptable rate of complications.

Conflict of interest

None.

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