Atrial Septal Defect: A Literary Review of Congenital Heart Disease

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Abstract:

Atrial septal defect is a common congenital abnormality that occurs in the form of ostium secundum, ostium primum, sinus venosus and rarely coronary sinus defects. Atrial septal defects are the third most common type of congenital heart disease. Included in this group of malformations are several types of atrial communications that allow shunting of blood between the systemic and pulmonary circulation. Most children with isolated atrial septal defects are free of symptoms but the rate of exercise intolerance, atrial tachyarrythmias, right ventricular dysfunction and pulmonary hypertension is increased with advanced age and life expectancy is reduced in adults with untreated defects. Surgical closure is safe and effective and when done before age 25 years is associated with normal life expectancy. An isolated atrial septal defect can occasionally go undiagnosed for decades. It accounts for 25-30 % of congenital heart disease cases diagnosed in adulthood. Transcatheter closure offers a less invasive alternative for patients with a secundum defect who fulfill anatomical and size criteria. Patent foramen ovale is a normal communication during fetal life and is commonly encountered after birth. Abnormalities in genes essential to cardiac septation have been associated with atrial septal defects. Echocardiography is central to diagnosis and also informs the interventional approach. Per cutaneous or surgical ASD closure may be indicated in presence of right heart volume overload, paradoxical embolism, orthodeoxia-platypnea or an elevated pulmonary systemic flow ratio.

Keywords : *Ostium primum, Ostium secundum, Septal defects, Transcatheter closure, Echocardiography, Paradoxical embolism, Orthodeoxia platypnea.*

Introduction :

Atrial septal defects belong to a group of congenital cardiac anomalies that allow communication between the left and right sides of the heart. These inter atrial communications include several distinct defects in the cardiac terminations of systemic and pulmonary veins (sinus venosus and coronary sinus defects) and in inter atrial septum (atrial septal defects). Patent foramen ovale is a normal communication during fetal life and is commonly encountered after birth.

Defects of atrial septum are the third most common type of congenital heart disease with an estimated incidence of 56 per 100000 live births [1]. With improved recognition of clinically silent defects by echocardiography, recent estimates are about 100 per 100000 live births [2]. About 65 – 70% of patients with a secundum defect, roughly 50 % of those with a primum atrial septal defect and 40 – 50 % of those with a sinus venosus defect are female.

Most atrial septal defects are sporadic with no identifiable cause. Reports of familial clusters of secundum defects have noted different modes of inheritance, most notably autosomal dominant [3, 4]. Abnoramalities in genes essential to cardiac septation have been associated with atrial septal defects [5]. The risk of secundum defect is increased in families with history of congenital heart disease, especially when an atrial septal defect is present in a sibling [3]. In patients with trisomy 21, secundum and primum defects are the more frequent lesions, accounting for 42% and 39% of major congenital heart disease, respectively [6]. Exposure to several substances has been associated with atrial septal defects, including fetal alcohol syndrome [7], first trimester maternal cigarette consumption [8,9], and some anti depressents [10-12]. Other maternal risk factors include diabetes, increased dietary glycemic index in women without diabetes [35,36] and advanced maternal age.(more than or equal to 35 years) [15,16].

Normal development of atrial septum results in formation of fossa ovalis, which include two

anatomical elements: first, muscular boundaries contributed by septum secundum, and second, the valve of fossa ovalis, which attaches on left atrial aspect of septum secundum – septum primum. A patent foramen ovale is seen in almost all newborn babies, but its frequency decreases with advancing age [17-18]. Complete anatomical closure of foramen ovale occurs in 70-75% of adults [20].

Secundum atrial septal defect is a defect within the fossa ovalis usually due to one or several defects within septum primum. With the exception of patent foramen ovale, secundum atrial septal defect is the most common cause of an atrial - level shunt. The size of secundum defects varies from several millimeters to 2-3 cm. Large defects usually associated with substantial deficiency, or even complete absence of septum primum.

Primum atrial septal defect is one of the several variants of common atrio ventricular canal defects (also termed atrio ventricular septal defect) with an inter atrial communication between the anterior inferior margin of fossa ovalis and atrio ventricular valves. The defect is characterized by a common atrio ventricular orifice with two distinct atrio ventricular valve annuli completed by valve tissue adhering to crest of the ventricular septum. In addition to septal defect, the atrio ventricular valve in this anomaly are always almost abnormal, including a cleft in the anterior mitral leaflet. Unlike other types of atrial septal defects, the position and course of conduction axis is abnormal as in complete atrio ventricular canal defect.

In most patients, an atrial septal defect results in left -to- right shunt. The direction and magnitude of blood flow through an atrial communication are determined by the size of the defect and by the relative atrial pressures, which relate to compliances of left and right ventricles. Both the size of the defect and the compliance of the ventricles can change over time [21].

Pathophysiologic consequences of ASDs typically begin in adulthood, and include arrhythmia, paradoxical embolism, cerebral abscess, pulmonary hypertension and right ventricular failure .Two dimensional transthoracic echocardiography with Doppler is a central aspect of the evaluation. This non- invasive imaging modality often establishes the diagnosis and provide critical information guiding intervention.

Clinical presentation:

Most patients remain asymptomatic throughout most of the childhood. Even those with a large left – to – right shunt might not have overt symptoms until adulthood. Rarely an isolated atrial septal defect is found in an infant with tachypnea, slow weight gain, or recurrent respiratory infections [23, 24].

By contrast, most adult patients with a large defect present with symptoms, including fatigue, exercise intolerance, palpitations, syncope, shortness of breath, peripheral oedema, manifestations of thromboembolism and cyanosis.

Exercise capacity and peak oxygen consumption are decreased in most adults with unpaired secundum defect, often at 50-60% of predicted values in healthy controls [27].

Major arrhythmias are uncommon in children with atrial septal defects. The most common arrhythmias are atrial flutter and fibrillation, incidences of which increase with age. Pulmonary hypertension is uncommon in children with an isolated atrial septal defect. In adults with large defects, mild or moderate pulmonary hypertension is common and tends to increase with age and in those living at high altitude [28-30]. Although uncommon, dyspnea in patients with ASD may be triggered by an upright position in orthodeoxia-platypnea syndrome and linked to arterial desaturation. Late post- operative atrial fibrillation or flutter tends to occur in those who undergo closure after the age of 40 years [2].

On physical examination, most young patients with an isolated secundum atrial septal defect are acyanotic and can have few or no symptoms. Characteristic electrocardiographic features of atrial septal defect include a tall P wave indicative of right atrial enlargement, incomplete right bundle branch block pattern and right axis deviation. Left axis deviation with superior axis is suggestive of primum defect.

Echocardiography :

Transthoracic echocardiography is a primary diagnostic method for determining the presence, location, size and haemodynamic characteristics of atrial septal defects. Contrast echocardiography with

injection of agitated saline through a peripheral venous cannula during imaging of atria and ventricles can assist in the diagnosis of atrial septal defect, especially in patients with restricted acoustic windows [32].

MRI and CT:

Advanced in cardiac and MRI techniques allow anatomical delineation of atrial septal defects and quantitative assessment of their haemodynamic consequences [33,34]. In patients with isolated secundum or primum defects, cardiac MRI is seldom necessary. Exceptions include those in whom the location of defect or its haemodynamic burden is in question. However, the risk of cancer related to ionizing radiation limits its application to only carefully selected patients in whom other modalities are insufficient [35].

Treatment:

Indications and contra indications of defect closure:

Closure of an atrial septal defect is indicated in the presence of a haemodynamically significant shunt that causes enlargement of right heart structures, irrespective of symptoms [35, 36]. Other indications include suspicion of paradoxical embolism in the absence of other causes or in the rare instance of documented Orthodeoxia – platypnoa (dyspnea and hypoxaemia accompanying a change to a sitting or standing from a recumbent position) irrespective of shunt size.

Timing of defect closure:

A haemodynamically significant atrial septal defect should be closed electively once the diagnosis is confirmed. Although, there is no lower limit of age for defect closure, many clinicians choose to refer asymptomatic children for the procedure at age 3-5 years. At the other end of the age spectrum, evidence indicates that with the exceptions of contraindications noted above, defect closure is safe and effective in improving symptoms, even in elderly patients. [29, 37-39].

Sinus venosus, primum and coronary sinus septal defects need surgical closure. Secundum defects can be closed either by surgery or by percutaneous route using an occluding device delivered by a catheter. Transcatheter closure might not be feasible in some large secundum defects or small infants.

Clinical and haemodynamic results of defect closure:

Patients commonly report subjective improvement in symptoms after closure of atrial septal defects [27, 37]. A younger age at closure and a lesser degree of chamber enlargement before repair are associated with a higher likelihood of normalization of right ventricular size [43].

Studies have shown improvements in symptoms and exercise capacity decrease in right atrial and left ventricular size and improvement in pulmonary hypertension in most but not all patients [29, 30, 45, 50, 51]. Although, these benefits are less pronounced after age 60 years [29, 30], symptomatic improvement and increase in 6 min. walking distance coupled with a low procedural risk provide the rationale for defect closure in elderly patients [29, 37,52].

Maternal complications are uncommon in isolated atrial septal defects not complicated by pulmonary hypertension [55]. Yap and colleagues [56] found similarly low rates of maternal complications in women with repaired and unrepaired defects, including arrhythmias (4%) and transient ischaemic attack (1%). Pre - pregnancy history of arrhythmia and maternal age older than 30 years were risk factors for maternal cardiac complications. The women with an ASD who have severe pulmonary arterial hypertension should be counseled to avoid pregnancy due to excess maternal and fetal mortality [13, 27].

Discussion:

Defects of atrial septum are the third most common type of congenital heart disease with an estimated incidence of 56 per 100000 live births [1]. With improved recognition of clinically silent defects by echocardiography, recent estimates are about 100 per 100000 live births [2]. In most patients, an atrial septal defect results in left -to-right shunt. The direction and magnitude of blood flow through an atrial communication are determined by the size of the defect and by the relative atrial pressures, which relate to compliances of left and right ventricles. Both the size of the defect and the compliance of the ventricles can change over time [21]. Left ventricular systolic dysfunction can develop late in patients with a large atrial septal defect [22].

Surgical closure is safe and effective and when done before age of 25 years is associated with normal life expectancy. Transcatheter closure offers a less invasive alternative for patients with a secundum defect who fulfill anatomical and size criteria. The diagnostic sensitivity of transthoracic echocardiography is excellent in young patients, but lower in those with restricted acoustic windows due to obesity, large body habitus and previous thoracic surgery. Closure of an atrial septal defect is indicated in the presence of a haemodynamically significant shunt that causes enlargement of tight heart structures, irrespective of symptoms [35, 36]. The primary indication for ASD closure is right heart volume overload, whether symptoms are present or not. ASD closure may also be reasonable in other contexts, such as paradoxical embolism.

American and European practice guidelines state that an atrial septal defect can be closed if the pulmonary vascular resistance is lower than two-thirds of the systemic vascular resistance and there is evidence of pulmonary-to-systemic flow ratio greater than 1.5. Some studies have shown an increase in exercise capacity in adults after defect closure [40], but in asymptomatic children the change has been minimum or none. Conversely, studies on respiratory symptoms and pulmonary function in children have shown a significant improvement after closure [41, 42]. A younger age at closure and a lesser degree of chamber enlargement before repair are associated with a higher likelihood of normalization of right ventricular size [43]. Atrial flutter and fibrillation are important causes of morbidity, seen in 21% of adults older than 40 years with a rising frequency over time [49].

Studies have shown improvement in symptoms and exercise capacity, decrease in right atrial and right ventricular size, and improvement in pulmonary hypertension in most but not all patients [29, 30, 45, 50, 51]. Pregnancy should be avoided in women with an atrial septal defect and severe pulmonary hypertension. Maternal deaths tended to occur shortly after delivery and were often caused by heart failure, thromboembolism, pulmonary hypertensive crisis and sudden cardiac death.

The 2008 American College of Cardiology and American Heart Association (ACC/AHA) adult congenital heart disease guidelines provide detailed clinical guidance on ASDs [1]. An interesting association of ASD with Klippel - Feil Syndrome was recently reported, which has the major physical examination features of a short neck, limited range of motion in the neck, and low hair line at the back of the head [64].

Conclusion:

ASDs are a common congenital abnormality that most commonly occurs as an ostium secundum defect. About 65-70% of patients with a secundum defect, roughly 50% of those with a primum atrial septal defect, and 40-50% of those with a sinus venosus defect are female. Exercise intolerance is uncommon in young children with an isolated atrial septal defect. Nonetheless, pulmonary function is often impaired in this age group [26]. Major arrhythmias are uncommon in children with atrial septal defects. Pulmonary hypertension is uncommon in children with an isolated atrial septal defect. Enlargement of right heart structures are evident on chest radiography in patients with haemodynamically significant atrial septal defects. Sinus venosus, Primum and coronary sinus septal defects need surgical closure. Secundum defects can be closed either by surgery or by percutaneous route using an occluding device delivered by a catheter. Transcatheter closure might not be feasible in some large secundum defects or small infants. The risk of atrial tachyarrythmias, especially atrial flutter and fibrillation, remains high after defect closure in adulthood. Risk factors include atrial arrhythmia before closure and age at closure older than 40 years [53, 54]. By comparison with general population, women with unpaired atrial septal defects had an increased risk of pre-eclampsia, fetal loss and low birth weight. A comprehensive echocardiogram includes evaluation of anatomical ASD characteristics, flow direction, associated abnormalities (e.g. anomalous pulmonary veins), right ventricular anatomy and function, pulmonary pressures and pulmonary or systemic flow ratio. ASD types strictly include ostium secundum (75% of cases), ostium primum (15-20%), while rare coronary sinus defects are closely related [1]. The overall prevalence of diagnosed ASDs has been estimated at 3.89 per 1000 children and 0.88 per 1000 adults, which may be underestimates due to

clinically silent and unidentified cases [3]. Sick sinus syndrome may also develop in ASD patients due to long standing right heart overload [1]. A patent foramen ovale was much more common and present in 81%. Complete heart block is characteristic of familial ASD [15]. Echocardiography is central to diagnosis and also informs the interventional approach. Percutaneous or surgical ASD closure may be indicated in presence of right heart volume overload, paradoxical embolism, orthodeoxia-platypnea, or an elevated pulmonary or systemic flow ratio.

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