ABSTRACT
Atrial septal defects (ASD) represent the most common congenital heart disease diagnosed in the adult population and can present with variable clinical findings. Recent literature emphasizes the importance of the management of ASD, especially if it is associated with structural right heart changes such as right ventricle (RV) dysfunction, right ventricular enlargement, arrhythmias, or paradoxical embolism. The decision between medical therapy versus surgical closure of ASD is a common clinical conundrum, especially in the setting of cryptogenic stroke.

KEYWORDS
Cryptogenic stroke, percutaneous occluder device, atrial septal defects, intracardiac echocardiography

ABBREVIATIONS
ASD Atrial Septal Defect
RV Right ventricle
NIHSS National Institutes of Health Stroke Scale
CT Computed Tomography
ECG Electrocardiogram
TTE Transthoracic Echocardiography
TEE Transoesophageal Echocardiography
ASA Atrial Septal Aneurysm
ICE Intra-cardiac Echocardiography
PFO Patent Foramen Ovale
DAPT Dual Antiplatelet Agent

INTRODUCTION
This case report highlights a unique presentation of a cryptogenic stroke in a 47-year-old male patient with a concomitant large atrial septal defect (ASD) and atrial septal aneurysm (ASA). The distinctive aspect of this case lies in the successful management of cryptogenic stroke through percutaneous ASD closure combined with antiplatelet therapy. This report contributes to the scientific literature by emphasizing the importance of considering structural heart abnormalities as potential contributors to cryptogenic strokes and the efficacy of percutaneous interventions in such cases.

CASE PRESENTATION
A 47-year-old male patient presented to emergency with a 30-minute episode of slurred, nonsensical speech with right arm numbness and weakness. On arrival, he was normotensive with a regular rhythm and rate. Examination demonstrated transient dyscalculia with a National Institutes of Health Stroke Scale (NIHSS) score 1.

PAST MEDICAL HISTORY
The patient’s medical history was notable for active smoking.

DIFFERENTIAL DIAGNOSIS
Differentials include migraine with aura, transient global amnesia, subdural hemorrhage, or functional mimics, including stress, depression, or somatization.
Investigations

Computed Tomography (CT) head and neck angiography revealed ischemic penumbra in the left parietal lobe with an MRI illustrating acute infarct in the left parietotemporal lobe. An Electrocardiogram (ECG) showed normal sinus rhythm with normal R wave progression, and on transthoracic echocardiography (TTE), there was no regional wall motion abnormality, along with preserved ejection fraction. The patient underwent a transesophageal echocardiography (TEE), which displayed a hypermobile atrial septum consistent with an atrial septal aneurysm (ASA) and a large atrial septal defect (ASD) with a left-to-right shunt. The left atrial appendage was negative for a clot. An ultrasound Doppler of the bilateral lower extremity was also negative for acute deep vein thrombosis. Screening for thrombophilia and rhythm surveillance with 30-day cardiac event monitoring was negative.

Management

Due to the low NIHSS score, the patient was deemed inappropriate for tissue plasminogen therapy and was started on dual antiplatelet agents with aspirin and clopidogrel. Given the coexistent large ASD with ASA, the decision was made for percutaneous ASD closure based on recent trials. Venous sheaths were placed bilaterally in the common femoral veins with an ultrasound-guided Seldinger technique. Intracardiac echocardiography (ICE) was performed via the left venous sheath with visualization of secundum ASD. A 6F MPA 1 catheter was advanced across the ASD via the right venous sheath with the J-tipped guide wire. The defect’s size was measured using an Amplatz balloon, which was approximately 21mm. Next, the 7F venous sheath was exchanged with the 14F Venus sheath to advance the Gore CardioForm Septal Occluder (diameter 37mm) into the left atrium. The position was confirmed via fluoroscopy and ICE, and the septal occluder device was deployed with no post-procedure complications.

Discussion

Atrial septal defect (ASD) is a common congenital heart defect. It is classified into 4 subtypes: secundum, primum, sinus venosus, and coronary sinus defects. Most cases (80%) are secundum...

FIGURE A: Transoesophageal echocardiography images from 1 through 4 shows large ASD measuring around 12.9mm coexistent with atrial septal aneurysm (as shown in image 5 marked with white arrow)
ASD, which results from the incomplete division of atria as the septum secundum progresses caudally towards endocardial cushions or excessive resorption of the septum primum. Conversely, a patent foramen ovale (PFO) is a common variant found in approximately 25%–27% of the general population. ASDs in adults cause a left-to-right shunt, leading to increased blood volume in the right heart chambers. Shunting mainly occurs during late ventricular systole and early diastole. Smaller defects, typically measuring less than 10mm, are linked to a minimal to nonexistent enlargement of the right heart structures and a small shunt. However, this process leads to an overload of volume in the right heart chambers and pulmonary arteries. Significant shunting can lead to progressive pulmonary vascular obstructive disease and pulmonary hypertension.

Closure of atrial septal defects (ASD) is recommended when a hemodynamically significant shunt is present, leading to the enlargement of the right heart structures, regardless of symptomatic manifestations. A hemodynamically significant shunt is defined as one that causes right-sided volume overload and pulmonary over-circulation, typically seen when the Qp:Qs ratio is above 1.5. Closure is also indicated for specific conditions such as orthodeoxia-platypnea and confirmed paradoxical embolism. Small defects without evidence of right heart volume overload may be monitored without immediate surgery, but the potential for increased shunting later in life may necessitate closure.

The American College of Cardiology and the American Heart Association (ACC/AHA) guidelines (2018) recommend closure if pulmonary vascular resistance is less than two-thirds of systemic vascular resistance and Qp:Qs is greater than 1.5. According to the European Society of Cardiology (ESC) guidelines (2020), when possible, device closure is now the preferred method for closing secundum defects, primarily determined by morphological factors such as a stretched diameter less than 38 mm and an adequate rim of 5 mm, excluding the area toward the aorta. This preference applies to approximately 80% of patients.

Surgical closure is a well-established approach with a long history of success in ASD. It allows direct visualization of the defect, enabling precise closure and repair. However, it involves general anesthesia, a longer recovery period, and a visible surgical scar. On the other hand, transcatheter percutaneous device closure has gained popularity as a minimally invasive alternative. This approach involves inserting a closure device through a catheter, guided to the heart. While it offers a shorter recovery time, reduced scarring, and avoidance of general anesthesia, it may not be suitable for all types and sizes of ASDs.

Once the indication of intervention is established, it is crucial to determine the accurate size of the defect for optimal device selection and prevention of complications such as device dehiscence, misalignment, and residual leaks. While TTE is a reasonably convenient procedure to obtain an initial diagnosis, it might underestimate the size of the ASD. Transesophageal echocardiography can aid in good visualization and size estimation with high sensitivity and specificity; however, the procedure requires sedation. Due to high-quality images and increased surgical efficacy, intracardiac ultrasound (ICE) has been gaining importance in several invasive procedures, such as aortic valve replacement, left atrial appendage, and patent foramen ovale (PFO) closure. Compared to the conventional TEE approach, ICE has demonstrated effectiveness and safety as a viable alternative in appropriately sizing ASDs and circumventing the requirement for general anesthesia. A prospective study carried out at a university center, detailed in the publication by Mullen et al., achieved successful closure of 24 out of 25 ASDs (96%) in 23 patients through ICE.

Our patient also had concomitant atrial septal aneurysm with ASD. Studies have suggested a potential link between cryptogenic strokes and the presence of an atrial septal aneurysm. Research, including studies by Cabanes et al., has shown a notable association between atrial septal aneurysms and cryptogenic strokes. Specifically, the incidence of cryptogenic strokes appears to be higher in individuals with larger excursions of the atrial septal aneurysm (ASA). Cabanes et al. found a significant association between atrial septal aneurysms, indicated by excursions greater than 10 mm, and the occurrence of cryptogenic strokes. This suggests that the presence of an ASA, especially when associated with larger excursions, may contribute to an
increased risk of cryptogenic stroke.\textsuperscript{14}

Understanding the relationship between cryptogenic strokes and atrial septal aneurysms is crucial for informing clinical management strategies and interventions aimed at reducing the risk of stroke in individuals with this particular cardiac anomaly. In addition, there is a need for future research focusing on devising a clinical risk assessment tool for the management of ASD to guide providers and patients and enhance shared decision-making.

**Follow-Up**

Following the procedure, the patient underwent a course of dual antiplatelet therapy (DAPT) consisting of aspirin and clopidogrel for 3 months, followed by aspirin alone for up to 6 months. Subsequent follow-ups with TTE at 1 month and 5 months revealed no residual defects. Additionally, a negative agitated saline study, both with and without a Valsalva maneuver, suggested effective endothelialization of the implanted device.

**CONCLUSION**

Cryptogenic stroke associated with a high-risk ASD such as a large size (>12mm), an ASA, and a hypermobile interatrial septum, should be evaluated for percutaneous closure and the antiplatelet agent for future strike risk reduction, especially in younger individuals.

**Learning Objectives**

Identify risk factors for cryptogenic stroke in patients with atrial septal defects. Summarize the management of ostium secundum ASDs, including percutaneous device closure combined with antiplatelet therapy.

**Primary Takeaway**

The primary takeaway from this case report is that in patients with cryptogenic stroke, a thorough evaluation for structural heart abnormalities, including atrial septal defects (ASD) and atrial septal aneurysms (ASA), is essential, as they can be potential contributors to stroke. Percutaneous closure of the ASD, when combined with antiplatelet therapy, is an effective and safe treatment strategy, emphasizing the significance of tailored interventions for improved patient outcomes in similar cases. This case underscores the need for a multidisciplinary approach to stroke management, considering both neurologic and cardiac aspects.

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**References**


