# Arrhythmias in Patients with Atrial Defects

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**KEYWORDS**

• Atrial septal defect • Atrial arrhythmia • Patent foramen ovale • Atrial fibrillation

**KEY POINTS**

- Atrial arrhythmias are common in patients with atrial septal defects.
- A myriad of factors are responsible for these that include remodeling related to the defect and scar created by the repair or closure.
- An understanding of potential arrhythmias, along with entrainment and high-density activation mapping can result in accurate diagnosis and successful ablation.
- Atrial fibrillation is being seen increasingly after patent foramen ovale closure and may be primary etiology of recurrent stroke in these patients.

## INTRODUCTION

Atrial septal defects (ASDs) are one of the most common congenital heart defects[1]; these can lead to significant left-to-right shunting with resultant right-sided chamber enlargement and pulmonary hypertension. Surgical and percutaneous closure of ASDs is commonly performed. Atriotomy scar along with the underlying substrate due to remodeling predisposes these patients to atrial arrhythmias[2–4] that increase morbidity and mortality.[5] Patent foramen ovales (PFOs) also are common in the general population. Closure of these defects is done to prevent strokes,[6] and atrial arrhythmias can be seen after closure.

In this article, we outline the mechanisms of atrial arrhythmias in patients with ASDs and PFOs. We then describe the management of these arrhythmias with an emphasis on interventional cardiac electrophysiology techniques.

## ATRIAL SEPTAL DEFECTS AND PATENT FORAMEN OVALES: PATHOLOGY AND GENERAL MANAGEMENT

The atrial septum is a complex structure that is formed by the embryologic septum primum (that grows from caudal to cranial direction) and septum secundum (that grows from cranial to caudal direction). Abnormalities in formation of this atrium septum can lead to the presence of ASD (primum [15%–20% of ASDs] or secundum [75% of ASDs])[7] or a PFO (seen in 25% of general population).[6] Other types of ASDs are rare and have a more complicated embryologic development (sinus venosus ASD and the unroofed coronary sinus).

An ASD leads to shunting of blood from the left to right side. This can lead to right atrial as well as ventricular dilation as well as increased pulmonary blood flow resulting in right-sided heart failure and pulmonary vasoconstriction. As such, closure is usually recommended when there is evidence of right-sided chamber dilation.[8] Closure of PFO is generally performed when it is thought to be a cause of recurrent stroke or thromboembolism.[9]

## ELECTROCARDIOGRAPHIC CHANGES SEEN WITH ATRIAL SEPTAL DEFECTS

A host of atrial tachyarrhythmias can be seen in patients with ASDs, as outlined later in this article. However, even in the absence of tachyarrhythmias,

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several electrocardiographic (ECG) abnormalities can be seen (Fig. 1)[10]:

1. A superior P-wave axis due to an abnormality in the sinus node, that can be seen in a sinus venosus defect.[11]
2. Evidence of right atrial abnormality may be seen due to right atrium enlargement.
3. A prolonged PR interval can be seen usually in primum ASD, but also in older patients with a secundum ASD.
4. The QRS axis is deviated to the right in secundum ASD, and leftward or extremely to the right in ostium primum ASDs.

Right ventricular hypertrophy and incomplete right bundle branch block can be seen, especially in the presence of pulmonary hypertension.

## ATRIAL ARRHYTHMIAS WITH ATRIAL SEPTAL DEFECTS/PATENT FORAMEN OVALES

In general, the mere presence of a PFO is not associated with an increased risk of atrial arrhythmias. However, there is a significantly increased incidence of atrial arrhythmias post-PFO closure. Most patients undergoing PFO closure have recurrent "cryptogenic" stroke; it is possible that these patients have atrial arrhythmias that were underdiagnosed before PFO closure and were likely the cause of stroke[12] (Fig. 2).

On the other hand, ASDs, whether repaired or unrepaired, are associated with an increased risk of atrial arrhythmias.[4] In general, the incidence of atrial flutter/fibrillation increases with age, and although atrial flutter is the most common arrhythmia in younger patients, atrial fibrillation is more common in older patients.[10] Untreated ASDs have an incidence of atrial arrhythmias of greater than 10% after the age of 40 years. If patients undergo closure of the ASD at a younger age (<25 years), the incidence of atrial arrhythmias (new onset and persistence of prior atrial arrhythmias) is much less than in patients who undergo closure at an older age (>40 years). This is likely because of shunt-related remodeling of the atria leading to arrhythmias (described in the next section).

## PATHOPHYSIOLOGY OF ARRHYTHMIAS WITH ATRIAL SEPTAL DEFECTS

### *Before Closure/Repair of an Atrial Septal Defect*

1. Geometric remodeling: Due to the left-to-right shunt, the right atrium undergoes stretching

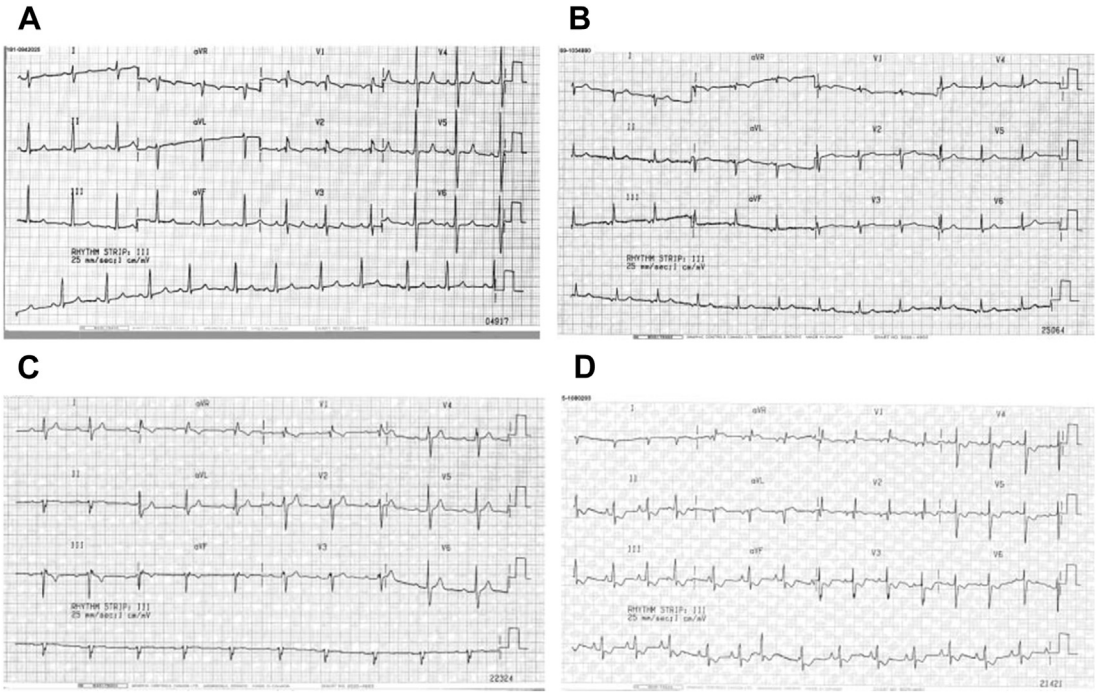


**Fig. 1.** ECG features of ASDs. (*A*) Ostium secundum ASD. Mild right-axis deviation, voltage evidence of right ventricular hypertrophy. (*B*) Sinus venosus ASD. Inverted inferior P-waves, right-axis deviation. (*C*) Ostium primum ASD. First-degree AV block, left-axis deviation, voltage evidence of right ventricular hypertrophy. (*D*) Eisenmenger ASD. Marked right-axis deviation, right atrial overload, right ventricular hypertrophy with extensive repolarization abnormalities ("strain pattern"). (*Reproduced with permission from* Webb G, Gatzoulis MA. Atrial septal defects in the adult: recent progress and overview. Circulation 2006;114(15):1645–53.)