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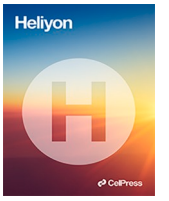

Case report

Two cerebral infarctions caused by thrombus and myxomatous embolus in a patient with cardiac myxoma: A case report

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ABSTRACT

An increasing number of cases of cerebral embolism caused by cardiac myxoma have been reported. However, cerebral infarction caused by different types of emboli obstructing different vascular regions within a short period of time has not been reported. This is the first report to histologically confirm cerebral infarctions independently caused by thrombus and myxomatous embolus in a patient with cardiac myxoma within a period of 23 days. The first cerebral infarction was due to embolization of thrombus to the right middle cerebral artery, whereas the second was due to embolization of tissue from a mucinous tumor to the left middle cerebral artery. Both cerebral infarctions underwent mechanical thrombectomy, but unfortunately, we ultimately failed to save the patient's life. Therefore, further attention should be paid to the surgical resection and treatment of cardiac myxoma.

1. Introduction

Cardiac myxomas are the most common benign tumors among primary cardiac tumors and are most commonly found in the left atrium [1–3]. The largest known case review to date demonstrated that the mucinous tumors were located in the left atrium in 54 out of 55 patients and in both atria in only one patient [4]. The triad of its clinical symptoms includes valve obstruction, systemic symptoms, and embolic events [5–8]. Of these, cerebral embolism is relatively common among patients who experience embolic events [5,8,9]. Studies have shown that vascular events, including transient ischemic attack (TIA) and stroke, are the most common (36.3 % of cases) events, followed by headache, seizures, dizziness, loss of consciousness, and subarachnoid hemorrhage, while asymptomatic cases are less common (only 3.6 % of cases) [4]. Clinically, atrial mucinous tumors are frequently detected after a stroke as the first event [10,11]. However, clinical randomized controlled trials and prospective studies cannot be conducted due to the rarity of cerebral infarction resulting from cardiac myxoma. Therefore, the current case report remains of great value. In this case report, we demonstrate evidence of cerebral infarction in different regions of the brain resulting from mixed thrombosis and myxomatous

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embolus using histopathologic examination findings.

1.1. Case presentation

A 65-year-old woman presented to the hospital with left limb immobility, an inability to stand, nausea, and vomiting. The patient had an atrial mucinous tumor and had not undergone atrial mucinoma resection. Additionally, the patient had a 2-year history of hypertension for which she was being administered oral felodipine on weekdays; however, her blood pressure was poorly controlled. The patient had no previous history of other chronic diseases or other cardiovascular risk factors, and her family history was unremarkable. No new hemorrhagic or infarct foci were seen on cranial CT (Computerized Tomography) immediately after admission, but acute cerebral infarction was considered based on the patient's symptoms, signs, and past history (Fig. 1a). The patient had no previous similar events and had no history of impaired consciousness or TIA (Transient Ischemic Attack). This embolic event was the first manifestation of the disease. After the exclusion of relevant contraindications and the administration of alteplase intravenously for thrombolysis, the patient's symptoms slightly improved. However, the mouth was slightly deviated to the left, and the muscle strength in the left limbs ranged from grades two to three. Half an hour after admission, percutaneous cerebral artery stenting, cerebral artery thrombolysis (stent retriever), and cerebral angiography were performed. Right middle cerebral artery embolization was observed during the surgery (Fig. 1b and c). Cranial MR (Magnetic Resonance) imaging revealed multiple foci of acute-subacute infarction in the brain (predominantly in the right temporal lobe), multiple foci of ischemia and infarction in the brain, ischemic changes in the cerebral white matter, and a vacuolated butterfly saddle (Fig. 1d). On the sixth postoperative day, a cranial CT revealed a patchy, low-density shadow with blurred borders in the right temporal lobe. No obvious abnormality was observed on the cranial CT performed on the day of the right cerebral infarction, but infarct foci were found on the cranial CT performed on the sixth day after the operation. This further confirmed the occurrence of the right cerebral infarction, the specific infarct site, and the extent of the infarction, and showed that the results of the cranial CT had a lagging effect (Fig. 1e). A transthoracic echocardiogram revealed an isoechoic mass in the left atrium, and the mass measured approximately 6.18 × 2.64 cm in the four-chamber cardiac view. It had a narrow tip, was attached to the atrial septum, had a base width of approximately 12 mm, and had an irregular surface. (Fig. 1f and g). During mechanical thrombectomy,

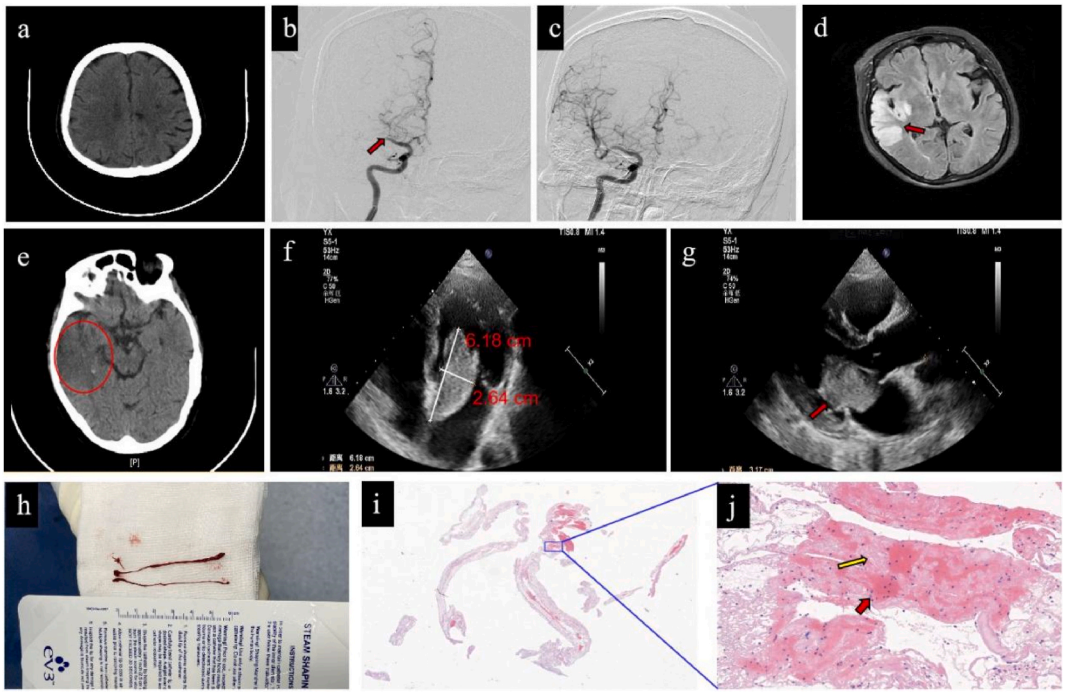

Fig. 1. **a**. No new hemorrhagic foci or infarct foci were seen on cranial CT. **b**. An angiography shows complete occlusion of the right middle cerebral artery (red arrow). **c**. Complete recanalization after mechanical thrombectomy is seen. **d**. A brain MRI performed on the second day after angiography showed multiple foci of acute-subacute infarcts in the brain, which are prominent in the right temporal lobe (red arrow). **e**. A cranial CT reveals a patchy low-density shadow with blurred borders in the right temporal lobe (red circle). **f**. A transthoracic echocardiogram reveals a 6.18 × 2.64 cm mucinous tumor in the atrium. **g**. The transthoracic echocardiogram suggests that the mass enters the left ventricle through the mitral valve and occludes the mitral orifice during left ventricular diastole (red arrow). **h**. The general appearance of the first embolus that was removed: two strips of tissue, 7–7.5 cm in length, 0.1–0.2 cm in diameter, grayish-yellow and grayish-red in color, and medium in texture, were observed. **i**. A low-magnification view of the mixed thrombus (hematoxylin and eosin stain, 6× magnification). **j**. Localized magnification of the mixed thrombus (hematoxylin and eosin stain, 100× magnification): the pale red, irregular area indicates platelet trabeculae (yellow arrow) in the mixed thrombus; the dark red area between the platelet trabeculae indicates a red blood cell-dominated thrombus (red arrow). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

two strips of tissue were removed from the cerebral vessels. They were 7–7.5 cm in length, 0.1–0.2 cm in diameter, grayish-yellow and grayish-red in color, and medium in texture (Fig. 1h). The pathological features of the embolus and the clinical presentation were consistent with those of a mixed thrombus (Fig. 1i and j). The patient's condition was stable after surgery, but the condition may have deteriorated in the acute phase of the disease, with sequelae such as large cerebral infarction, cerebral edema caused by over-perfusion, and cerebral hemorrhage. The patient and her family were asked to express their understanding and actively cooperated with the medical team during the performance of comprehensive treatments such as anticoagulation, fiber reduction, blood circulation activation, cerebral circulation improvement, nerve nourishment, and promotion of neurological function recovery. The patient was discharged after she improved.

The patient had a second acute cerebral infarction 23 days after the initial one. The main symptoms were impaired consciousness and failure to respond to calls. The patient's pupils were equal in size, round, and responsive to light. The patient was uncooperative during the limb muscle power examination, and there was a positive Bartholomew's sign on the right side. An emergency cranial CT did not reveal any new infarcts or hemorrhagic foci. Based on the patient's history of cerebral infarction, the history of an atrial mucinous tumor, and the patient's symptoms and signs, cerebral infarction was still considered (Fig. 2a). After admission to the hospital, a mechanical thrombectomy (direct aspiration) for stroke was performed. Intraoperatively, embolization of the left middle cerebral artery was seen, and the left middle cerebral artery was revascularized after mechanical thrombectomy. However, the distal end of the middle cerebral artery (M2) was not visualized (Fig. 2b and c). During the operation, a pile of fragmented tissue was removed from the cerebral vessels. It measured 1.8 × 1.5 × 0.8 cm, was gray to gray-red in color, and had a medium texture (Fig. 2d). Its intraoperative pathology (cerebral thrombosis) revealed stellate and polygonal cells in a mucus-like stroma. A myxomatous embolus originating from the cardiac myxoma could not be ruled out due to her medical history. (Fig. 2e). Furthermore, AB-PAS suggested that the thrombus was mucinous (Fig. 2f). Immunohistochemical staining showed strong positivity for CD34, CD31, vimentin, and Ki-67 (Fig. 2g–j). The tissue was also positive for ERG, factor VIII, calretinin, SMA, desmin, CKAE1/AE3, MDM2, GFAP, and S100 (Supplementary Information Fig. 1). Although no autopsy was performed, this pattern is consistent with that of previous studies on cardiac myxoma. Due to the large cerebral infarction, cerebral herniation, and central respiratory failure, the condition was

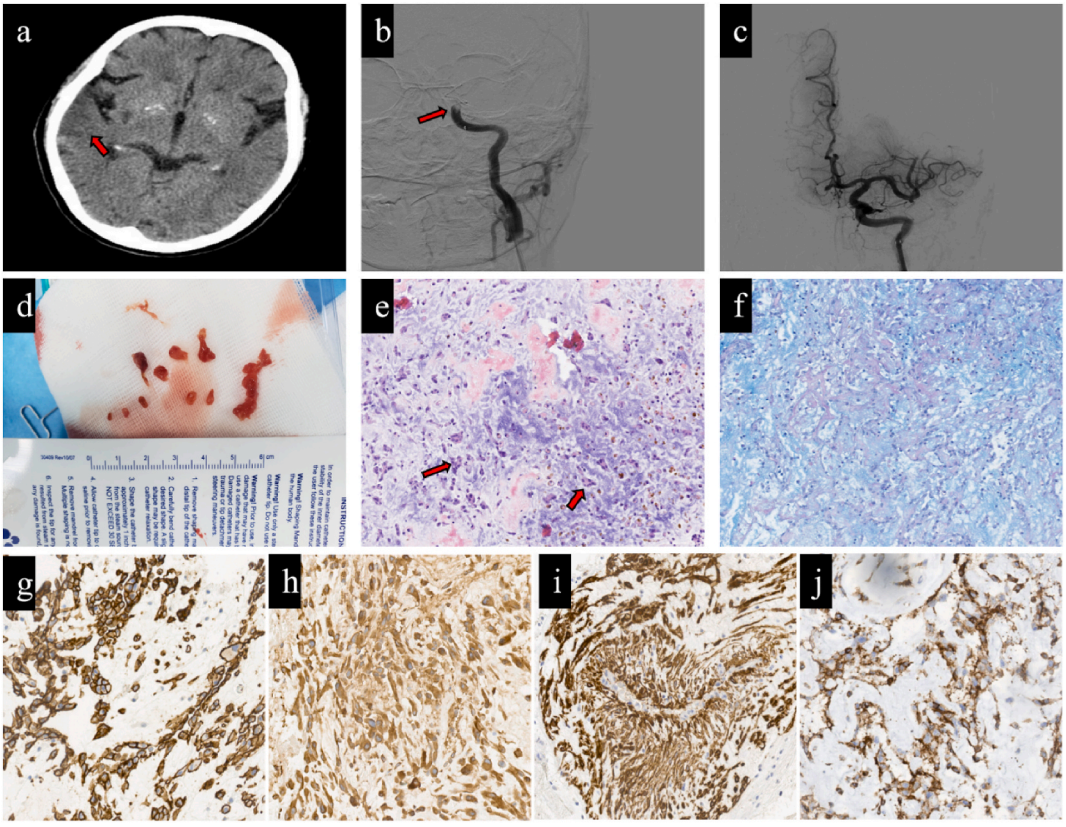

Fig. 2. **a**. The head CT does not reveal any new infarcts or hemorrhagic foci and shows only the old cerebral infarct in the first right temporal lobe (red arrow). **b**. An angiography shows the left middle cerebral artery embolism (red arrow). **c**. The left middle cerebral artery is patent after mechanical thrombectomy. **d**. The general appearance of the second embolus: a pile of gray to gray-red medium-textured fragmented tissue is seen. The tissue measures 1.8 × 1.5 × 0.8 cm. **e**. The microscopic appearance of the embolus (hematoxylin and eosin stain, 100× magnification): stellate and polygonal cells are seen in the mucus-like stroma (red arrow). **f**. AB-PAS staining (100× magnification) shows a purplish-red color, suggesting that the embolus contains mixed mucus. **g-j**. Immunohistochemical staining (100× magnification) for CD34, CD31, vimentin, and Ki-67 is strongly positive. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

difficult to reverse. The patient eventually developed respiratory and circulatory failure.

2. Discussion

Previous studies have shown that cerebral infarcts due to cardiac myxoma are mainly caused by thrombi on the surface of the cardiac myxoma and/or myxomatous emboli [12–14]. We confirmed this for the first time in a patient with cardiac myxoma. A recent systematic review and meta-analysis suggested that patients with cardiac myxoma had risk factors for embolism [15]. In this case, the patient had multiple risk factors for cardiac myxoma-induced embolism, such as hypertension, an irregular tumor surface, and elevated fibrinogen levels. Additionally, no other risk factors for stroke or alternative etiologies were identified apart from the cardiac myxoma. Most importantly, the pathology of the first embolus removed was consistent with that of a thrombus. Therefore, the thrombus in the patient's first cerebral infarction most likely originated from a thrombus that formed on the surface of the cardiac myxoma. The first cerebral infarction suggested that the mucinous tumor in the atrium may have been highly unstable, with a very high risk of tumor particle dislodgement. However, treating the cardiac myxoma was not prioritized. This resulted in the second cerebral infarction within a short period of time, which was histologically determined to be due to a myxomatous embolus. Considering the patient's poor physical condition after the cerebral infarction, surgical resection of the cardiac myxoma was not performed as early as possible. This was the most important cause of the patient's death.

The treatment of choice for cardiac myxoma is surgical resection [16]. For small strokes and embolisms with low NIHSS (National Institutes of Health Stroke Scale) scores, early surgical treatment should be performed to prevent sudden death from mucinous tumor embolism or re-embolism caused by dislodgment of the mucinous tumor or a thrombus [17]. Although cardiac myxoma is a benign tumor, it has many malignant characteristics. Therefore, cardiac myxoma should be treated in preference to myxoma of other sites if there are no immediate life-threatening problems [9]. However, severe cerebral embolism is usually considered a contraindication to immediate mechanical thrombectomy, and it can easily lead to post-infarction cerebral hemorrhage and aggravate cerebral edema. Furthermore, mechanical thrombectomy should be postponed after thrombolysis.

Mechanical thrombectomy is safe and effective and is the first-line of treatment for acute ischemic stroke caused by cardiac myxoma embolization [18]. Among the procedures used for mechanical thrombectomy, stent retriever and direct aspiration are currently the most commonly used procedures for treating cerebral infarction in patients with cardiac myxoma [19]. However, the most appropriate procedure for treating patients with cardiac myxoma-related acute ischemic stroke remains uncertain. The choice is generally based on the patient's condition, the site and size of the obstruction, and the experience of the surgeon. Studies have shown that both stent retriever and direct aspiration have higher recanalization rates and lower risks of bleeding, and the etiology of the stroke has been explored by histopathological analysis of the recovered embolus [13]. In this case report, we confirmed that mucinous tumors can cause both thromboembolism and tumor embolism. Additionally, the above types of embolic events can occur sequentially in the same patient. Therefore, patients with atrial mucinous tumors should be followed up to detect a possible recurrent cerebral infarction, concomitant cerebral aneurysm, and other complications. Furthermore, we found that different treatment strategies may be used, depending on the nature of the thrombus. In this case, the patient underwent direct aspiration after a second cerebral infarction, which was more likely to cause embolus migration due to the fragility and pliability of the mucinous tumor emboli. This may be the main reason for the poor prognosis after the second embolism. In contrast, the stent retriever procedure performed after the patient's first cerebral infarction allowed for easy removal of the thromboembolus. Therefore, performing direct aspiration for mucinous tumor embolism requires further validation.

In patients with atrial mucinous aneurysms, although surgical resection minimizes the risk of embolization, it does not reduce the risk of delayed cerebral aneurysm formation. Therefore, cerebral aneurysms caused by atrial mucinous aneurysms should be aggressively treated using mechanical thrombectomy, endovascular therapy, chemotherapy, radiotherapy, frameless stereotactic radiosurgery, or a combination of these approaches [20–23].

Mechanical thrombectomy is of great value both diagnostically and therapeutically. However, choosing the procedure to perform for cerebral infarctions due to different types of emboli remains challenging.

3. Conclusions

This report highlights the importance of cardiac myxoma resection, especially in patients who have already had a cerebral infarction. In the absence of immediate life-threatening problems, surgical resection of cardiac myxomas should be prioritized to avoid recurrent cerebral infarction caused by dislodgement of an unstable mucocele. Despite the high recanalization rate of mechanical thrombectomy, some patients still have a poor postoperative prognosis. Therefore, it is important to focus on early surgical resection of myxomas and mechanical thrombectomy.

Declarations

Ethics statement: Patient's legal guardians provided informed consent for the publication of their anonymised case details and images.

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Data availability statement

No data was used for the research described in the article.

CRediT authorship contribution statement

Ju Zhang: Writing – review & editing, Writing – original draft, Project administration. **Xiangfeng Guan:** Writing – review & editing, Writing – original draft, Project administration. **Guanzhao Zhang:** Writing – review & editing. **Yingchun Yin:** Visualization, Supervision. **Zuowei Sha:** Visualization, Supervision. **Yunhe Zhao:** Writing – original draft, Visualization, Supervision. **Jing Li:** Writing – review & editing, Visualization, Supervision, Resources. **Bo Li:** Writing – review & editing, Visualization, Supervision, Funding acquisition. **Xueliang Qiu:** Writing – original draft, Resources, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e30199.

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