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Case Report: A Case of Acute Contrast-Induced Neurotoxicity Simulating Stroke After Middle Meningeal Artery Embolization: Insights from Literature

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Author Name:
Tarabay Rami MD; Habbal Fuad MD; Colon Leo APRN; Nikfarjman Iraj MD; Dorsey Nicholas MD

Corresponding Author:
Tarabay Rami MD

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ABSTRACT

Introduction: Middle meningeal artery (MMA) embolization is becoming an important treatment option for chronic subdural hematoma (CSDH), particularly for patients who are at a higher risk of recurrence or are not candidates for surgery. This technique is associated with lower rates of complications and recurrences when compared to traditional surgical methods. Contrast-induced neurotoxicity (CIN) is a rare complication of endovascular procedures, and its underlying mechanisms remain poorly understood.

Case Presentation: An 82-year-old female presented to the emergency department (ED) with a worsening headache, two months after a fall. A non-contrast computed tomography (NCCT) scan revealed a mixed-age left-sided subdural hematoma measuring approximately 1.7 cm, causing mass effect on the sulci of the left cerebral hemisphere. The patient was admitted for observation with a diagnosis of acute on chronic subdural hematoma and scheduled for left middle meningeal artery embolization. The procedure was successful; however, the patient developed neurological deficits one hour post-procedure, with aNational Institutes of Health Stroke Scale (NIHSS) score of 16. Urgent NCCT, CT angiography (CTA) of the head and neck, and Magnetic resonance imaging (MRI) of the brain showed no acute findings or evidence of large vessel occlusion, high-grade stenosis, or ischemia. The patient's symptoms resolved within 24 hours, and she returned to baseline the following day. Contrast-induced neurotoxicity was diagnosed as the cause of her symptoms.

Conclusion: With ongoing advancements in neurointerventional techniques, MMA embolization has established itself as a trusted method for treating CSDH. Although uncommon, CIN is still a potential complication and should be considered when assessing the gradual onset of neurological deficits after neuro-endovascular procedures.

Keywords: Chronic subdural hematoma, middle meningeal artery, MMA embolization, neurotoxicity, Contrast-induced, Contrast toxicity, Neurointerventional, endovascular procedures

Introduction

Chronic Subdural Hematoma(CSDH) is a frequently encountered condition that, if left untreated, can result in significant complications. Traditionally, surgical evacuation has been the primary treatment approach; however, Middle meningeal artery (MMA) embolization has emerged as a promising, less invasive alternative that aims to lower the risk of recurrence.[1]

Contrast induced neurotoxicity (CIN) refers to the development of new neurological symptoms following endovascular procedures that utilize contrast agents, once other potential causes are ruled out.[2] While it is generally thought to arise from the disruption of the blood-brain barrier (BBB), the exact mechanisms responsible for this phenomenon remain inadequately understood.[3]

It is a rare but recognized complication of endovascular procedures, with incidence rates reported between 0.15% and 2.5%, varying based on the type of procedure performed and the characteristics of the patient population.[4,5,6]

Case Presentation

An 82-year-old female presented to the ED with a progressively worsening headache. The patient reported the onset of mild headache following a fall two months prior, which had gradually worsened in the past few days, despite regular use of acetaminophen. The headache was bilateral, localized to the frontal region, and non-radiating. She denied any visual disturbances, nausea, vomiting, fever, altered mental status, or neurological deficits. The patient did not seek medical attention after the fall and had been ambulating independently within her home, though she noted an increasing need for a walker.

Her medical history included hypertension, ovarian cancer, and hyperlipidemia. Surgical history included bilateral knee replacements, hysterectomy, cholecystectomy, and appendectomy. She reported allergies to latex, penicillin, and codeine. The patient denied smoking or illicit drug use but consumed scotch nightly. Her current medications included Rosuvastatin, Valsartan, and Hydrochlorothiazide, with no history of anticoagulant use.

Upon evaluation in the ED, the patient's vital signs were as follows: temperature 36.6°C, pulse 87 beats per minute, respiratory rate 18 breaths per minute, blood pressure 153/69 mmHg, and oxygen saturation 98% on room air. A comprehensive physical and neurological examination was unremarkable. Basic laboratory tests, including complete blood count (CBC), basic metabolic panel (BMP), and coagulation profile, were within normal limits. Non-contrast cranial computed tomography (CT) revealed a left-sided subdural hematoma, measuring approximately 1.7 cm, with mass effect on the sulci of the left cerebral hemisphere. Severe nonspecific white matter changes were also noted.

Neurosurgical consultation was obtained, and the patient was admitted for observation in the intensive care unit (ICU) with a diagnosis of acute-on-chronic subdural hematoma. Interventional neurology was consulted, and the patient underwent left middle meningeal artery embolization four days later, under conscious sedation. The procedure was successful without immediate complications.

One hour post-procedure, the patient developed neurological deficits, including altered mental status, expressive aphasia, left gaze preference, and right-sided weakness, with a NIHSS score of 16. Urgent non-contrast CT of the head revealed no acute changes, and subsequent CTA of the head and neck demonstrated no evidence of large vessel occlusion or high-grade stenosis. MRI of the brain was also negative for acute ischemic changes. Permissive hypertension was initiated, and the patient's neurological symptoms gradually resolved within 24 hours. By the following day, the patient had returned to her baseline neurologic status.

Contrast-induced neurotoxicity was diagnosed as the likely cause of the patient's post-procedural symptoms. The patient was discharged home in stable condition,one week from initial admission.

Discussion

Traditional management of CSDH consists of observation for asymptomatic cases and surgical evacuation for symptomatic patients. However, the high recurrence rate of CSDH after surgery—ranging up to 20%—suggests the need for alternative treatments.7,8The role of the MMA in supplying blood to the neovascular membranes in CSDH has led to the investigation of MMA embolization as a potential treatment. By targeting the MMA, embolization can interrupt the recurrent cycle of hemorrhage and inflammation, which are key contributors to CSDH. Increasing evidence supports the effectiveness of MMA embolization, with some studies showing that CSDH continues to resolve over several months, with up to 92% resolution within six months following embolization.9

MMA embolization is generally regarded as a safe procedure with a low complication rate.10,11,12A systematic review assessing the impact of different embolic agents on treatment outcomes found that Onyx embolization resulted in the lowest rates of hematoma recurrence, reoperation, and complications. In contrast, the combination of polyvinyl alcohol and coils was associated with the most favorable clinical outcomes.13 Furthermore, a recent cohort study focused on acute-on-chronic subdural hematomas found that patients with larger hematomas (greater than 10 mm) and those undergoing embolization more than three weeks after initial imaging had significantly better outcomes.14

Although the procedure is safe, rare complications such as periprocedural strokes have been reported, particularly in patients with tortuous aortic arch anatomy when a transfemoral approach is used.15However, the focus of MMA embolization on the external carotid circulation helps to mitigate this stroke risk.

Another complication related to neurointerventional procedures is CIN, a rare but significant issue. CIN typically manifests as new neurological symptoms within 24 hours following contrast administration, and the diagnosis is made by excluding other potential causes such as ischemic or hemorrhagic stroke, seizures, or metabolic imbalances. Encephalopathy and transient cortical blindness are the most commonly reported symptoms of CIN.16Several factors increase the risk of CIN, including patient characteristics (such as age, renal failure, liver disease, and hypertension), procedure-specific factors (like type and duration), and contrast agent properties (osmolality and volume). Unlike in cardiac procedures, CIN symptoms in neurovascular procedures are typically localized to the hemisphere treated.

A systematic review of 48 patients diagnosed with CIN after neurological endovascular procedures found that over half of the patients (54.2%) experienced clinical manifestations such as encephalopathy, cortical blindness, and motor deficits. Imaging revealed cortical contrast enhancement and effacement of cortical sulci. Most patients (89.6%) experienced full recovery within a median of three days.17 A study investigating the incidence of CIN in patients undergoing neurointerventional procedures with low-osmolality nonionic contrast agents reported an incidence of 0.4%, which aligns with the <1% incidence reported in studies using ionic agents.18,19Interestingly, 82% of these patients showed abnormal imaging on the ipsilateral side to the treated lesion, and all exhibited signs of brain edema. Despite these findings, all patients with CIN showed gradual clinical improvement, with 27% experiencing symptom relief within 24 hours and 73% improving over the next two days. Full resolution occurred within a median of three days, reinforcing the idea that CIN is a generally benign condition, with symptoms typically resolving within hours to days.20The acute onset of right sided weaknessand change in mental status with expressive aphasia, within one hour post-procedure, and complete resolution of these symptoms within 24 hours, strongly support contrast-induced neurotoxicity as the most likely diagnosis in our case.

Conclusion

MMA embolization is emerging as safe and effective treatment for CSDH, particularly for patients with recurrent or surgically

challenging cases. CIN remains a rare complication of neurointerensional procedures. Fortunatly, it is typically self-limiting and resolves within a few days. Further research is required to optimize the use of MMA embolization and to better understand the underlying mechanisms and management of CIN.

Abbreviations
MMA Middle Meningeal Artery
CSDH Chronic Subdural Hematoma
CIN Contrast-Induced Neurotoxicity
CT Computed Tomography
CTA Computed Tomography Angiography
CTP Computed Tomography Perfusion
MRI Magnetic Resonance Imaging
BBB Blood-Brain Barrier
ATSH Acute Traumatic Subdural Hematoma

Author contributions
RT, FH, LC, IN, ND: drafted the manuscript, reviewed the literature, followed up with the patient, and edited the final manuscript. All authors read and approved the final manuscript.

Availability of data and materials
Materials and data provided in this case study are available from the corresponding author upon reasonable request.

Consent for publication
Written informed consent was obtained from the patient for the publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests
The authors declare that they have no competing interests.

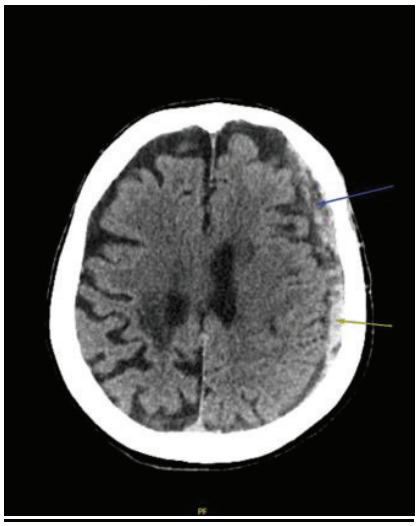

Figure 1:Initial CT Head showing left SDH(blue and yellow arrows)

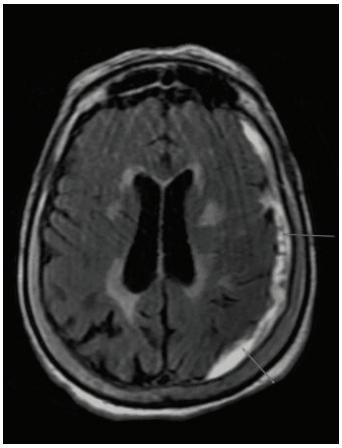

Figure 2: Initial MRI showing left SDH (blue and yellow arrows)

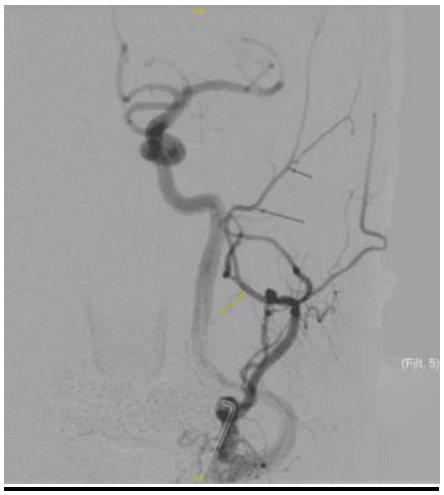

Figure 3: Image obtained Pre-MMA embolization

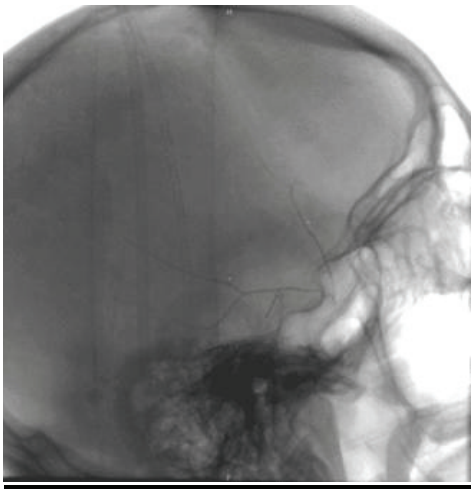

Figure 4: Image obtained post-MMA embolization

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