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JSCAI Case Report

Contrast-Induced Encephalopathy Following Transcatheter Aortic Valve Replacement: A Case Series

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ABSTRACT

Contrast-induced encephalopathy (CIE) is an idiopathic reaction following iodine-contrast dye administration in patients undergoing angiographic procedures. While it has been well-documented following coronary and carotid interventions, literature on CIE following transcatheter aortic valve replacement is limited. We report the multidisciplinary management of 3 patients with CIE following transcatheter aortic valve replacement.

Introduction

Contrast-induced encephalopathy (CIE) is a rare complication following administration of iodine-contrast to patients undergoing angiographic procedures. First described in 1970, the reported incidence of CIE in the medical literature has varied widely, ranging from 0.3% to 4.0%.[1,2] This variation is due to its heterogeneity in clinical presentation and overlap with other cerebrovascular complications, making CIE primarily a diagnosis of exclusion. While previously described following coronary and carotid interventions, literature on CIE following transcatheter aortic valve replacement (TAVR) is limited.[3–5] Here, we describe 3 cases of probable CIE following TAVR.

Patient 1

A 79-year-old-male with a past medical history (PMH) of hypertension and coronary artery disease was found to have severe aortic stenosis and a 6.4-cm infrarenal abdominal aortic aneurysm amenable to TAVR with combined endovascular aortic aneurysm repair. Five hours after the procedure, he had an episode of a generalized tonic-clonic seizure associated with left upper extremity weakness. Brain computed tomography (CT) scan showed multifocal sulcal and bilateral caudate hyper-attenuation, concerning either subarachnoid hemorrhage or contrast media extravasation (Figure 1A). Computed tomography angiography (CTA) ruled out large vessel occlusion, dissection, or cerebral aneurysm. Due to the possibility of subarachnoid hemorrhage, protamine and desmopressin were administered. Intravenous (IV) hydration was initiated based on the suspicion for CIE along with levetiracetam for seizure prophylaxis.

The patient was subsequently monitored with supportive care. From a neurological perspective, he made a complete recovery, and a repeat CT scan 2 days later showed near-complete resolution of the sulcal and parenchymal hyper-attenuation (Figure 1B). He was discharged, and at the 1-month post-TAVR follow-up visit, reported no persistent neurological symptoms.

Patient 2

An 80-year-old woman with a PMH of hypertension and diabetes underwent transfemoral TAVR for severe aortic stenosis. Six hours later, the patient demonstrated a new-onset left-sided hemiplegia leading to stroke code activation. At the time, her National Institutes of Health Stroke Scale score was 17. Noncontrast CT demonstrated diffuse hyperattenuation within the sulci, falx, and tentorium cerebelli (Figure 2A).

Keywords: aortic stenosis; encephalopathy; stroke; transcatheter aortic valve replacement.

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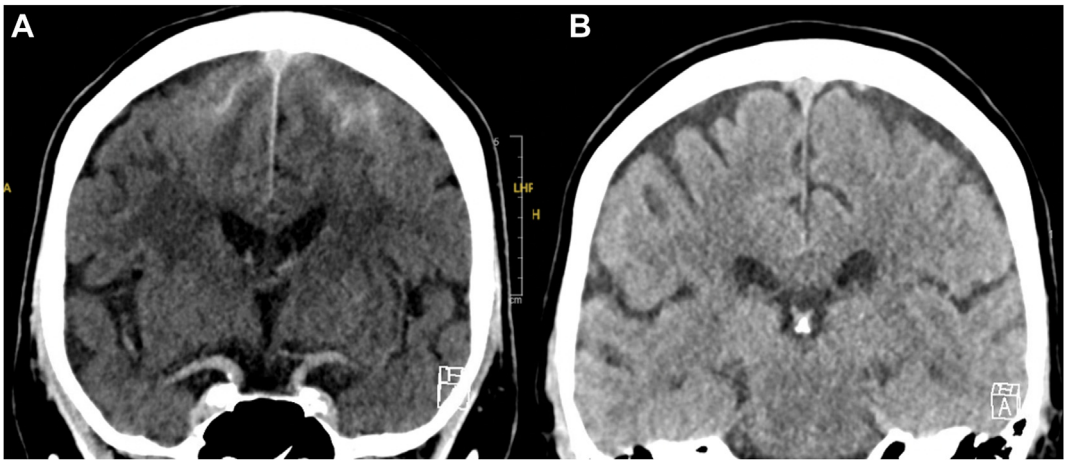

Figure 1.
Noncontrast CT of patient 1 on (A) day 0 and (B) day 2 post-TAVR + EVAR showing rapid-onset parenchymal hyper-attenuation with resolution. TAVR, transcatheter aortic valve replacement; EVAR, endovascular aneurysm repair.

Subsequent CTA ruled out aneurysm, or large vessel occlusion, and the patient was managed with i.v. hydration, blood pressure management, and seizure prophylaxis. A follow-up CT scan performed approximately 13 hours later showed no change in diffuse hyper-attenuation (Figure 2B). However, the patient demonstrated a recovery in her left upper and lower extremity weakness. Considering clinical improvement, the decision to perform further brain magnetic resonance imaging (MRI) was withheld. She was discharged to subacute rehabilitation on post-TAVR day 8 and at the 1-month follow-up, she had returned to her baseline function with no additional complaints.

Patient 3

An 80-year-old woman with a PMH of hypertension, diabetes, rheumatic fever, and previous percutaneous coronary interventions underwent TAVR at our institution. There was no history of any contrast-induced reaction during her previous percutaneous coronary interventions. However, 2 hours following her TAVR, she developed left-sided facial drooping, aphasia, and altered mental status. Stroke code was activated, and head CT showed no signs of acute parenchymal hemorrhage or large vascular infarction, but diffuse sulcal hyper-attenuation was noted (Figure 3A). A CTA of the head/neck ruled out any significant stenosis or aneurysm of the proximal intracranial arteries. The patient was medically managed with IV hydration and antiepileptic prophylaxis.

During follow-up assessment, a new-onset left gaze deviation, a lack of right-sided pain response, and persistent left-sided upper extremity weakness were noted, with a National Institutes of Health Stroke Scale score of 31. Follow-up CT of the head, performed 12 hours later, showed persistence of contrast staining with sulcal effacement, suggestive of cerebral edema (Figure 3B). Head MRI was undiagnostic due to motion artifacts and electroencephalogram, which did not detect any epileptiform discharges.

A third interval CT (2 days after the symptom onset) demonstrated improvement in the diffuse sulcal effacement (Figure 3C). Over the next several days, the patient's mental status, speech, strength, and ability to follow commands showed gradual recovery. The patient was discharged to subacute rehabilitation on post-TAVR day 13 for further rehabilitation. At her 1-year follow-up, she reported improved strength with no persistent weakness.

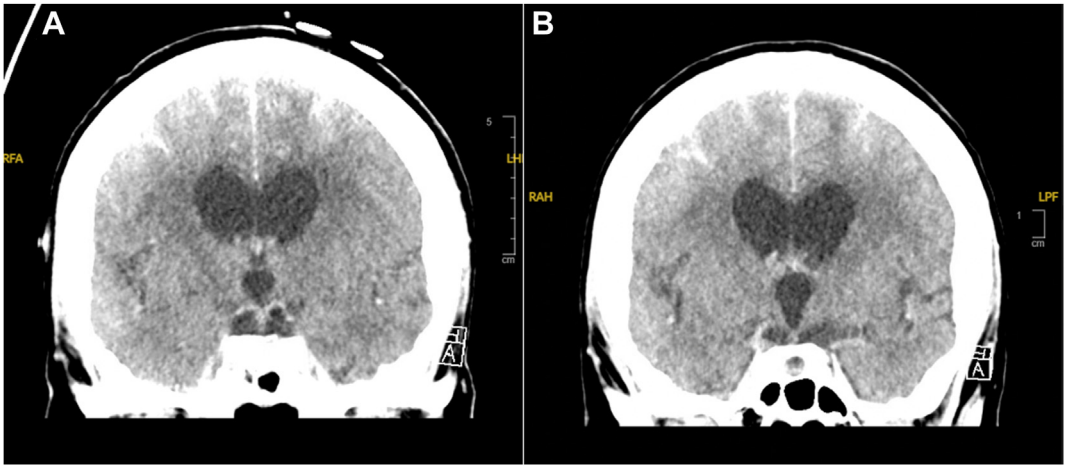

Figure 2.
Noncontrast CT of patient 2 (A) 6 hours post-TAVR and (B) 13 hours post-TAVR showing persistence of diffuse hyper-attenuation within the sulci, falx, and tentorium cerebelli despite improvement in clinical status. TAVR, transcatheter aortic valve replacement.

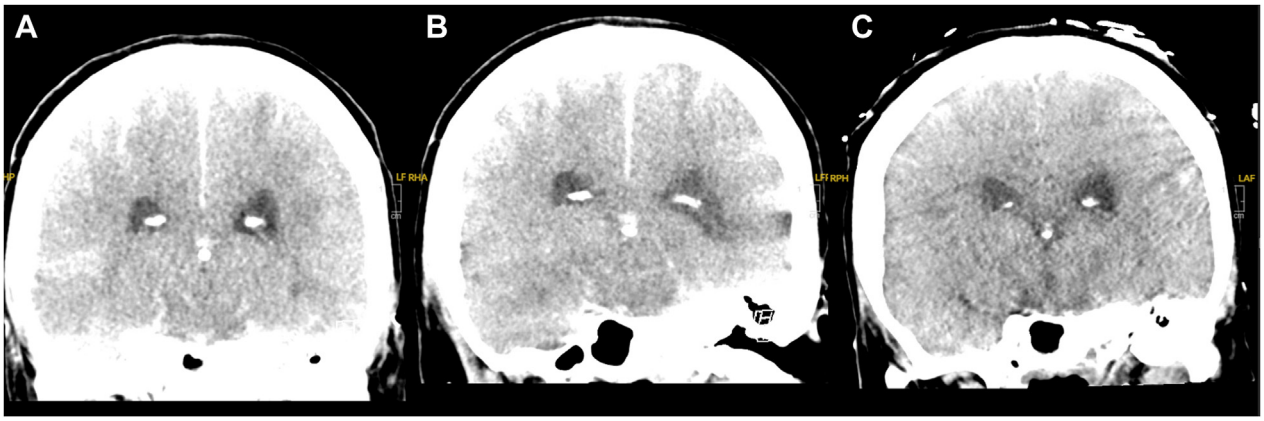

Figure 3.
Noncontrast CT of patient 3 on (A) day 0 (B) 12 hours post-TAVR and (C) day 2 post-TAVR showing mild interval improvement in the diffuse sulcal effacement. TAVR, transcatheter aortic valve replacement.

Discussion

Contrast-induced encephalopathy is an idiosyncratic reaction associated with iodine-based contrast agents. Symptoms range from seizures, focal neurological deficits, cortical blindness, aphasia, and signs of cerebral edema.[2] We report the presentation and management of 3 patients who developed CIE following routine TAVR deployment at our high-volume center (Table 1). Notably, sentinel cerebral protection was deployed in each of these cases and there was no excessive manipulation of the valve delivery system or aortic root. In line with our cases, CIE symptoms usually resolve within 48 hours; however, persistent neurological deficits following CIE have also been previously reported.[4] Although the pathophysiological mechanism behind CIE remains unclear, contrast-induced breakdown of the blood-brain barrier is believed to mediate the iatrogenic reaction. The higher osmolality of contrast agents relative to blood may induce fluid extravasation into the central nervous system with subsequent neuronal excitation and cerebral edema.[3] Although the risk factors for CIE remain unclear, prior reports have showed a similar incidence in both men and women, with a higher average age of onset in females developing symptoms (62.2 vs 58.8 years, respectively).[2] Early differentiation of CIE from large vessel occlusion is therefore paramount as fibrinolytic therapy may increase blood-brain barrier permeability and exacerbate contrast-induced toxicity.[6] Centers may benefit from the implementation of a multidisciplinary stroke initiative for the early identification of neurological deficits following TAVR to mitigate risk and optimize clinical decision-making.[7,8] After multidisciplinary discussion, the decision was made to forego MRI imaging in 2 of our patients due to the high risk of false positive results and improvement in clinical status. In the third patient, MRI imaging was performed due to persisting weakness and new-onset gaze deviation but was undiagnostic due to motion artifact, with subsequent improvement in interval CT imaging and clinical status. In all 3 patients, conservative management without fibrinolysis was deployed as per our institutional suspected stroke algorithm.

Given that its clinical presentation may mimic that of hemorrhagic or ischemic stroke, acute metabolic encephalopathy, or epilepsy,[5] CIE is often a diagnosis of exclusion and requires multimodality imaging and consideration of patient vascular disease risk factors, such as carotid/cerebral arterial disease, symptom onset/severity, and time to resolution. Characteristics that may help distinguish CIE from more catastrophic neurological events include rapid-onset cortical enhancement and parenchymal hyper-attenuation inconsistent with infarction and lack of large vascular occlusion. Contrast load is also believed to be an important risk factor, although the range of contrast used in reported cases of CIE is highly heterogenous (range, 6-1500 mL).[2]

Table 1. Clinical summary and overview of included patients.

No.	Description	Indication	Procedure	Contrast volume (mL)	Serum creatinine (mg/dL)	eGFR (mL/min/1.73 m^2)	Access route	TAVR valve type	Cerebral protection	Clinical resolution	CT resolution	Persistent neurological deficits at the last follow-up
1	79-y-old male	Severe aortic stenosis + infrarenal AAA	TAVR + EVAR[a]	190	1.26	58	TF	BEV	Yes	Yes	Yes	No
2	80-y-old woman	Severe aortic stenosis	TAVR	150	0.72	84	TF	SEV	Yes	Yes	No	No
3	80-y-old woman	Severe aortic stenosis	TAVR	200	0.77	76	TF	BEV	Yes	Yes	No	No

AAA, abdominal aortic aneurysm; BEV, balloon-expandable valve; CT, computed tomography; EVAR, endovascular aneurysm repair; SEV, self-expandable valve; TAVR, transcatheter aortic valve replacement; TF, transfemoral.

[a] EVAR of abdominal aortic aneurysm was performed using a 28 mm × 14 mm × 103 mm main body Endurant IIs endograft (Medtronic Vascular) deployed below the left renal artery followed by deployment of two 16 mm × 20 mm × 124 mm iliac limbs.

Treatment for CIE is largely supportive as symptoms will often resolve with renal clearance of contrast. In addition to intravenous hydration and seizure prophylaxis, steroids and mannitol may be used to decrease cerebral edema and enhance contrast clearance.[6] Additionally, extensive documentation of CIE incidence, clinical course, and the amount of contrast used is important to help guide future operators if patients need further interventions involving contrast agents.

Conclusion

CIE is typically a self-limiting idiosyncratic reaction to contrast media, often managed conservatively. We summarized a series of cases involving CIE following TAVR, highlighting the importance of considering CIE in post-TAVR neurotoxicity differentials.

Declaration of competing interest

Anoop N. Koshy is supported by a post-doctoral scholarship from the Heart Foundation of Australia. George D. Dangas has received personal fees from Biosensors and Philips. Gilbert H. L. Tang is a physician proctor and consultant for Medtronic, a consultant and physician advisory board member for Abbott Structural Heart, and a physician advisory board member for JenaValve. Samin K. Sharma has received speaker's bureau fees from Abbott Vascular, Boston Scientific, and Cardiovascular Systems Inc. Sahil Khera is a consultant and proctor for Medtronic, a consultant for Abbott Structural Heart, Terumo, W. L. Gore & Associates, EastEnd Medical, and serves on the speaker's bureau for Zoll Medical and Edwards Lifesciences. The remaining authors have nothing to disclose.

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Ethics statement and patient consent

This manuscript follows ethical guidelines and informed consent was obtained from patients for this case series.

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