Case Report

Pulmonary Artery Sarcoma with Extensive Invasion of the Right Ventricle: A Case Report and Review of Therapeutic Options

Alev Gumus,[1] Alain De Caevel,[2] and Bogdan F. Trifan[3]

Pulmonary artery sarcoma (PAS) is a rare, aggressive cancer originating from the intimal layer of the pulmonary artery (PA), often mistaken for pulmonary thromboembolism. This case report underscores the complex management of PAS and the necessity of a multidisciplinary approach for accurate diagnosis and treatment. A 52-year-old woman with PAS was diagnosed using imaging and therapeutic tests to distinguish it from pulmonary embolism. Primary treatment included surgical resection of the pulmonary trunk, valve, and tumor, followed by reconstruction. Complete resection was impossible due to extensive endocardial infiltration in the right ventricle, precluding cardiac transplant. The patient underwent adjuvant radiotherapy; however, the disease recurred, and she died 3 years post-diagnosis. This case highlights the rarity of an extensive right ventricle invasion, the absence of clear PAS management guidelines, and the limited evidence on the effectiveness of adjuvant therapies. It concludes that multidisciplinary teams are vital for decision-making and stresses the need for further research to establish effective treatment protocols.

Keywords: pulmonary artery intimal sarcoma, surgical treatment, adjuvant treatment, pulmonary embolism

Introduction

Pulmonary artery sarcoma (PAS) is a rare, aggressive, poorly understood disease. This cancer arises from the intimal layer of the pulmonary artery (PA). The reported incidence of PAS varies from 0.001% to 0.03%,[1)] although its precise incidence remains unclear because of the large number of undiagnosed patients. In fact, PAS is often mistaken for pulmonary embolism (PE) because their clinical and radiological signs are similar.[2,3)] In advanced cases, PAS can obstruct the PA, as the tumor grows in the lumen, and therefore causes right heart failure.[4)]

Furthermore, the insidious and nonspecific clinical signs that include chest pain, dyspnea, asthenia, and cough result in a compromised early diagnosis of the disease.[5,6)]

Imaging techniques play an important role in diagnosis and treatment decision-making.[7)] Surgery associated with chemotherapy represents the main treatment of PAS.[4,8)] However, guidelines lack to be reported in the literature, and the management of the disease is controversial on multiple levels.

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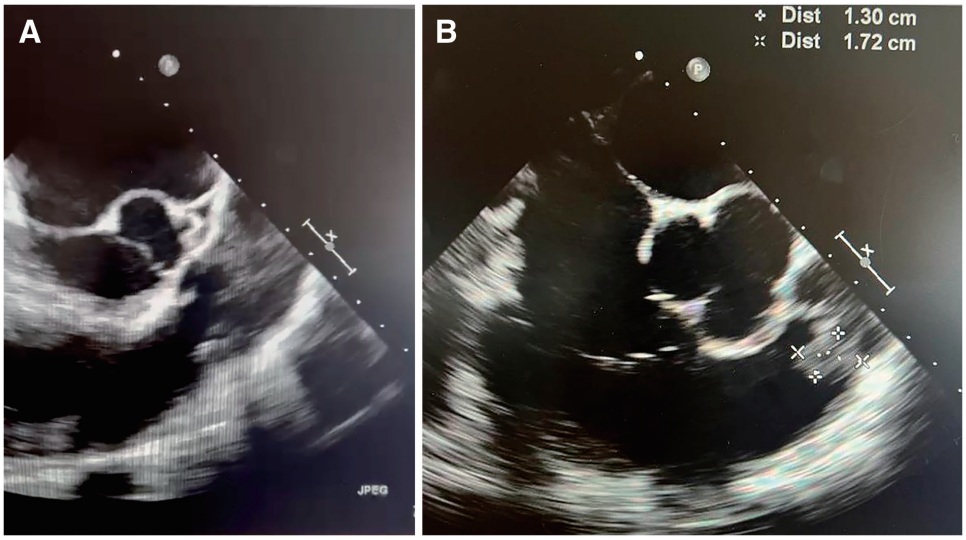

Fig. 1 (**A**) Transesophageal echocardiogram showing a mass in the PA lumen. (**B**) Transesophageal echocardiogram showing a mass on a pulmonary valve leaflet, prolapsing in RVOT. PA: pulmonary artery; RVOT: right ventricle outflow tract

Our case report highlights the importance of multidisciplinary work regarding the diagnosis and treatment, the need for a tight follow-up, and insufficient scientific reports and consensus about the disease. PAS is a challenging pathology that needs further studies to provide better management of the disease and better survival rates for patients suffering from it.

Case Report

We present the case of a 52-year-old female patient complaining of increasing dyspnea for 12 months. The surgical history of the patient involved an upper right limb melanoma, operated along with an axillary lymphadenectomy. She also went through several benign abdominal surgeries, including appendicectomy, cholecystectomy, laparotomy for acute diverticulitis, adhesiolysis, and hepatic wedge resection for benign adenomas. The patient also suffers from potomania and presents hepatic cysts. Her medications included mostly anti-depressant medications.

The patient was referred to the cardiologist at the end of 2020 by her family doctor for New York Heart Association (NYHA) grade II dyspnea. The symptoms started a few months earlier. A physical examination spotted a systolic heart murmur in the pulmonary valve (PV) area. A first transthoracic echocardiogram (TTE) was conducted, showing severe PV stenosis with suspicion of a valvular mass. TTE showed good right and left ventricular function of the heart but a moderate dilatation of the right ventricle. No other valvulopathy was described, nor was there a presence of pericardial effusion.

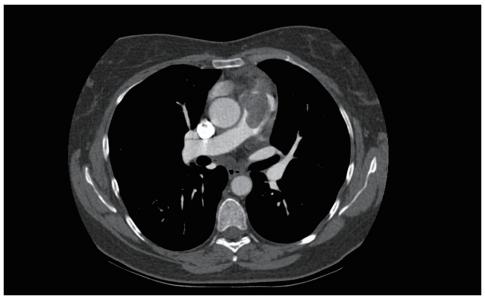

Fig. 2 Thoracic angio-CT showing tumor in the PA, measuring 35 × 28 × 21 mm. CT: computed tomography; PA: pulmonary artery

Transesophageal echocardiogram (**Fig. 1**) confirmed a 13 × 17 mm mass on one of the PV leaflets, prolapsing through the right ventricle outflow tract (RVOT), along with another more voluminous mass occupying the lumen of the root of the PA. The first mass fixation on the PV was difficult to assess. The second mass was described as a major obstacle to the ventricular ejection of the heart. The moderate dilatation of the right cavities of the heart was confirmed. Severe pulmonary stenosis was measured, with a peak gradient of 70 mmHg and a mean gradient of 50 mmHg.

The thoracic computed tomography scanner (CT scanner) confirmed a PA mass infiltrating the PV and measuring up to 35 × 28 × 21 mm (**Fig. 2**).

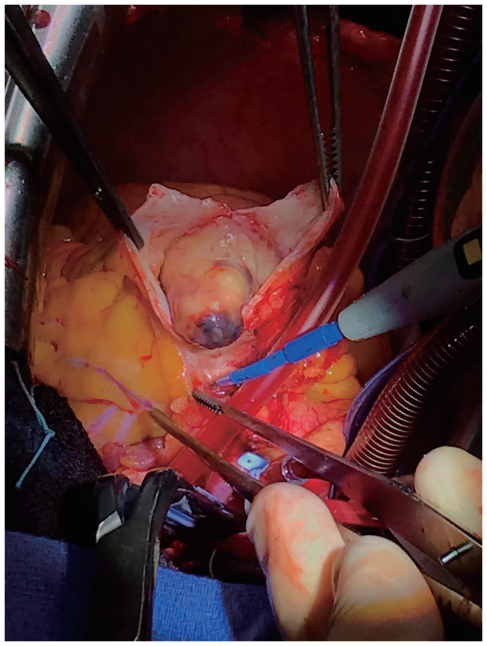

Fig. 3 Opened PA close to its bifurcation. Finding of a large tumor measuring around 4–5 cm, invading the PA wall and the PV. PA: pulmonary artery; PV: pulmonary valve

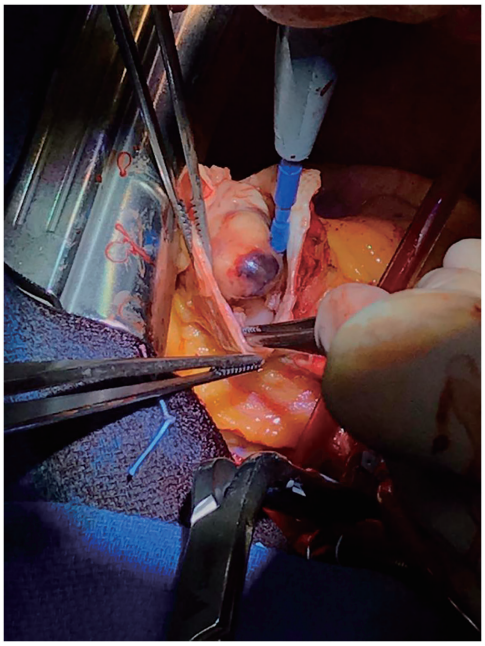

Fig. 4 Figure showing the PV which is majorly destroyed by the tumor. A tumor appendix is seen prolapsing into the RVOT. RVOT: right ventricle outflow tract; PV: pulmonary valve

At this stage, the origin and nature of the mass were unknown, and the main differential diagnosis included a thrombus versus a tumoral process. Endothelial sarcoma tumor, fibro-elastoma, myxoma, or melanoma metastasis (cancer that the patient presented a few years earlier) were suspected within the tumoral possibilities.

A therapeutic test by anticoagulation was initially carried out. After 3 months of anti-vitamin K anticoagulation, the mass did not decrease in size, and the patient's symptoms did not improve. Consequently, the diagnosis of a tumor became at this stage most likely.

A multidisciplinary heart team was then held and concluded a surgical resection indication as the first treatment of the tumor. The surgical indication was imposed by 2 arguments: oncological treatment and treatment of right heart failure.

The patient underwent surgery in April 2021. Our surgical treatment consisted of a total resection and replacement of the pulmonary trunk and PV.

The operation was performed under normothermic cardiopulmonary bypass between the aorta and the 2 vena cavas. An invagination was seen at the bulb of the PA after opening the pericardium by external inspection. However, no tumoral signs were visible outside the artery or the heart. Sequenced anterograde cardioplegia was performed every 15–20 minutes. After cardiac arrest, the PA was opened close to its bifurcation. A large tumor was found, measuring around 4–5 cm, invading the PA wall and the PV (**Fig. 3**). The PV was majorly destroyed by the tumor. A small part of the tumor, corresponding to an appendix, was prolapsing into the RVOT (**Fig. 4**).

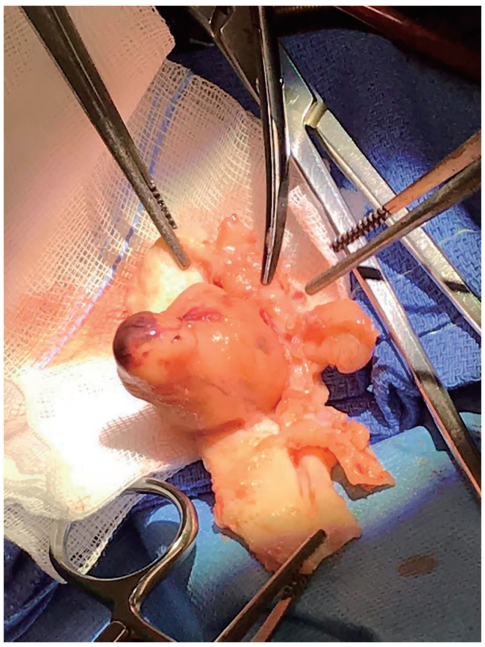

Fig. 5 "En bloc" mass resection of the pulmonary trunk and RVOT, containing the mass. RVOT: right ventricle outflow tract

We decided to perform a total "en bloc" resection of the pulmonary trunk, along with the PV and the first centimeter of the RVOT (**Fig. 5**).

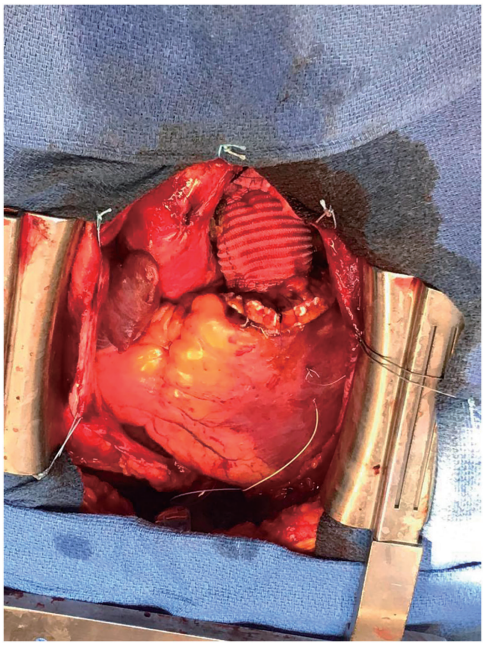

Fig. 6 Result of reconstruction with a previously prepared valved tube graft using a Dacron tube graft (30 mm) onto which we stitched a 25 mm bioprosthesis. The direct proximal anastomosis was conducted on the RVOT and distal anastomosis close to the PA bifurcation. RVOT: right ventricle outflow tract; PA: pulmonary artery

Following that, an exploration of the right ventricle showed signs of an extensive tumoral invasion of its endocardium. At this stage, we noted that a radical resection of the tumor was not possible since it would have needed an almost total resection of the right ventricle. Subsequently, we stopped the resection at this point and performed biopsies of the right ventricle endocardium that were sent to pathology. The reconstruction was performed with a previously prepared valved tube graft using a Dacron tube graft (Intervascular SAS, La Ciotat, France) (30 mm) onto which we stitched a 25 mm bioprosthesis (**Fig. 6**). Direct proximal anastomosis was conducted on the RVOT and distal anastomosis close to the PA bifurcation.

Weaning of the extracorporeal circulation was achieved without complications. The patient was transferred to the intensive care unit and extubated 5 hours later.

No complication was reported during postoperative recovery. The patient was monitored in the intensive care unit for 4 days because of a transitory hypoxemia, treated by noninvasive ventilation. When parameters and hemodynamic conditions were in a favorable state, she was transferred to the surgical normal care unit. Four days after surgery, a TTE showed a normal functional PV bioprosthesis with a peak gradient of 6 mmHg and a mildly altered right ventricular function. Oral anticoagulation with acenocoumarol was initiated for 3 months. The patient was discharged on the sixth day of the postoperative course.

Histopathological examinations revealed tumorous alterations developed in the intimal space, consistent with an intimal sarcoma (**Fig. 7**). Molecular cytogenetics by fluorescence in situ hybridization (FISH) detected an MDM2 gene amplification at 12q15 in the sample, which was compatible with the histological diagnosis of sarcoma developed at the expense of the intima. Distal pulmonary trunk margins were negative, but proximal right outflow track margins, as well as the biopsies taken from the right ventricle endocardium, were positive, shifting surgical treatment from complete resection to debulking. The operation improved heart failure by removing PV stenosis and replacing it, enhancing right ventricular function. A heart transplant was considered but rejected due to the patient's oncological status and recurrence risk.

The patient's follow-up included clinical and imaging assessments. Two months after surgery, positron emission tomography (PET)/CT, MRI, and CT scans showed no distant metastasis but confirmed local right ventricle invasion (**Fig. 8**). The patient underwent local radiotherapy 3 months post-surgery (56 Gray). In the first year, she showed clinical improvement with reduced dyspnea. However, 7 months post-surgery, a thoracic CT revealed a 6-mm nodule in the right lung. Seventeen months after surgery, follow-up imaging showed disease progression with increased nodule size and new nodes, leading to a second radiotherapy session targeting those nodes (60 Gray). Nineteen months after surgery, a thoracic CT showed a decrease in the original nodes, but a new upper right lobe mass appeared. Twenty months after surgery, PET/CT revealed further disease progression, including new masses and metastases on thoracic and abdominal levels, along with declining right ventricular function and recurring dyspnea.

Despite advanced disease, the patient remained clinically stable for several months, living at home with oxygen dependency. Thirty-one months after surgery, she was hospitalized due to worsening right ventricular dysfunction from tumor recurrence, with complete obstruction of the main right PA (**Fig. 9**). She succumbed to complications from right heart failure around 33 months post-surgery.

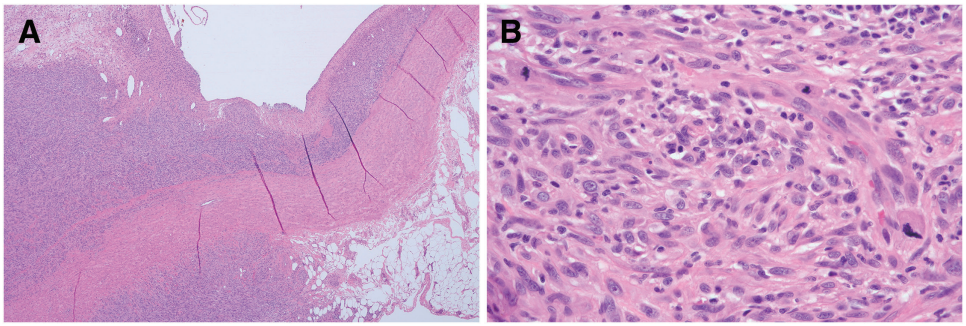

Fig. 7 Pathology reports. (**A**) Histological findings of resected specimens showing malignant tumorous alterations developed in the intimal space of the PA (H&E ×10). (**B**) The tumor showed the proliferation of atypical spindle cells, forming multidirectional bundles. A pronounced mitotic activity is noted, along with significant cellular atypia (H&E ×40). H&E: hematoxylin and eosin; PA: pulmonary artery

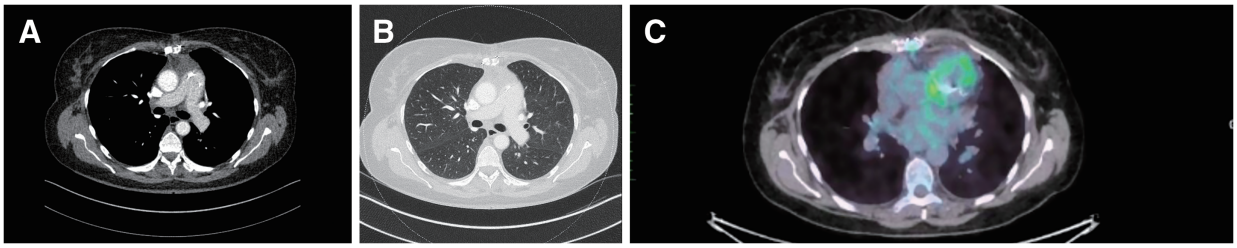

Fig. 8 (**A**) and (**B**) Two months after surgery, the thoracic CT scanner showed no distant metastasis. (**C**) Two months after surgery, PET/CT confirmed the local invasion of the right ventricle. PET/CT: positron emission tomography/computed tomography

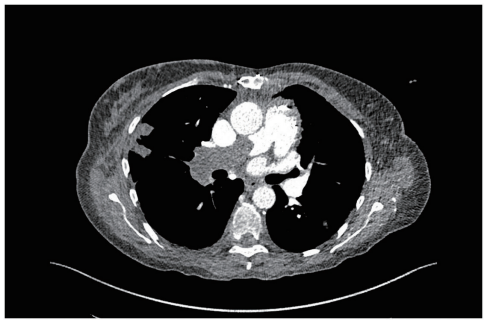

Fig. 9 Two years after surgery, the thoracic CT showed complete obstruction of the main right PA. CT: computed tomography; PA: pulmonary artery

Discussion

PAS is an unknown, rare, and aggressive tumor. A consensus on the management of the disease remains unclear, resulting in a poor prognosis. Symptoms are unspecific and may include cardiopulmonary manifestations, evidence of cardiac obstruction, and distal embolization.[3,7] Severe symptoms can be simulated by pulmonary stenosis or right heart failure.[9] The tumor's location predominantly influences clinical manifestations. These nonspecific symptoms often lead to an incorrect diagnosis of PE. Nevertheless, differential diagnosis with PE is crucial since treatment drastically differs. Starting anticoagulation treatment for a misdiagnosed PAS thought to be a PE may delay the right and most effective treatment and thus may increase mortality.[2,7] Imaging is the key to diagnosing PAS while excluding PE.[7,10] Imaging will define characterizations of the tumor, such as location, mobility, size, and extension (e.g., invasion of PV or outflow tract, metastases). Although locoregional extent typically occurs in the direction of the flow toward the lungs and thus retrograde invasion is less common,[11] few cases of PAS invading the PV and the RVOT have been reported.[12–14] The use of CT scanners, TTE, transesophageal echocardiography, MRI, and PET/CT will describe the features of the tumor[3,7,9] and might detect the presence of a right ventricle invasion.[7,15] On preoperative imaging of our patient, extensive right ventricle endocardium invasion was not suspected, and extension was thought to be only limited to the RVOT. Moreover, MRI may play a notable

role, offering information on both the tumor's extent and its characteristics (localization and differentiation).[11,15] All these findings about the tumor will define the course of treatment. Imaging examinations should be repeated to stage and monitor the response to treatment.[9]

In addition, endocardial biopsies proceeded by right heart catheterization can provide the definitive diagnosis and histological type of PAS.[3,9,16] However, limitations of this technique have to be considered, such as insufficient amount of specimen collection,[16] tumor emboli, bleeding, pseudoaneurysm, and harming contiguous structures.[17]

Several studies agree that surgery is likely considered to be the key to treatment and is mainly performed to prolong the patient's survival time rather than cure the disease.[4,5,11] Survival time without operation of PAS is estimated to be 1.5 months.[5,8]

However, we lack precise guidelines on which surgical options to choose because of a small number of reported cases and the absence of standard preoperative conditions such as tumor location, extension, and the patient's overall cardiopulmonary status.[5] Local surgical treatment is essentially based on radical tumor resection reaching negative surgical margins, showing an improvement of the illness.[10] Partial removal of the tumor only allows a temporary solution, even though it can help decrease cardiac symptoms and delay progression.[9]

Surgical resection possibilities are diversified, depending on tumor size and location, and include mostly pulmonary endarterectomy (PEA) but also PA resection, pneumonectomy, extensive tumor resection, palliative PA stenting, or debulking.[3,6] Extensive resection can include resection of left or right PA, PV, or right outflow tract, depending on the tumor's location.[6]

Some small reviews indicate that PA endarterectomy remains the most widely performed surgery for PAS.[5]

However, a few series declared that PEA may not be sufficient, and complete aggressive resection of the diseased segment of the PA is preferred to obtain an R0 result,[6,7,18] but more powerful studies are needed to confirm these findings.

Furthermore, each radical surgical resection has to be followed by complex reconstructions.[7] Reconstruction of the PA can be performed with a Dacron graft, PA allograft, or bovine pericardium.[7,19] This PA reconstruction can be associated with a PV prosthesis if the latter needs to be resected. In our case, the intraoperative discovery of the extensive RV endocardium invasion did not allow to perform a radical resection, and this type of large retrograde extent is exceptionally reported in the literature. One case of similar extensive right ventricle involvement by a recurrent PAS was reported, but it was also without the feasibility of radical resection.[19] In this latter case, a palliative tumoral excision was performed by a direct RV approach, closed with a Hemashield patch to avoid stenosis on recurrence.[19] The rare reports of extensive RV invasion by PAS increase the difficulty in defining the management of the disease when PAS is not limited to the PA. In these advanced cases, involving an extension to the RV or the lung, surgical resection, as radical as possible, should be performed.[19] Consequently, heart or heart–lung transplantation may become an option to achieve total resection and has been considered an option for curative treatment in young patients. However, the outcomes have generally been disappointing due to the local and distal extent and aggressiveness of the tumor in the majority of these patients.[9,20] In other situations, surgical treatment has to be performed in an emergency. Hence, optimal radical resection or heart transplant cannot immediately proceed. This increases local recurrence, spread of metastases, adhesions, and difficulties in reoperating and performing a heart transplant in a later stage.[9]

Moreover, discussions remain challenging around heart transplantation indications as the prognosis of PAS is poor, and organ shortage is a real issue. Receiving patient's status and survival chances should be carefully assessed, knowing that transplantation may be the only treatment possible.[9]

In addition to tumor resection and/or transplantation, multimodal treatment involving the combination of neoadjuvant and adjuvant chemotherapy and/or radiotherapy has been proposed. Neo-adjuvant chemotherapy is initiated to facilitate local surgical resection by tumor regression and to prevent and decrease the progression of distant metastases.[9,10] Reported cases show that chemotherapy alone yields poor outcomes.[8] Several other reports conclude that radiotherapy has also a role to play in PAS treatment and showed that it might increase the length of survival.[5,18]

Considering these findings in the literature, we can conclude that the preferred therapy for PA sarcoma typically involves neoadjuvant chemotherapy (when feasible), surgical resection with removal of the PA segment, and reconstruction.[7,10] Treatment can be enhanced with adjuvant chemotherapy and/or radiotherapy. Follow-up with imaging is imperative.

In our case, the patient underwent surgery followed by 2 radiotherapy sessions for local recurrence and distant

metastasis, which prolonged her survival by up to 3 years. This underscores the role of adjuvant radiotherapy in extending survival.

Given the absence of clear consensus, the difficult management and treatment of PAS should be conducted by experienced centers following multidisciplinary discussions, including different specialties such as radiology, cardiology, oncology, radiotherapy, and cardiothoracic surgery.

Conclusion

PAS is an uncommon challenging disease. Disease management should focus on differential diagnosis with PE, appropriate imaging, preoperative catheter-guided biopsies, and discussion among multidisciplinary teams in experienced centers to determine the best medical and surgical treatment options. Delayed diagnosis or inadequate management tends to reduce the survival rates of this complex pathology.

However, precise guidelines are lacking in the literature, and the management of the disease is still controversial on different levels. Current treatment relies on a surgical radical resection and chemotherapy (adjuvant and/or neoadjuvant), sometimes combined with adjuvant radiotherapy. These combined treatments seem to increase long-term survival. Further research is needed to confirm the benefits of adjuvant treatment and determine appropriate indications, in particular of radiotherapy.

Currently, surgical techniques are determined on a case-by-case basis depending on tumor characteristics and the experience of the surgeon. Our case describes a rare situation of an extensive retrograde invasion of the right ventricle unexpectedly discovered intraoperatively. Furthermore, special attention must be given to the presence of right ventricle invasion during the preoperative evaluation, in addition to a meticulous intraoperative exploration. Retrospectively, in our case, additional preoperative MRI and/or PET/CT, along with right ventricle catheter-guided biopsy, could have helped diagnose the invasion of the right ventricle. Resection of the pulmonary trunk and outflow tract followed by reconstruction with a valved tube proved to be a safe procedure. Although radical resection was not possible in our case, the aggressive palliative resection combined with radiotherapy seems to have prolonged our patient's survival up to 3 years.

Reported algorithms for precise surgical techniques and medical management are rare and insufficiently described to assist surgeons facing PAS, especially in situations of extent to the RVOT and RV endocardium. More studies are necessary to establish pathways for controlling this aggressive disease through improved diagnosis, multimodal treatment, and surgical algorithms to optimize patient survival outcomes.

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Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Informed consent was obtained from the patient for this case report.

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Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Author contributions

Alev Gumus gathered the patient's medical record information, reviewed related literature, and contributed to the manuscript from its initial drafting to the final version. Alain De Caevel made the clinical initial diagnosis and contributed to the cardiological follow-up of the patient throughout the treatment, particularly by sharing reports of complementary exams like echocardiography results. Bogdan F. Trifan performed the surgical procedure and was involved in sharing multimedia data such as intraoperative photographs, collecting the patient's medical record data, assisting in the writing process of the final version, and providing supervision and guidance throughout the project. All authors read and approved the final version of the manuscript.

Disclosure statement

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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