

Pediatric Cardiomyopathies — Pathophysiology and Diagnostic Workup

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Cardiomyopathies encompass a wide range of myocardial diseases that present with various structures such as ventricular dilatation as seen in dilated cardiomyopathy, or ventricular constriction as seen with restrictive cardiomyopathy and constrictive pericarditis. The eventual serious outcome is the development of congestive heart failure, where Symptomatic treatment or even heart transplantation should be offered for affected children. Echocardiography and magnetic resonance imaging are the main diagnostic modalities for cardiomyopathies in children.



Classification

Cardiomyopathies can be classified into:

1. Dilated cardiomyopathy

- Dilated cardiomyopathy is defined as the dilatation of the myocardial wall that is associated with congestive cardiac failure manifestations.
- Idiopathic dilated cardiomyopathy is very common. This term is used usually when the condition is not caused by congenital, valvular or coronary artery disease.

2. Restrictive cardiomyopathy

Restrictive cardiomyopathy is one of the rare forms of cardiomyopathies that is **characterized by reduced end-diastolic volume in the right and left ventricles**, but with intact systolic function and normal ventricular wall thickness. The heart looks structurally normal but histologic examination might reveal some abnormalities.

3. Constrictive pericarditis

Constrictive Pericarditis is a condition that is **characterized by the inability of the heart to expand during diastole** and therefore impedes normal diastolic filling. The condition is caused by a thickened fibrotic pericardium which can be due to a chronic infectious etiology.

Epidemiology of Pediatric Cardiomyopathies

Dilated cardiomyopathy is considered the most common form of cardiomyopathies in children with an estimated incidence of 0.57 per 100,000 children. Genetic predisposition has been described in at least one-third of the cases of

dilated cardiomyopathy. Boys are more likely to be affected by the condition. Prognosis is not very good as one-third of the patients will die, and only one third are expected to improve with medical treatment. The remainder of the patients goes on to develop chronic congestive heart failure.

Constrictive pericarditis is becoming less recognized nowadays because the incidence of infectious pericarditis in the developed world has decreased. The current estimated incidence of constrictive pericarditis is approximately 1 in 10,000. The condition is very rare in children without any accurate figures of the true incidence in children younger than 16 years. Again, boys are more likely to develop constrictive cardiomyopathy compared to girls. If constrictive pericarditis is diagnosed early and treated properly, the condition can be curable.

The only form of cardiomyopathies that is more common in girls is restrictive cardiomyopathy. The exact condition of restrictive cardiomyopathy in children is unknown, but the condition is considered as extremely rare. Without early heart transplantation, the prognosis is usually very bad. Approximately, 3 quarters of the patients who are diagnosed with restrictive cardiomyopathy die within six years of the diagnosis.

Etiology of Pediatric Cardiomyopathies

The exact etiology of the different types of cardiomyopathy is largely unknown but is very likely to be genetic in origin.

Most patients with dilated cardiomyopathy have an idiopathic form of the disease without any identifiable cause. On the other hand, any disease process that is known to cause myocardial damage can also cause dilated cardiomyopathy. For instance, carnitine deficiency, the use of anthracycline, a previous history of viral myocarditis, and autoimmune disorders have all been linked to an increased risk of dilated cardiomyopathy.

Genetic predisposition is implicated in a significant number of cases of dilated cardiomyopathy. Defects in the genes encoding for actin, desmin, or lamin A/C have been linked to autosomal dominant dilated cardiomyopathy. Patients with genetic defects in the loci 1p1, 3p22 or 3p25 might develop dilated cardiomyopathy with conduction defects. X-linked forms of the disease have been also described. X-linked dilated cardiomyopathy is characterized by genetic defects in the genes encoding for dystrophin and tafazzin.

Constrictive pericarditis is most commonly of an unknown etiology. In the developing world, tuberculosis is considered as the most common cause of constrictive pericarditis. Additionally, children who develop purulent bacterial pericarditis are at risk of developing constrictive pericarditis. The previous history of thoracic or mediastinal radiation therapy has been linked to an increased risk of constrictive pericarditis. Uremia and systemic lupus erythematosus or scleroderma have been linked to constrictive pericarditis in a small number of patients. Finally, previous exposure to hydralazine or procainamide might cause constrictive pericarditis.

Restrictive cardiomyopathy can be caused by infiltrative or non-infiltrative processes. Infiltrative restrictive cardiomyopathy can be caused by amyloidosis, sarcoidosis, hemochromatosis, and lysosomal storage diseases. The most common form of non-infiltrative restrictive cardiomyopathy is of unknown etiology, i.e. idiopathic. Familial cases of restrictive cardiomyopathy have also been described, but the condition

is considered very rare to link it to certain genetic loci with enough certainty.

Pathophysiology of Pediatric Cardiomyopathies

The main pathology in dilated cardiomyopathy is systolic dysfunction. Cardiac output is decreased which activates the renin-angiotensin-aldosterone system, the sympathetic autonomic nervous system, and increase the release of the atrial natriuretic peptide. The activation of these systems help maintain the cardiac output at first, but cardiac decompensation eventually happens.

It is believed that prolonged ventricular stretching plays an important role in ventricular wall thinning and ventricular dilatation. Additionally, it seems that myocyte apoptosis becomes activated in patients with congestive heart failure which further worsens the condition and makes the ventricles thinner, lose their ability to contract properly during systole and dilate more.

Constrictive pericarditis happens because of prolonged and chronic inflammation of the thin parietal and visceral pericardial linings. **Chronic inflammation is associated with pericardial linings thickening and fusion.** In addition to this, fibrotic changes within the pericardium are also implicated in the pathology of constrictive pericarditis. The myocardium is usually normal in patients with constrictive pericarditis.

Patients have impaired end-diastolic filling due to the inability of the heart to expand within the constricted pericardium. In early diastole, the ventricular filling is usually normal in patients with constrictive pericarditis. Due to the reduced diastolic filling of the ventricles, the stroke volume is decreased and cardiac output is decreased.

Infiltrative etiologies of restrictive cardiomyopathy, as the name implies, are **characterized by the infiltration of the myocardium by inflammatory cells, or amyloid deposits.** This is associated with interstitial fibrosis and increased stiffness of the heart. Accordingly, even though the heart looks grossly normal, the early diastolic filling volume is decreased compared to constrictive pericarditis. The pathology behind idiopathic restrictive cardiomyopathy is poorly understood.

Clinical Presentation of Pediatric Cardiomyopathies

Patients with dilated cardiomyopathy might present with chest pain, palpitations, and syncope. Symptoms and signs suggestive of congestive heart failures such as orthopnea, hemoptysis, frothy sputum, and abdominal pain due to liver enlargement are also common. The family history of dilated cardiomyopathy might be evident in as high as 25 % of the cases.

The clinical presentation of constrictive pericarditis is very non-specific. Patients might develop palpitations, easy fatigability and sometimes night sweats and fevers due to tuberculosis. The previous history of purulent pericarditis might be an important clue, but, in many cases, the preceding episode of acute pericarditis might go unrecognized.

Patients with restrictive cardiomyopathy might develop congestive heart failure, dyspnea, orthopnea, and might have a positive family history. The condition cannot be diagnosed based on the clinical picture alone.

Diagnostic Workup for Pediatric Cardiomyopathies

Dilated cardiomyopathy due to active viral myocarditis might be associated with elevated erythrocyte sedimentation rate and c-reactive protein levels in the blood. Imaging studies are very important in establishing the diagnosis of dilated cardiomyopathy.

Chest X-rays show cardiomegaly with a prominent left ventricular apex. Patients might also have pulmonary edema and congestion due to congestive heart failure. Echocardiography reveals a decreased ejection fraction (< 50 %), thinned left ventricular walls and areas of dyskinesia. Due to the massive dilatation of the left ventricle, mitral valve regurgitation and insufficiency are commonly seen on Doppler echocardiography. Dilatation of the left atrium might be also evident on echocardiography.

Patients with constrictive pericarditis should undergo laboratory testing for possible inflammatory etiologies. Elevated erythrocyte sedimentation rate and an elevated c-reactive protein might be seen in patients with systemic lupus erythematosus. Antinuclear antibodies and rheumatoid factor might be positive in patients with connective tissue diseases.

Patients with a suspected history of tuberculosis should undergo the purified protein derivative skin test. Chest X-rays might reveal severe pericardial calcification. Echocardiography might show impaired late diastolic filling. Magnetic resonance imaging can reveal a thickened pericardium and a narrow right ventricle. The diagnosis is usually made based on the collection of chest X-ray findings, echocardiography findings and magnetic resonance imaging results with the clinical presentation of the patient.

Restrictive cardiomyopathy diagnosis is based on echocardiography. Patients usually have an enlarged left atrium with normal left ventricular end-diastolic dimensions. Patients with restrictive pericarditis might have impaired early diastolic filling. The pericardium is usually normal in patients with restrictive cardiomyopathy. Histologic examination is very helpful in infiltrative conditions, such as sarcoidosis and amyloidosis.

Differential Diagnosis of Pediatric Cardiomyopathies

Dilated cardiomyopathy can be caused by:

1. Coarctation of the aorta
2. Pediatric nonviral myocarditis
3. Pediatric viral myocarditis
4. Anomalous left coronary artery from the pulmonary artery
5. Myocardial infarction in childhood
6. Carnitine deficiency
7. Pediatric valvar aortic stenosis

Restrictive cardiomyopathy

The main differential diagnosis of restrictive cardiomyopathy (RCM) is constrictive pericarditis (CP). However, differentiating them can be tricky, especially in kids that have been treated with anthracycline drugs as well as thoracic radiation during cancer therapy. Even though cardiac catheterization and Doppler echocardiography both show abnormal ventricular filling and heightened end-diastolic pressure of the ventricles, they can still be used to differentiate between RCM and CP. In

cases where the stigmata of constrictive pericardial disease is available, MRI of the cardiac area is helpful.

Treatment of Pediatric Cardiomyopathies

Due to our poor understanding of the pathophysiology of pediatric cardiomyopathies, treatment options are usually symptomatic and limited.

Patients with dilated cardiomyopathy very commonly develop congestive heart failure. Symptomatic treatment of congestive heart failure include diuretics, angiotensin-converting-enzyme inhibitors, and beta-blockers. Stem cell transplantation is currently being investigated as an option for dilated cardiomyopathy.

The treatment of choice for constrictive pericarditis is surgical. A pericardiectomy is the procedure of choice with an excellent curative rate if done early. Diuretics might be used to help with pulmonary congestions.

Symptomatic treatment of restrictive cardiomyopathy is not recommended because of the very high mortality rate. Instead, early consideration for cardiac transplantation should be made. Some experts suggest that the patient should be listed for cardiac transplantation once the diagnosis of restrictive cardiomyopathy is made. Ventricular assist devices should be used as a bridge until the patient receives a heart transplant.

Prognosis of Pediatric Cardiomyopathies

The long-term outcome of any form of pediatric cardiomyopathy is presently unpredictable since it takes place within a wide spectrum of severity and outcome. In children with a family history of pediatric cardiomyopathy, the outcome may not be the same as that of his/her parents. The general prognosis is dependent on the type of cardiomyopathy as well as the stage of initial diagnosis.

For example, the 5-year survival rate for kids who suffer from hypertrophic cardiomyopathy is approximately 85–95 %, 40–50 % for those with dilated cardiomyopathy and 44–50 % for those with restrictive cardiomyopathy. However, following a heart transplant, the three-year survival rises to 77 %.

References

Parks J. Constrictive Pericarditis. Background, Pathophysiology, Etiology. <http://emedicine.medscape.com/article/157096>. Published February 24, 2017. Accessed March 14, 2017.

Lin K. Pediatric Restrictive Cardiomyopathy. Background, Pathophysiology, Etiology. <http://emedicine.medscape.com/article/895392>. Published September 30, 2016. Accessed March 14, 2017.

Venugopalan P. Pediatric Dilated Cardiomyopathy. Practice Essentials, Background, Pathophysiology. <http://emedicine.medscape.com/article/895187>. Published January 6, 2017. Accessed March 14, 2017.

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