Atrial Septal Defects and Cardioembolic Strokes

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KEYWORDS

• Stroke • Paradoxic embolism • Atrial septal defect • Atrial fibrillation • Shunt

KEY POINTS

- Cardioembolic strokes associated with ASDs principally occur with 2 mechanisms. The first is paradoxic embolism involving a venous-based source of thrombus that then becomes an embolism, which may subsequently pass through the ASD by right-to-left shunting, finally causing a cardioembolic stroke. The second is atrial fibrillation that can complicate the course of patients with ASDs, especially as they age. Atrial fibrillation may lead to cardioembolic strokes primarily with the embolism arising from a left atrial appendage thrombus.
- Surgical and transcatheter closure of ASDs will prevent paradoxic embolism but not cardioembolic strokes from atrial fibrillation.
- Surgical and transcatheter closure is recommended if a patient has a stroke from a presumed paradoxic embolism even if the defect is anatomically small with no signs of cardiac volume overload. Early closure in children or adolescents mitigates the risk of developing tachyarrhythmias later in life, whereas patients after ASD closure as an adult continue to carry a high risk of developing tachyarrhythmias.
- Patients with ASDs, both before and after closure, need to have cardiac rhythm monitoring to detect occult paroxysmal atrial fibrillation that would necessitate anticoagulation to prevent cardioembolic stroke. Prolonged, continuous heart rhythm monitoring is more effective at detecting occult atrial fibrillation than short-term monitors.
- Routine full anticoagulation is not recommended as primary prevention of ischemic stroke for all patients with ASDs. An individualized approach is recommended and is principally influenced by the presence or absence of any degree of atrial fibrillation; any indication of venous thromboembolism, such as deep venous thrombophlebitis and pulmonary embolism; and a history of prior systemic embolism, including that causing ischemic stroke.

BACKGROUND AND PRESENTATION

Atrial septal defects (ASDs) are the third most common type of congenital heart disease with an estimated incidence of 56 per 100,000 live births (**Fig. 1**).[1] There are 3 major types of ASDs: ostium secundum, ostium primum, and sinus venosus defect, accounting for 65% to 75%, 20%, and 5% to 10% of all ASDs, respectively. Females compose 65% to 75% of patients with secundum ASDs, but the sex distribution is equal for ostium primum and sinus venosus ASDs.[2] Ostium secundum defect, the most common of the 3, is located in the region of the fossa ovalis and considered a true defect of the atrial septum. It is not confluent with other structures and is most associated with paradoxic embolus leading to stroke.

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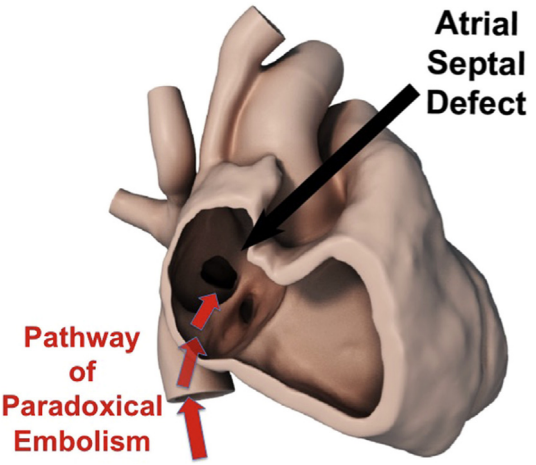

Fig. 1. This graphic shows a cutaway revealing the right atrial side of an ostium secundum ASD. The black arrow identifies the defect. The red arrows show a portion of the pathway of a paradoxic embolism. The embolism travels up the inferior vena cava and in the right atrium can cross the defect during transient right-to-left blood flow that may occur with all ASDs.

Many patients remain asymptomatic throughout most of childhood, although most will become symptomatic at some point in their lives. ASDs account for 25% to 30% of congenital heart disease cases diagnosed in adulthood.[3] Patients most commonly become symptomatic in the second decade of life with exercise intolerance in the form of exertional dyspnea or fatigue as the most common presenting symptom.[4] Atrial fibrillation or flutter is a common complication of ASD and reflects age-related atrial dilation but is uncommon before 40 years of age.[5] Occasionally, a paradoxic embolus or transient ischemic attack may be the first presentation of an ASD. Less commonly, decompensated right heart failure will occur, typically in older patients in association with substantial tricuspid regurgitation.

EPIDEMIOLOGY OF STROKE IN ATRIAL SEPTAL DEFECTS

The overall incidence of strokes due to ASD remains unknown. There has been strong evidence that patent foramen ovale (PFO) and atrial septal aneurysm is strongly associated with strokes in patients younger than 55 years.[6] This finding is consistent with ASDs whereby the average age of stroke onset was 55 years compared with 68 years in risk-matched controls without ASDs.[6]

The risk of stroke seems to be elevated in all patients with ASDs, regardless of closure status. However, there is evidence that patients with unclosed defects have an increased risk compared with closed defects. Hoffman and colleagues[7] analyzed aggregated European and Canadian databases with a total of 23,253 patients with congenital heart disease excluding patients who had an isolated patent foramen ovale. With a mean follow-up of 36.4 years, they found that the prevalence of stroke was 4.0% in an open ASD and 1.4% in a closed atrial or ventricular defect, compared with 2.0% in all patients with congenital heart disease. Another cohort of Danish patients with ASDs similarly found that the risk of stroke was higher both before and after closure compared with a control population without ASD.[8] The hazard ratio for stroke with an open ASD was 2.6 compared with 1.8 five years after ASD closure, while adjusting for cardiovascular risk factors.

CAUSES OF STROKE

There are 2 major mechanisms of embolic strokes in patients with ASDs, either due to paradoxic emboli or related to atrial fibrillation. Given the high incidence of atrial fibrillation in ASD, as well as the limitations in proving paradoxic emboli, it is difficult to separate the mechanism of strokes in studies and to quantify the number of strokes related to each.

The most obvious cause of stroke in ASD is a paradoxic embolism. Although most patients with ASDs have left-to-right shunts, intermittent right-to-left shunting may occur during transient increases in right heart pressure allowing for the introduction of paradoxic embolus to the brain. Regardless of the size of ASD, paradoxic embolism from any source, including peripheral venous thromboses, atrial arrhythmias, unfiltered intravenous infusions, or indwelling venous catheters, is a risk.[9–11] In fact, one study found that of patients with ASDs undergoing repair, those with a paradoxic embolism had significantly smaller left-to-right shunt (mean ratio of pulmonary blood flow to systemic blood flow Qp:Qs of 1.4) compared with patients with ASD without a paradoxic emboli (mean Qp:Qs of 1.95).[12] These results are likely confounded by the fact that larger defects likely present with symptoms requiring repair. However, it does draw attention to the fact that even small defects are likely at risk of paradoxic emboli.

Another major risk factor for ischemic stroke in patients with ASDs is the development of atrial fibrillation, which can lead to embolism arising most often from a thrombus in the left atrial appendage. The prevalence of atrial tachyarrhythmia was found to be approximately 19% in