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WHEN THE HEART AND BRAIN COLLIDE: A CASE OF MALIGNANT MIDDLE CORONARY ARTERY INFARCTION AND CARDIAC ARRHYTHMIAS LINKED TO RIGHT INSULAR CORTEX DYSFUNCTION

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ABSTRACT

Introduction: Stroke is a common cause of insular cortex injury, and it is associated with a rare complication of cardiac arrhythmia, which can be life-threatening. Here we present a case of this complication.

Case presentation: An 88-year-old female presented to the emergency department for acute and severe abdominal pain, non-radiating, associated with 3 days of watery diarrhea with no other symptoms. The patient was adequately resuscitated and admitted for gastroenteritis. During the hospitalization, the patient had episodic hypertension requiring as needed hydralazine use. The patient was doing well until she had an episode of syncope. She was vitally stable, and examination was again unremarkable. One hour later, the patient developed slurred speech and left-sided weakness. CT angiography (CTA) revealed acute occlusion on chronic stenosis of the M2 branch corresponding to insular cortex on the right, and mild stenosis of the proximal M1 segment of the right middle cerebral artery was noted. The patient went on to become hemodynamically unstable with hypotension and bradycardia and eventually underwent cardiac arrest. The patient achieved the return of spontaneous circulation but coded again and did not survive the event.

Conclusion: Stroke affecting the insular cortex can cause a variety of cardiac complications, including arrhythmia. Early recognition and prompt management of cardiac arrhythmia in patients with insular cortex stroke is crucial to prevent life-threatening complications. CTA with contrast should be carefully considered after weighing the potential benefits and risks of the procedure, as well as the implementation of strategies to minimize the risk of CIN. Further research is needed to understand mechanisms underlying these complications and to develop more effective treatments.

KEYWORDS

Autonomic regulation, thrombectomy, malignant middle cerebral artery, cardiac arrhythmias, right insular cortex stroke

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LEARNING POINTS

- The insular cortex is crucial for autonomic regulation, and strokes affecting this region are associated with deadly arrhythmias.
- Early cardiac monitoring, especially within the first 2-3 days after a stroke, is critical for avoiding life-threatening complications.
- Early stroke therapies like thrombolysis and thrombectomy with intensive post-stroke care improves recovery prospects dramatically.

INTRODUCTION

Stroke remains one of the leading causes of morbidity and mortality worldwide, with ischemic strokes being responsible for a significant proportion of these outcomes. While the majority of stroke-related deaths are directly attributed to brain damage, studies show that 2-6% of stroke patients succumb to heart-related complications. One of the most critical and potentially fatal complications in stroke patients is the development of cardiac arrhythmias, which are particularly prevalent in the setting of ischemic stroke involving the right middle cerebral artery (MCA)[1]. The right insular cortex, a key structure in the regulation of cardiac autonomic function, has been identified as a significant player in the development of arrhythmias following a cerebrovascular event. Damage to this area can result in heart rate variability and severe arrhythmias, including bradycardia, heart block, and even cardiac arrest[2].

The right insula's role in regulating parasympathetic control of the heart rate and blood pressure has been well-established, and ischemic injury to this region can disrupt normal autonomic control, leading to life- threatening arrhythmias. It is relatively uncommon to witness an infarction of the right insular cortex without the involvement of other structures supplied by the MCA. This highlights the complexity of stroke- related arrhythmias, as damage to the insula often occurs in conjunction with ischemia in surrounding regions. Moreover, advanced imaging techniques, such as magnetic resonance imaging (MRI), are more sensitive than computed tomography (CT) scans in the early identification of such strokes, allowing for more accurate diagnosis and timely interventions.

In this case report, we present an 88-year-old female with a complex cardiovascular history who developed an ischemic stroke affecting the right MCA, specifically the M2 insular segment, and experienced significant cardiac arrhythmias. This case underscores the importance of early diagnosis, timely intervention, and vigilant cardiac monitoring in managing stroke patients, especially those with infarction in regions such as the right insula that are critically involved in cardiac autonomic regulation.

CASE PRESENTATION

An 88-year-old female with a complex medical history presented to the emergency department with sudden confusion, slurred speech, weakness, and disorientation that began earlier that morning. Her history included hypertension, hyperlipidemia, diastolic heart failure, aortic stenosis (which had been managed with valve replacement in June 2021), and chronic kidney disease (CKD) stage IV. Additionally, she had a history of coronary artery disease, including previous percutaneous coronary intervention and coronary artery bypass grafting x3. She had also experienced multiple hospitalizations for transient ischemic attacks and hyperosmolar hyperglycemic states. Her diabetes mellitus had been poorly controlled, and her recent medical history included a recent hospitalization for congestive heart failure exacerbation, during which an aortic valve leak was detected and managed conservatively. Following this, she was discharged to a rehabilitation center for recovery.

Three days before this admission, the patient had been experiencing severe, non-radiating epigastric pain associated with diarrhea, which had resolved by the time of her hospital visit. She had also been experiencing recurrent dizziness, although a CT scan performed in 2021 had shown no abnormalities, and further workup was deferred due to her reduced renal function. Since then, her episodes of dizziness had continued, but no additional diagnostic tests had been performed.

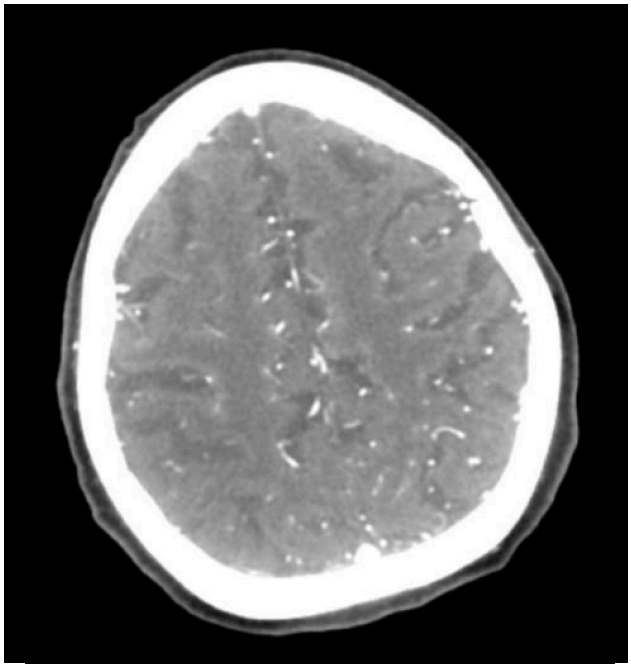

Figure 1. CT angiography of the head showing relative decreased vascularity within the more distal right middle cerebral artery territory.

On initial examination, she appeared distressed with significant tenderness in the epigastric region but had no focal neurological deficits. Her vital signs were stable, though her lab results showed a mild elevation in white blood cell count (15.3), anemia (hemoglobin 8.9 g/dl), and worsening kidney function (blood urea nitrogen 62 mg/fl, creatinine 2.34 mg/dl), which were consistent with her CKD. An abdominal ultrasound revealed a small hepatic hemangioma, and the rest of her abdominal examination was unremarkable. The diagnosis was made of acute gastroenteritis, and she was admitted for conservative management.

The following day, the patient experienced a brief episode of unresponsiveness, lasting only 3-5 minutes, which resolved spontaneously. However, she remained confused and disoriented, though she was still able to follow commands and move her limbs. Notably, her blood pressure had dropped significantly from 128/74 mmHg to 93/43 mmHg upon standing, prompting a 500 ml saline bolus to be administered. A CT scan of the head was ordered to investigate his symptoms further.

About 30 minutes later, the patient's condition rapidly deteriorated. She developed acute left-sided weakness (hemiparesis) and slurred speech, signs suggesting an evolving ischemic stroke. Her physical exam revealed significant distress, with markedly reduced strength in both upper and lower extremities. A STAT CT scan of the head revealed an acute occlusion in the M2 insular segment of the right MCA *(Fig. 1)*. Prompt action was taken, and the patient was given intravenous (IV) tenecteplase as part of thrombolysis therapy, with an immediate plan for transfer to a tertiary care center for thrombectomy.

Further imaging showed high-grade stenosis in the M2 branch of the right MCA, reduced blood flow in the distal MCA territory, and multifocal stenosis in the cavernous branches of both internal carotid arteries *(Fig. 2)*. Additionally, the carotid scan revealed moderate stenosis at the bifurcation of the right common carotid artery (CCA) and mild stenosis in the left CCA. Around 7:20 AM, the patient became severely bradycardic with a heart rate dropping to the 30s. Her blood pressure, however, remained relatively stable, with readings in the 150s. A dose of atropine was administered, improving his heart rate to the 60s, but her mental status remained confused and disoriented. An electrocardiogram (EKG) revealed first-degree atrioventricular block, right bundle branch block, bifascicular block, and T wave inversion in several leads. Despite these interventions, her blood pressure dropped further to 77/47 mmHg, and she eventually went into pulseless electrical activity after about an hour. Immediate cardiopulmonary resuscitation was initiated, and a dose of epinephrine was administered. Within 3 minutes, the patient regained return of spontaneous circulation though her EKG now showed complete heart block. The clinical team remained focused on stabilizing her, recognizing the complex interplay of ischemic stroke and cardiac arrhythmias. The patient coded again and did not make it through the event.

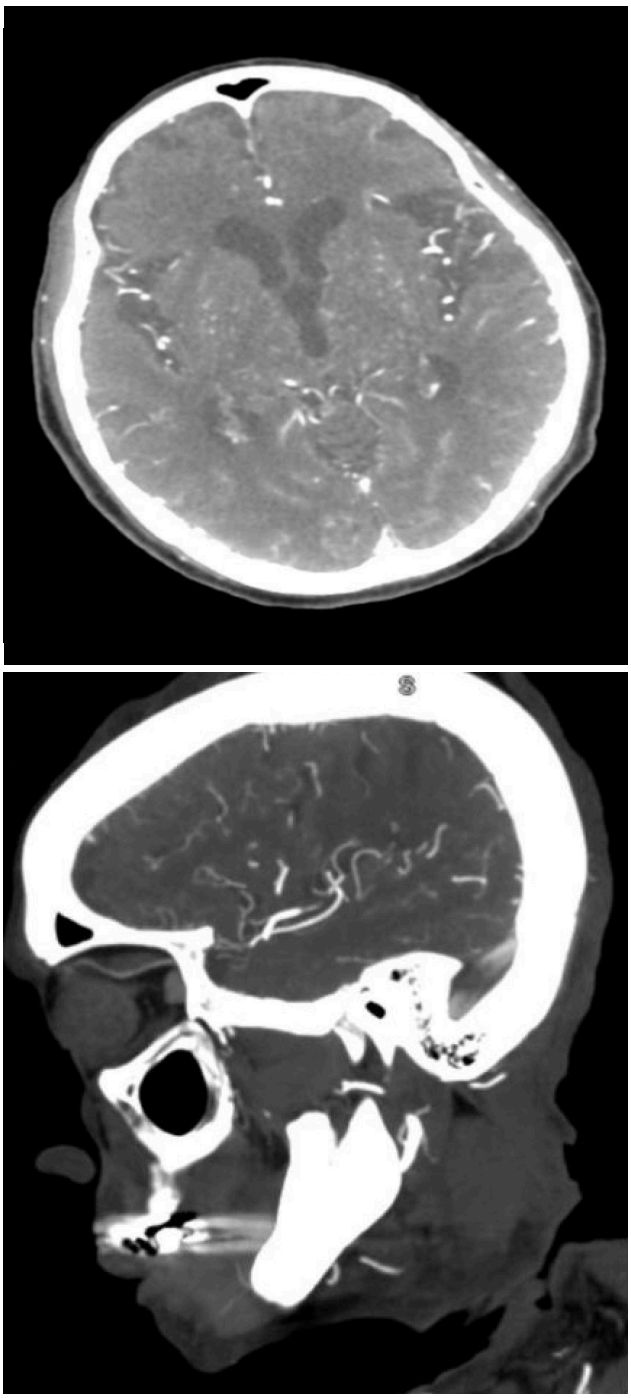

Figure 2. CT angiography of the head showing short segment non-opacification of right M2 (insular segment) branch with distal reconstitution was seen possibly representing a high-grade stenosis vs occlusion with collateral flow.

DISCUSSION

This case exemplifies the critical role of the right insular cortex in cardiac autonomic regulation and its involvement in stroke-related arrhythmias. The right insula is a key area in the brain for regulating the parasympathetic control of heart rate and blood pressure. Damage to this region in the setting of ischemic stroke, particularly involving the MCA, can lead to severe cardiac arrhythmias, including bradycardia, heart block, and even cardiac arrest. These arrhythmic complications are often seen in the early stages of stroke, with the first 24-48 hours being the period of greatest risk[3].

The pathophysiological mechanisms linking stroke and arrhythmias are still under investigation, but several theories have been proposed. The Cushing reflex, which occurs due to cerebral edema from massive strokes, can lead to increased vagal tone, converting first-degree heart block to complete heart block and eventually precipitating cardiac arrest. This reflex was first described by Cushing in the early 20th century and is thought to be a protective mechanism against intracranial pressure increases. Still, it can have severe cardiac consequences when it occurs in the context of a large stroke[4]. Another theory is that damage to the cardiac control centers in the insula directly impacts heart function. The insular cortex, which is involved in regulating the autonomic nervous system, plays a pivotal role in the brain's control of cardiac function, particularly during stress or injury, such as stroke. Dysfunction in this area can lead to disturbances in heart rate and rhythm, contributing to arrhythmic events like bradycardia and heart block[5]. Additionally, concurrent right heart infarction due to ischemia may also contribute to arrhythmic events.

The incidence of arrhythmias in ischemic stroke patients, especially those with large vessel occlusions and those involving the right MCA, has been well-documented. Studies show that these arrhythmic events are most likely to occur during the first three days post-stroke, particularly with large vessel occlusions and severe neurological deficits[6]. Given that stroke patients, particularly those with damage to the insular cortex, are at increased risk for arrhythmias, continuous cardiac monitoring (telemetry) is essential in the first 24-48 hours after the event. Such monitoring can help detect arrhythmias early and prevent potentially fatal complications.

This patient's clinical course also underscores the importance of early recognition and intervention in ischemic stroke. The time-to-treatment paradigm for ischemic stroke management emphasizes the importance of delivering thrombolytic therapy within 60 minutes of arrival and mechanical thrombectomy for eligible patients with large vessel occlusion within 24 hours of symptom onset[7]. In this case, timely administration of IV tenecteplase followed by thrombectomy gave the patient the best chance of recovery. Mechanical thrombectomy, in particular, has been shown to significantly improve outcomes in patients with acute ischemic stroke due to large vessel occlusions[8].

Moreover, the potential for severe arrhythmias, especially those linked to insular cortex infarctions, demands vigilance and proactive management strategies. The ability to quickly identify and address these complications is critical to reducing mortality and improving recovery outcomes. Studies have shown that stroke patients with large infarctions in the MCA territory, particularly those involving the right insula, have a higher incidence of arrhythmic events that may require immediate medical intervention, such as the use of atropine for bradycardia or more intensive treatments in cases of cardiac arrest[9,10]. Given these risks, a multidisciplinary approach involving neurologists, cardiologists, and intensivists is essential for optimal management. Furthermore, the integration of early stroke interventions like thrombolysis and thrombectomy with vigilant post-stroke care can optimize the chances for recovery. Early reperfusion reduces the size of the ischemic area and can also mitigate secondary complications like arrhythmias. The patient's favorable outcome following a timely thrombectomy highlights the importance of adhering to established stroke protocols[11,12]. However, it is equally crucial to address the potential cardiac complications, particularly in patients with a complex medical history such as this one, where comorbid conditions like heart failure, chronic kidney disease, and previous transient ischemic attacks may predispose the patient to an increased risk of arrhythmias.

CONCLUSION

This case highlights the complex and often life-threatening interplay between ischemic stroke and cardiac arrhythmias, particularly when the right insular cortex is involved. The right insula's role in autonomic regulation, including heart rate and rhythm, makes it a crucial area in stroke-related arrhythmias, as evidenced by the patient's development of severe bradycardia, heart block, and pulseless electrical activity following his MCA infarction. This underscores the importance of early diagnosis, timely intervention with thrombolysis and thrombectomy, and continuous cardiac monitoring in the initial 24-48 hours post-stroke, a critical period when arrhythmic complications are most likely to occur. In this patient, prompt management, including mechanical thrombectomy, as well as vigilant cardiac care, were vital in stabilizing his condition. Further research into the pathophysiological mechanisms linking brain injury to cardiac arrhythmias will enhance our understanding and improve outcomes for stroke patients with similar complications. The case also reinforces the necessity of a multidisciplinary approach in managing patients with complex medical histories, where timely interventions can significantly impact the patient's recovery and prognosis.

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