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*Original Article*

# Sarcoma of the mitral valve causing coronary arterial occlusion in children

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**Abstract** Primary tumors of the cardiac valves are rare. One of the most common reasons that left-sided cardiac tumors come to clinical attention is embolization to the systemic circulation. We present two children who suffered left coronary arterial occlusion due to embolization of a sarcoma of the mitral valve. A 6-year-old female who had been admitted to the hospital after cerebrovascular embolization of a fragment of sarcoma of the mitral valve experienced sudden cardiovascular collapse due to occlusion of the left coronary artery. She was placed on extracorporeal membrane oxygenation, and underwent coronary embolectomy and resection of the tumor from the mitral valve and its tendinous cords. Left ventricular function did not improve, and she underwent orthotopic heart transplantation. On follow-up 32 months after transplant, the patient is well, with no evidence of recurrence of or metastasis from the tumor. The tumor arose from the leaflets and tendinous cords of the mitral valve, and was composed grossly of multiple white nodules. Histopathologic evaluation disclosed fragments composed predominantly of peripheral spindle cells in an extensive fibromyxoid stroma. The mildly pleomorphic cells of the tumor gradually blended with adjacent pieces of the mitral valvar leaflet and tendinous cords. Immunohistochemical studies revealed strong staining for vimentin, smooth muscle actin, muscle specific actin, and myoglobin, suggesting myogenic differentiation. The other patient was a 2½-year-old female who died suddenly at home. Grossly and histologically, the tumor was essentially identical to the first case, and there was a 3 cm string-like extension passing into the orifice of the left coronary artery. To put the cases in context, we compare them with other descriptions of this rare type of tumor.

PRIMARY TUMORS OF THE CARDIAC VALVES ARE extremely uncommon, especially in children.[1] Sarcoma of the mitral valve is one of the rarest forms of cardiac tumor with, to the best of our knowledge, only two previously reported cases.[2,3] An important complication of such tumors, which often brings them to clinical attention, is embolization to the systemic circulation.[4,5] We present young children in whom fragments of a mitral valvar sarcoma embolized to the left coronary artery, causing myocardial infarction.

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## Patients and results

The first patient was a 6-year-old female who was transported to our institution after presenting at an outside hospital with sudden onset of right hemiplegia 6 days earlier. A magnetic resonance scan of the brain at the outside center showed infarction of the left cerebral hemisphere in the distribution of the middle cerebral artery. Echocardiography revealed a fibrillary mass attached to the mitral valve. She was placed on systemic heparin, but developed signs consistent with a second cerebral embolization, so she was transferred to our institution and scheduled for surgical removal of the tumor. The morning following transfer, the patient suffered a sudden cardiovascular collapse associated with seizure activity. She could not be resuscitated due to severe cardiac dysfunction and was placed on extracorporeal membrane

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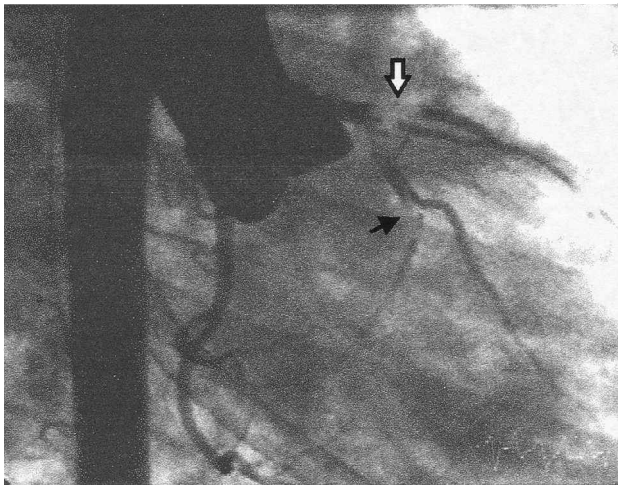

**Figure 1.**
*Aortic root angiogram in the right anterior oblique projection in the first patient shows an irregular filling defect in the main stem of the left coronary artery, with extension into the left anterior descending, intermediate, and circumflex branches (hollow arrow). A separate filling defect is seen more distally in the circumflex branch (solid arrow).*

oxygenation via the right carotid artery and jugular vein. Echocardiography at that time demonstrated virtual absence of left ventricular function, but with good right ventricular function. Cardiac catheterization and angiography, performed as an emergency, revealed nearly complete occlusion of the main stem of the left coronary artery, with extension of the embolus into the circumflex and left anterior descending coronary arteries (Fig. 1). From the catheterization suite, she was taken directly to the operating room for removal of the cardiac tumor and coronary revascularization.

After initiation of cardiopulmonary bypass, extracorporeal membrane oxygenation was discontinued and the cannulas were removed. The right carotid artery and jugular vein were repaired because of the prior left hemispheric stroke. A right atriotomy was performed and retrograde cardioplegia was administered through the coronary sinus. The ascending aorta was incised and the orifice of the left coronary artery was inspected. Approximately 1 mm of white, bead-like fibrous material was visible extending from the coronary arterial orifice into the sinus of Valsalva. Gentle traction was applied with forceps, and a 4 cm fragment of fibrillary tumor material was extracted. Forceps were inserted into the artery, and approximately 2 cm of additional tumor was removed. Antegrade and retrograde cardioplegia was administered, and there did not appear to be residual obstruction of the left coronary artery. The mitral valve was then examined through the aortic valve and right atriotomy by way of an atrial septal incision. There was a small amount of a similar appearing mass attached to the atrial and ventricular surfaces of the aortic leaflet of the valve at the posteromedial end of the commissure between the leaflets, and to the posteromedial papillary muscle and its tendinous cords. This was resected and the defect repaired by commissuroplasty of the posteromedial end of the commissure of the mitral valve. As the patient was warmed, sinus rhythm returned spontaneously and left ventricular function appeared somewhat improved. After discontinuation of bypass, however, the patient was hypotensive and left atrial pressure ranged from 25–30 mmHg, so a left ventricular assist device was placed and the patient was returned to the intensive care unit.

Although the ventricular function improved over the following week as judged by serial echocardiographic examinations, she could not be weaned from the assist device, again with left atrial pressure rising above 20 mmHg. Ten days after embolectomy, the patient underwent an orthotopic heart transplant. On follow-up evaluation 32 months later, the patient is alive and well on a standard immunosuppressive regimen. Annual computed tomography scans of the head have shown no evidence of intracranial mass lesions consistent with metastasis.

Histopathologic evaluation of the embolized fragment and excised mass disclosed fragments composed predominantly of peripheral spindle cells in an extensive fibromyxoid stroma, with focuses of central necrosis. The tumor cells gradually blended with adjacent pieces of the leaflet and tendinous cords (Fig. 2A), and were mildly pleomorphic. The elongated nucleuses contained small nucleoluses (Fig. 2B). Mitotic figures averaged one per high power field. Immunohistochemical studies revealed strong staining for vimentin, smooth muscle actin (Fig. 2C), muscle specific actin, and myoglobin, suggesting myogenic differentiation. Negative stains argued against tumors with epithelial, vascular, and neural differentiation.[6] The Ki-67 proliferative index was approximately 10% (Fig. 2D). The margins of the resected valvar tissue were free of tumor. The explanted heart had extensive necrosis throughout the entire left ventricle and septum. There was no evidence of thrombus or embolus in the left coronary artery or its major branches.

The second case was a 2½-year-old female with a past medical history significant only for several urinary tract infections and vesicoureteral reflux. She had no known cardiac disease, and no documented history of a cardiac murmur. She died suddenly at home after a witnessed period of crying. At autopsy, the heart was found to be normal except for the presence of multiple white 5 mm verrucous nodules attached to both leaflets of the mitral valve and their

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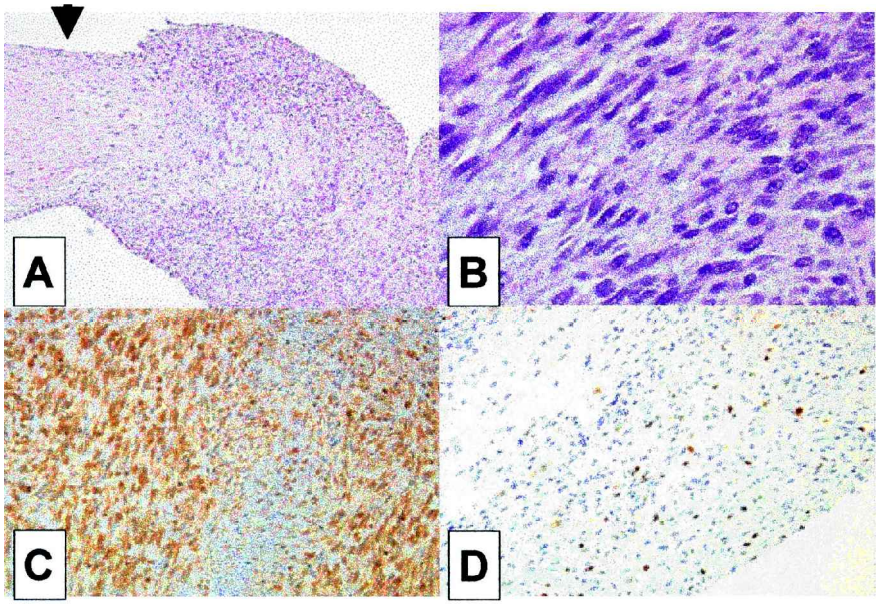


**Figure 2.**
*Histopathologic sections of the tumor in the first patient. (A) This low-power image demonstrates continuity between the tumor (right) and a tendinous cord of the mitral valve (arrow, left). (B) This high-power image shows the cytologic features of the tumor, with compact arrangement of uniform spindle cells and no visible mitosis. (C) Immunohistochemical stain for smooth muscle actin with strong biotin-avidin staining. (D) Ki-67 staining shows a low proliferative index.*

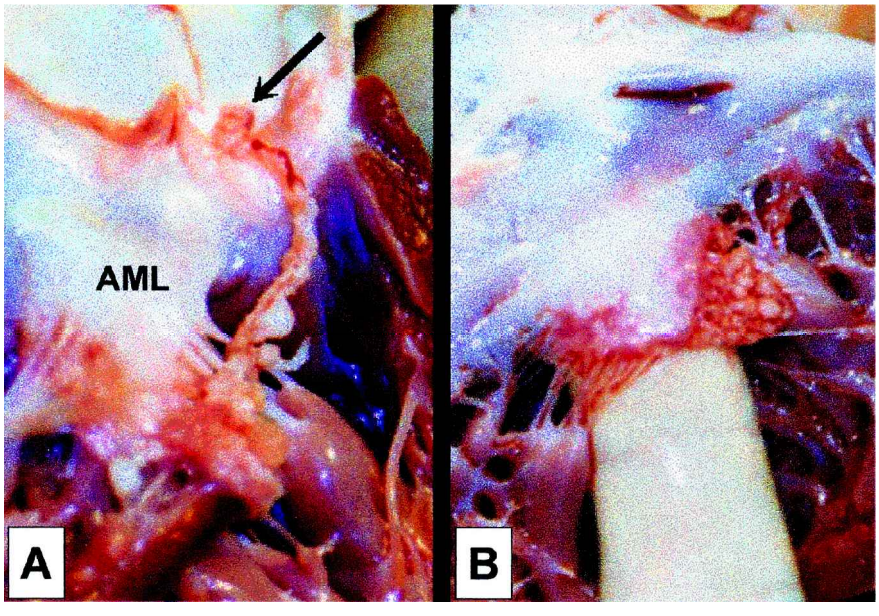


**Figure 3.**
*Photographs of the gross pathologic specimen of the heart in the second case. (A) The multinodular tumor can be seen arising from the ventricular surface of the aortic leaflet of the mitral valve (AML) and its tendinous cords, with a stringlike extension passing through the aortic valve and into the orifice of the left coronary artery (arrow). (B) The tumor is also seen arising from the atrial surface of the mural leaflet of the mitral valve and its tendinous cords.*

tendinous cords, with a beaded string-like extension measuring 3 cm in length arising from the tendinous cords of the aortic leaflet of the mitral valve, passing through the aortic valve, and into the orifice of the left coronary artery (Fig. 3). The immediate cause of death was determined to be acute myocardial infarction due to occlusion of the left coronary artery. Histopathologic examination disclosed very similar features to the previous case.

## Comment

Acute coronary arterial occlusion by embolized cardiac tumors is uncommon. Although a relatively high percentage of tumors arising from the left heart are complicated by embolization to the systemic circulation, such tumors are rare, and the predominant site of embolism is the brain.[4,5] Only a handful of cases have been described of cardiac tumors embolizing to the coronary circulation,[4,5] and only one that we are aware of in a child.[7] The most common types of cardiac tumor causing embolic complications are myxoma and papillary fibroelastoma, both of which occur much more frequently in adults than in young children.[4,5] In our first patient, the mass was initially thought to be most consistent with a papillary fibroelastoma, based on the small fibrillary mass visualized on echocardiography. Although the overall

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tumor was larger than a typical papillary fibroelastoma, which is generally a small papillary mass with a discrete pedunculated origin from the valvar tissue, the bulk of the tumor had fragmented and embolized to the systemic circulation, and thus was not seen on the echocardiogram. As most embolic complications resulting from papillary fibroelastomas of the mitral valve are thought to be thrombotic rather than due to dislodgement of the tumor itself, making anticoagulation a potentially effective therapy, distinction of the types arising from the cardiac valves may have implications for management.[8]

When cardiac tumors cause coronary occlusion, the presenting symptoms depend on the extent and distribution of the occlusion and underlying comorbidity, and are typical of more common causes of myocardial infarction. With extensive occlusion of the left coronary arterial system, our first patient developed sudden cardiovascular collapse and almost certainly survived only because she happened to be in the hospital already, with extracorporeal membrane oxygenation readily at hand. The second patient was not so fortunate and died at home.

Interestingly, the pathologic features of the tumors in our two cases were the same. They were consistent with primary sarcomas involving the mitral valve with apparent myogenic differentiation, an extremely rare form of tumor that has been reported only twice before, as far as we are aware. The first report of this type of tumor, published in 1986 by Hajar et al., was termed an embryonal botryoid rhabdomyosarcoma of the mitral valve.[2] This report did not include extensive description of the histology or immunohistochemistry of the mass, so the specific cellular features cannot be compared with our cases. The gross appearance of the mass and its anatomic location, nonetheless, were sufficiently similar that the tumor was very likely the same type as our two cases, and the appellation "rhabdomyosarcoma" suggests that the authors determined the tumor to be of myogenic differentiation, as appeared to be the case in our patients. In the other previously reported case, Itoh et al. described a primary sarcoma of the mitral valve in a 7-month-old infant that was diagnosed after cerebral embolization of the tumor caused a stroke.[3] The gross and microscopic features of the tumor, including additional immunohistochemical analysis performed on the specimen by Becker and van der Wal,[9] were essentially identical to our cases.

The natural history of this rare type of cardiac tumor is not known. It is not clear whether the tumor is of malignant potential, though features consistent with a sarcoma suggest that it may be. In our first patient, this has been an issue of concern, inasmuch as she is on post-transplant immunosuppressive therapy, and the coronary embolic event was preceded by embolization of tumor fragments to the brain. Hence, if the tumor is indeed malignant, these two factors would likely place her at increased risk for cerebral metastasis. Follow-up computed tomography scans of the brain have been normal. This, along with the low proliferative index and paucity of mitotic activity in the tumor suggest that, if the tumor is cytogenetically malignant, it is of a very low grade. Continued close follow-up will hopefully clarify this issue.

## References

1. Marx GR. Cardiac tumors. In: Emmanouilides GC, Riemenschneider TA, Allen HD, Gutgesell HP (eds). Moss and Adams Heart Disease in Infants, Children and Adolescents, 5th edition. Williams and Wilkins, Baltimore, 1995, pp 1773–1786.
2. Hajar R, Roberts WC, Folger GM. Embryonal botryoid rhabdomyosarcoma of the mitral valve. Am J Cardiol 1986; 57: 376.
3. Itoh K, Matsumura T, Egawa Y, Watanabe M, Ohshio T, Ohta A, Hayabuchi Y, Seki K. Primary mitral valve sarcoma in infancy. Pediatr Cardiol 1998; 19: 174–177.
4. Shahian DM, Labib SB, Chang G. Cardiac papillary fibroelastoma. Ann Thorac Surg 1995; 59: 538–541.
5. Burke AP, Virmani R. Cardiac myxoma: a clinicopathologic study. Am J Clin Pathol 1993; 100: 671–680.
6. Burke A, Virmani R. Primary cardiac sarcomas. In: Tumors of the heart and great vessels. Atlas of Tumor Pathology, Third Series, Fascicle 16. Armed Forces Institute of Pathology, Bethesda, MD, 1996, pp. 127–170.
7. Tanabe J, Williams RL, Diethrich EB. Left atrial myxoma: association with acute coronary embolization in an 11-year-old boy. Pediatrics 1979; 63: 778–781.
8. Roberts WC. Papillary fibroelastomas of the heart. Am J Cardiol 1997; 80: 973–975.
9. Becker AE, van der Wal AC. Leiomyosarcoma on an infant's mitral valve. Pediatr Cardiol 1998; 19: 193.

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