



## Clinical Observations

## Cardiac Myxoma Causing Acute Ischemic Stroke in a Pediatric Patient and a Review of Literature

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## ABSTRACT

**BACKGROUND:** Ischemic stroke in the pediatric population is a rare occurrence, and its possible causes span a wide differential that includes atrial myxomas. Myxomas are friable cardiac tumors that produce “showers” of emboli resulting in transient neurological deficits, cutaneous eruptions, and ophthalmologic deficits. **PATIENT:** We present an 11-year-old boy with a months-long history of an intermittent spotted “rash” who presented with acute ischemic stroke caused by a left atrial myxoma. We also review clinical features in all 16 other cases of cardiac myxoma causing pediatric stroke reported in the literature. **RESULTS:** Our case, along with the review of the literature, highlights the fact that myxomas often initially present as stroke with acute hemiplegia and transient cutaneous eruptions due to fragmentation of the tumor. **CONCLUSIONS:** Cardiac myxoma should be considered in any child presenting with ischemic stroke, and transient skin findings may provide an important diagnostic clue prior to onset of neurological symptoms.

**Keywords:** cardiac myxoma, stroke, acute hemiplegia, evanescent rash, retinal artery occlusion, children

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## Introduction

Ischemic stroke is an uncommon phenomenon in children and the list of possible causes is long. Primary cardiac tumors are rare in children and do not often cause cerebrovascular disease. However, when the tumor is a friable myxoma and is located in the left side of the heart, cerebral embolization can result from thrombi or tumor fragmentation. Other manifestations of the tumor are consistent with peripheral embolization and include transient hemiparesis, cutaneous eruptions, and loss of or blurry vision. Currently, only 16 cases of cardiac myxoma initially presenting as ischemic stroke in patients younger than 18 years of age have been reported in the literature. We describe the seventeenth case and review the other cases to determine what signs and symptoms may be clinical clues to alert others to suspect cardiac tumor.

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## Case report

An 11-year-old white male presented to the emergency department with sudden onset left-sided hemiparesis, dysarthria, and right gaze preference with concern for stroke. His medical history was unremarkable, and he was playing soccer at school when he collapsed with left-sided hemiparesis. His examination revealed total left-sided neglect, left hemiplegia, gaze deviation to the right, left facial weakness, and left ankle clonus. Computed tomography/computed tomography angiography of the head demonstrated a right proximal middle cerebral artery occlusion with collateralization. He underwent an emergency mechanical thrombectomy and, per the surgical report, the thrombus appeared “fatty” but was not sent for review by pathology.

Upon further questioning, the boy parents denied any family history of stroke or hypercoagulability. However, for the last 3 months they had noticed an intermittent spotted “rash” on both feet that was occasionally painful (Fig 1). He had been seen by four different providers and had been diagnosed with fungal infection, Raynaud's, and chilblains (pernio). Postoperative magnetic resonance imaging (MRI) revealed acute ischemia involving the right basal ganglia, posterior parietal lobe, (Fig 2) precentral gyrus, occipital lobe, and right temporal lobe. Laboratory evaluation revealed a mildly elevated C-reactive protein (3.3 mg/L) and erythrocyte sedimentation rate (ESR; 25 mm/hr) with normal lipids and negative hypercoagulable studies. An echocardiogram showed a large mass (4 × 4 cm) in left atria (Fig 3 with associated real-time video) A large gelatinous myxoma was successfully removed.

**FIGURE 1.**

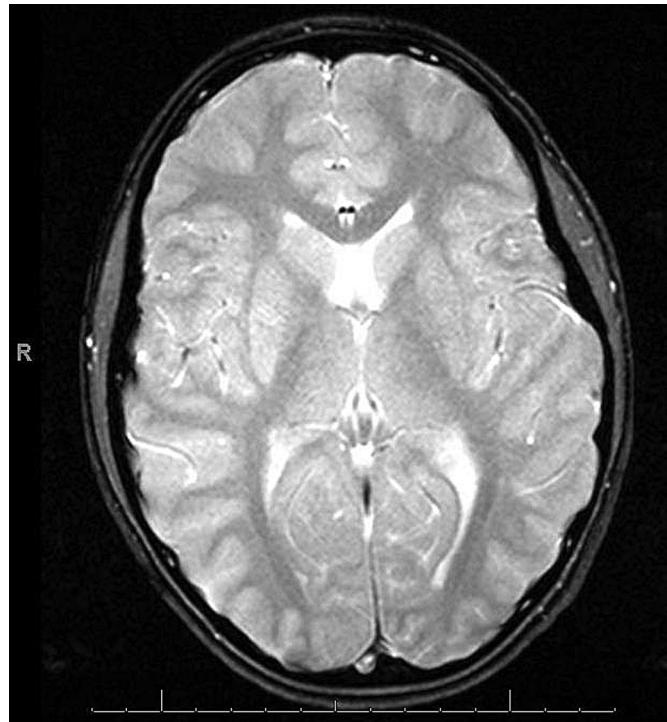
Patient's "rash": nontender, nonpalpable erythematous lesions demonstrating the cutaneous manifestations of atrial myxoma emboli. (Color version of figure is available in the online edition.)

He remained hospitalized for 10 days and aspirin was started on hospital day 2. His neurological examination at discharge revealed 4/5 left upper- and lower-extremity strength, mild persistent facial weakness, and mild dysarthria. He was discharged to inpatient rehabilitation, met rehabilitation goals, and successfully returned to school 2 months after his initial presentation. He is currently asymptomatic with mild, persistent, left-sided weakness.

## Discussion

Although rare, ischemic stroke represents a significant burden in terms of mortality (up to 20%) and permanent morbidity (50–80%) in the pediatric population.<sup>1</sup> The majority of ischemic strokes present with hemiplegia, but seizures are also common and can occur in up to 50% of children with ischemic stroke.<sup>2</sup> In children, the differential diagnosis for ischemic stroke is broader than in adults and should include: fatty embolus, hypercoagulable state, endocarditis, tumor, sickle cell anemia, and inflammatory disorders. The heart is the most common source of cerebral emboli in children, and although rhabdomyomas are the most common primary pediatric cardiac tumor, myxomas are more likely to embolize as the result of their friable nature.

Between 20% and 45% of patients with myxoma have symptomatic emboli and if left sided, half of these emboli affect the brain, most commonly causing occlusion of the middle cerebral or supraclinoid internal carotid artery.<sup>3,4</sup> Oftentimes, neurological deficits are the first symptom of heart disease.<sup>3</sup> Embolism to other organs is also reported in 10–45% of cases, occurring in the spleen, adrenals, intestine, kidneys, abdominal aorta, and limb arteries and also causing visual disturbances and cutaneous eruptions.<sup>5</sup> Cutaneous emboli cause splinter hemorrhages, Osler nodes, Janeway lesions (visible at presentation in our patient), and conjunctival petechiae.<sup>3</sup> Emboli are usually myxomatous in nature (as with our patient) but can also be thrombotic, as pieces of the thrombus adherent to the tumor break off and embolize as well. In addition to symptomatic emboli, myxoma patients may develop

**FIGURE 2.**

Postoperative magnetic resonance imaging after mechanical thrombectomy via an endoscopic approach demonstrates an acute right basal ganglia infarction.

constitutional symptoms, including fatigue, malaise, dizziness, anorexia, and weight loss.<sup>5</sup>

In adults and older children, embolism and constitutional symptoms are the most common clinical features of cardiac myxoma.<sup>6</sup> Sixty-four percent of all pediatric patients present with congestive heart failure, with most of these being infants, as their smaller hearts have less capacity to support a rapidly growing myxoma.<sup>6</sup> Our literature review revealed no patients younger than 3 years of age presenting with ischemic stroke, likely because the myxoma presents as congestive heart failure without embolism in these individuals. For this reason, despite its benign histology, cardiac myxoma often proves fatal in infants, and stroke is not typically seen.<sup>6</sup> Although cardiac myxomas are benign tumors, it is important to note that there is at least one example in the literature of malignant myxosarcoma in a 2 year-old girl who presented with right hemiplegia with angiographic demonstration of multiple occlusions of left middle cerebral artery.<sup>7</sup>

Diagnosis of atrial myxoma is typically achieved by echocardiography because the electrocardiogram is nonspecific.<sup>7</sup> Other laboratory can help to rule out other causes of stroke, such as hypercoagulability. Typically, C-reactive protein and ESR levels are both increased, with ESR typically being around 65 mm/hr.<sup>5,7</sup> Currently, the treatment for stroke due to atrial myxoma is prompt surgical removal of emboli and of the primary tumor.<sup>4</sup>

The Table summarizes the children with ischemic stroke caused by cardiac myxoma from the literature along with our patient.<sup>3,4,8–19</sup> A 16-year-old subject is included in one of the reports, but the clinical details are not discussed.<sup>5</sup> In all

**TABLE.**

Clinical summary of 14 pediatric cases of cerebrovascular infarction attributable to cardiac myxoma

Reference	Age/ Gender	Location of Tumor	Presentation	Other Symptoms	Murmur	Brain Imaging/ Arteriography	Outcome After Removal of Myxoma
3	10 yr, M	Left atrium	Dizziness, ataxia, diplopia	Red spots on left foot	No	MRI: lesions of cerebellum, corpus callosum, right parietal	Normal
3	11 yr, F	Left atrium	Right hemiparesis, expressive aphasia	Red spots on hands and feet, retinal artery occlusion	No	MRI: infarcts of both hemispheres MRA: normal	Left hemiparesis
4	14 yr, F	Left atrium	Right hemiparesis, aphasia, dysarthria, lethargy	Cool right leg	Yes	MRI: left hemisphere lesion MRA: absent flow in left ICA, MCA	Nonfluent aphasia
8	5 yr, F	Left atrium, anterior mitral valve leaflet	Left hemiparesis, seizures, loss of consciousness	None	No	CT: normal, MRI*: new left MCA infarct, old right MCA infarct	Recurrence of tumor
9	17 yr, M	Left atrium	Right hemiparesis, lethargy	None	No	Angiogram: left MCA occlusion	Right hemiparesis, dysphasic speech
10	15 yr, F	Left atrium, right atrium	Right hemiparesis, headache	None	No	CT: left intracerebral hemorrhage angiogram: small fusiform aneurysm of right MCA	Impaired fine motor of right hand, recurrence of tumor
11	8 yr, M	Left atrium	Right hemiparesis, seizures, aphasia	Red spots on hands and feet, retinal artery occlusion	No	MRI: multiple cerebral lesions	Right hemiparesis, visual impairment
12	10 yr, F	Left atrium, left ventricle	Right hemiparesis, left eye blindness	Retinal artery occlusion	No	CT: hypodensities in left internal capsule and corpus callosum angiogram: fusiform aneurysms left ACA, MCA	Right hemiparesis, left eye blindness, recurrence of tumor
13	3 yr, M	Left atrium	Right hemiparesis	Red spots left foot	No	None	Died
14	8 yr, F	Left atrium	Right hemiparesis, expressive aphasia	Pulmonary embolus?	Yes	MRI: left MCA infarct MRA: complete occlusion left MCA	Not reported
15	8 yr, M	Left atrium	Fever, fatigue, shortness of breath, weight loss, anemia, intermittent blurry vision	None	Yes	MRI: multiple emboli in frontal area	Normal
16	11 yr, F	Left atrium	Vertigo, right hemiparesis, dysarthria	Dizziness, intermittent blindness of right eye	No	CT: hypodensities in left internal capsule and caudate nucleus	Normal
17	13 yr, F	Left atrium	Left hemiparesis, dysarthria	Hyperpigmented skin spots	No	MRI: left MCA infarct Initial CT negative, repeat CT with large right frontoparietal ischemic region	Recurrence of tumor
18	12 yr, M	Left atrium	Left hemiparesis, confusion, dysphagia, dysarthria	Bilateral leg pain, cellulitis, vomiting, faintness	Yes	None	Leg amputation
18	7 yr, M	Left atrium	Right hemiparesis, right hemianopia, dysarthria	Leg pain	Yes	Carotid arteriography: middle cerebral artery occlusion	Right hemiparesis, dysarthria, intellectual disability
19	8 yr, F	Left atrium	Left hemiparesis	Leg discoloration and pulselessness	No	Right carotid arteriography: "atrophy" and ischemia	Right hemiplegia, gangrene of two toes
Case 1	11 yr, M	Left atrium	Left hemiparesis, dysarthria, left gaze preference	Red spots on hands and feet	No	CT/CTA: right proximal MCA infarct	Left hemiparesis; dysphasic speech

## Abbreviations:

ACA = Anterior cerebral artery

CT = Computed tomography

CTA = Computed tomography angiography

F = Female

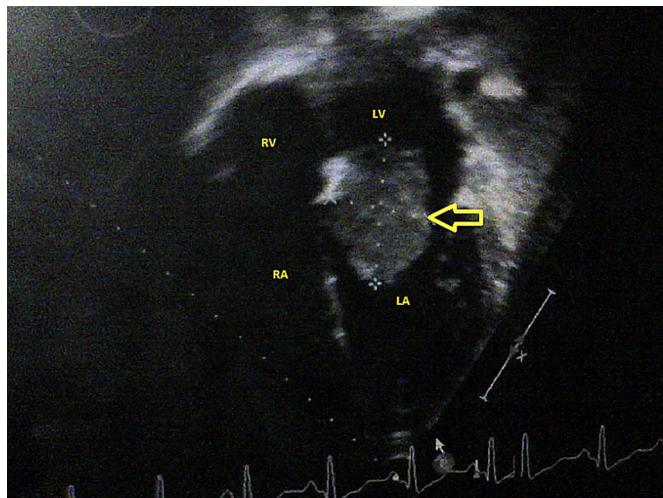
ICA = Internal carotid artery

M = Male

MCA = Middle cerebral artery

MRI = Magnetic resonance imaging

\* Obtained with recurrent lesion.

**FIGURE 3.**

Transthoracic echocardiogram in apical four-chamber view demonstrating a large heterogeneous  $4 \times 4$  cm left atrial (LA) mass (indicated by arrow) adherent to interatrial septum and prolapsing through the mitral valve into the left ventricle (LV) during diastole. RA, right atrium; RV, right ventricle. (For accompanying video please reference the online version of the article.) (Color version of figure is available in the online edition.)

cases, the tumor was located in the left atrium. Patients' ages ranged from 3 years to 18 years, and nine of the 17 (53%) were female. In all but two cases, hemiparesis was the presenting symptom, most commonly right-sided hemiparesis (67% of those presenting with hemiplegia). "Red spots" was commonly used in literature to describe transient cutaneous eruptions most likely caused by embolic lesions.<sup>1</sup> Our patient's family referred to it as a rash, and it was previously misdiagnosed by three different providers. This skin finding was present in six of the 17 cases in the literature (35%), but cutaneous symptoms such as pulselessness, cool extremities, or discoloration was described in an additional four patients (resulting in 59% with cutaneous symptoms). Retinal artery occlusion was present in three of the 17 (18%). An additional two patients experienced intermittent loss of or blurry vision without retinal artery occlusion at the time of presentation, making five in total (29%) who experienced vision problems associated with the atrial myxoma. Only five of the 17 patients (29%) had cardiac murmurs at the time of diagnosis. All of the patients underwent resection of the cardiac tumor. One patient died as the result of complications associated with resection, nine patients experienced residual neurological deficits, and four patients had recurrence of the tumor, possibly because of incomplete resection.

A second distinct tumor or recurrence of tumor is rare (reportedly 1–5%, although 24% of our cases), but the recurrent tumors can grow rapidly. Some individuals experience complete regrowth of a tumor within 4 months' time, and recurrence has been reported up to 11 years after the original tumor discovery.<sup>20</sup> Therefore, close monitoring after resection of the tumor is warranted, typically with echocardiography every 4–6 months initially and then annually after that.<sup>20</sup> Additionally, familial occurrence of cardiac myxomas occurs in about 10% of the patients, typically in adult relatives. These patients tend to present

with Carney complex, with hyperpigmentation, other neoplasias, and endocrine disorders.<sup>3,4,17</sup> For this reason, it may be reasonable for family members receive a screening echocardiogram to rule out hereditary tumor, especially if any other symptoms of the complex are present.

In addition to cerebral infarction from systemic emboli, cardiac myxomas are also linked to the development of cerebral aneurysms, sometimes years after successful surgical removal of the myxoma.<sup>21</sup> These aneurysms are rare, as only 40 cases have been reported in the adult literature and the mechanism for their development remains unknown. Theories include invasion of the cerebral arteries by tumor cells or vascular occlusion by tumor cells leading to pseudo aneurysm formation. Aneurysms have been reported up to 25 years after resection of the cardiac tumor.<sup>21</sup> Therefore, clinical and radiological follow-up, including cerebral angiography and MRI, are critical in cardiac myxoma patients, even after apparently successful resection.

## Conclusions

Cardiac myxoma should be considered in any child presenting with signs and symptoms of ischemic stroke. Stroke is typically not seen in infants, who are more likely to decompensate as the result of heart failure without progressing to embolization. Transient skin mottling, Osler nodes, Janeway lesions, and splinter hemorrhages may provide important diagnostic clues before the onset of neurological symptoms. Any patient with myxoma needs a dilated eye examination to rule out any retinal artery lesions and close cardiac and neurological follow-up with routine echocardiograms looking for tumor recurrence and cerebral angiography and MRI to monitor for cerebral aneurysms caused by the myxoma.

## Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.pediatrneurol.2014.01.011>.

## References

- Roach S, Golomb M, Adams R, et al. Management of Stroke in Infants and Children: A Scientific Statement from a Special Writing Group of the American Heart Association Stroke Council and the Council on Cardiovascular Disease in the Young. *Stroke*. 2008;39:2644–2691.
- Yang J, Park Y, Hartlage P. Seizures associated with stroke in childhood. *Pediatr Neurol*. 1995;12:136–138.
- Al-Mateen M, Hood M, Trippel D, Samuel JI, Otto RK, Vitikainen KJ. Cerebral embolism from atrial myxoma in pediatric patients. *Pediatrics*. 2003;112:e162–e167.
- Bayir H, Morelli PJ, Smith TH, Biancaniello TA. A left atrial myxoma presenting as a cerebrovascular accident. *Pediatr Neurol*. 1999;21:569–572.
- Knepper LE, Biller J, Adams Jr HP, Bruno A. Neurologic manifestations of atrial myxoma: a 12 year experience and review. *Stroke*. 1988;19:1435–1440.
- Padalino M, Basso C, Svaluto Moreolo G, et al. Left atrial myxoma in a child: case report and review of the literature. *Cardiovasc Pathol*. 2003;12:233–236.
- Mahar LJ, Lie JT, Groover RV, et al. Primary cardiac myxosarcoma in a child. *Mayo Clin Proc*. 1979;54:261–266.
- Ghosh A, Bhattacharyya A, Niyogi P. Recurrent left atrial myxoma with recurrent stroke. *Indian Pediatr*. 2001;38:1190–1192.
- Tipton BK, Robertson JT, Robertson JH. Embolism to the central nervous system from cardiac myxoma: report of two cases. *J Neurol*. 1977;47:927–940.

10. Bobo H, Evans OB. Intracranial aneurysms in a child with recurrent atrial myxoma. *Pediatr Neurol*. 1987;3:230–232.
11. Tonz M, Laske A, Carrel T, et al. Convulsions, hemiparesis and central retinal artery occlusion due to left atrial myxoma in a child. *Eur J Pediatr*. 1992;151:652–654.
12. Hung PC, Wang HS, Chou ML, et al. Multiple cerebral aneurysms in a child with cardiac myxoma. *J Formos Med Assoc*. 1992;91:818–821.
13. Goldberg HP, Glenn F, Dotter CT, et al. Myxoma of the left atrium: diagnosis made during life with operative and post-mortem findings. *Circulation*. 1952;6:762–767.
14. Landes C, Baumann R, Coffrill CM. Embolic strokes in an 8-year-old girl. *Neurology*. 2000;55:146.
15. Sernich S, Chauhan A, Singh D, Fuchs H, Caspi J. Left atrial myxoma in a child: a challenging diagnosis of a rare lesion. *World J Pediatr Congenit Heart Surg*. 2013;4:220–222.
16. Ruiz Pérez L, Sempere Pérez A, García Alonso A, Alenda González C, Flores Serrano J. Cerebrovascular stroke as a sign of atrial myxoma in childhood [in Spanish]. *An Pediatr (Barc)*. 2003; 58:273–276.
17. Briassoulis G, Kuburovic V, Xekouki P, et al. Recurrent left atrial myxomas in carney complex: a genetic cause of multiple strokes that can be prevented. *J Stroke Cerebrovasc Dis*. 2012;21:914. e1–914.e8.
18. Pridie R. Left atrial myxomas in childhood: presentation with emboli – diagnosis by ultrasonics. *Thorax*. 1972;27:759–763.
19. Beanlands D, Dolan D, Shane S. Myxoma of the left atrium – case report. *CMAJ*. 1960;83:715–717.
20. Reynen K. Cardiac myxomas. *N Engl J Med*. 1995;333:1610–1617.
21. Sedat J, Chau A, Dunac N, et al. Multiple cerebral aneurysms caused by cardiac myxoma. *Interv Neuroradiol*. 2007;13:179–184.

*There is no grail more elusive or precious in the life of the mind than the key to understanding the human condition. It has always been the custom of those who seek it to explore the labyrinth of myth: for religion the myths of creation and the dreams of prophets; for philosophers, the insights of introspection and reasoning based upon them; for the creative arts, statements based upon a play of the senses.*

Edward O. Wilson  
*The Social Conquest of Earth*