

Arrhythmias in Children: Bradycardia and Tachycardia — Diagnosis and Treatment

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The most common form of cardiac arrhythmia in children is sinus tachycardia, which can be caused by fever. Bradycardia can occur in children due to a depressed sinus node as is seen in hypoxemia, acidosis, or structural heart disease. Complete heart blockage is another possible cause for a slow heart rate in children. Patients can present with palpitations, presyncope, syncope, dizziness, and confusion. Diagnostic workup should focus on the identification of the exact type of arrhythmia by performing an electrocardiogram, identifying the etiology, and ordering advanced electrophysiology studies. Treatment should be tailored against the possible etiology of the arrhythmia whenever possible.



Overview

Bradycardia is defined as a heart rate slower than the lower limit of a normal heart rate for the child's age.

- Infants: < 100/min
- Young children (3-9 years): < 60/min
- Older children (9-16 years): < 50/min

Tachycardia is defined as a heart rate that is faster than the upper limit of a normal heart rate for the child's age.

Bradycardia can have metabolic causes such as metabolic acidosis, drug-induced or hypoxemia due to depression of the sinus node or a block in the conduction system. Tachycardia can originate from ectopic foci in the atria as seen in atrial ectopic beats, atrial flutter, or atrial fibrillation from the atrioventricular (AV) node as part of re-entrant tachycardia. Tachycardia can also originate from the ventricles in the case of ventricular

arrhythmias which are a less common cause of arrhythmia in children.

Epidemiology of Bradycardia and Tachycardia in Children

Cardiac arrhythmia is quite common in children, with an estimated incidence of 55 per 100,000 children presenting to the emergency department. The most common form of cardiac arrhythmia in children is sinus tachycardia, followed by the collective disorders known as supraventricular tachycardia, then bradycardia. Atrial fibrillation is rare in children.

Etiology and Pathophysiology of Bradycardia and Tachycardia in Children

The most common form of cardiac arrhythmias in children is sinus tachycardia which can be caused by any febrile illness, be a consequence of dehydration, or be related to respiratory distress.

Atrial fibrillation can occur in children due to atrial dilatation which is a possible complication of large atrial septal defects, mitral valve stenosis, or mitral valve insufficiency.

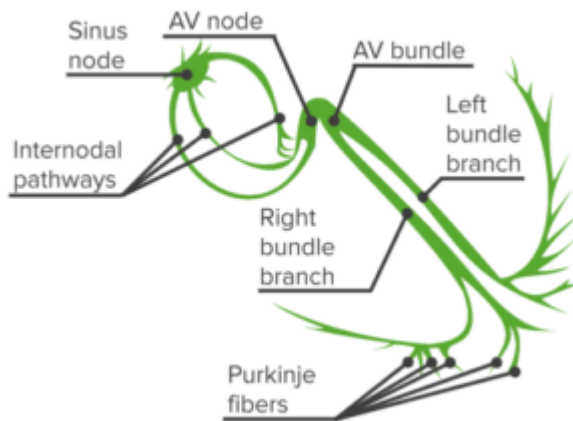


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Sinus bradycardia is most commonly caused by hypoxemia; respiratory failure, inadequate oxygenation of the blood due to the congenital heart or lung disease, and hypothermia are commonly associated with a depressed sinus node and sinus bradycardia.

Metabolic acidosis is another common cause of bradycardia in children.

Patients with increased intracranial pressure due to tumors or other obstructive lesions can present with hypertension and bradycardia, a sign of impending brain tonsillar herniation.

Complete heart block can be an isolated disease in children or can be a complication of structural heart disorders. A common cause of complete AV block is cardiac surgery utilizing catheter-alcohol ablation of the left ventricular wall in hypertrophic cardiomyopathy. Maternal history of systemic lupus erythematosus or scleroderma has also been linked to an increased risk of complete heart block in the offspring.

Hypothyroidism should be excluded in any child presenting with bradycardia due to AV block.

Infective endocarditis and viral myocarditis can also be associated with bradycardia, but are more commonly associated with ventricular arrhythmia. Electrolyte disturbances such as hypocalcemia or hyperkalemia can also cause bradycardia.

The most common cause of ventricular arrhythmia is ventricular fibrosis and scarring. The most common mechanisms for ventricular arrhythmia are reentrant arrhythmia or automatic ventricular pacemakers observed, for example, in ventricular ectopic beats. Postoperative ventricular tachycardia can happen as a complication of any heart surgery involving the ventricles. Atrial arrhythmia is also caused by spontaneous depolarization and electrical automaticity of the myocardium.

Clinical Presentation of Bradycardia and Tachycardia in Children

Though patients with bradycardia may be asymptomatic, the most common symptoms are decreased cardiac output, presyncope, and syncope, dizziness, confusion, and decreased exercise tolerance. Young children and infants with a complete heart block may present with congestive heart failure.

Patients with ventricular tachycardia or other ventricular arrhythmias usually complain of palpitations, presyncope, syncope, or dizziness and confusion. Respiratory distress is also commonly seen. Sudden cardiac death due to ventricular fibrillation can be the presenting feature of ventricular arrhythmia, especially in children with hypertrophic cardiomyopathy.

Patients who have an ongoing infection or a febrile illness may present with sinus tachycardia. Such patients will complain of palpitations, shortness of breath, and other symptoms that are specific to the site of infection. Chest pain can be related to myocarditis and can be associated with ventricular arrhythmia.

The most common presenting feature of supraventricular tachycardia is palpitations followed by dizziness and shortness of breath. These types of arrhythmia are less likely to be associated with syncope.

Finally, patients who have atrial fibrillation may present with symptoms and signs suggestive of embolic diseases, such as ischemic stroke.

Diagnostic Workup for Bradycardia and Tachycardia in Children

The first step in the evaluation of a child presenting with palpitations is to perform an electrocardiogram. The electrocardiogram can help the treating physician identify the type of arrhythmia and the seriousness of the condition.

Because of the association between myocyte damage and ventricular arrhythmia, it is recommended to check troponins levels in children presenting with suspected myositis, as it elevates myocyte damage. A complete blood count is also indicated to exclude anemia which is a common cause of sinus tachycardia, leukocytosis which is suggestive of an ongoing infection, and elevated erythrocyte sedimentation rate which is linked to

myocarditis or endocarditis.

Patients should also undergo echocardiography when myocarditis or endocarditis is suspected. Serum electrolytes should also be checked; hypocalcemia has been linked with ventricular arrhythmia and complete heart block whereas hyper- and hypokalemia is associated with an increased risk of ventricular ectopic beats and ventricular tachycardia.

Thyroid function tests are indicated to exclude hypothyroidism, a common cause of bradycardia in children. Arterial blood gasses should also be assessed as acidosis and hypoxemia have both been linked with bradycardia.

Patients who complain of palpitations but are found to have a normal electrocardiogram may need Holter monitoring. Holter monitoring makes it possible to identify the type of arrhythmia the child may have.

Finally, cardiac electrophysiology studies are indicated to evaluate the heart for possible abnormal conduction pathways and automatic ectopic ventricular or atrial paces.

Treatment of Bradycardia and Tachycardia in Children

Asymptomatic children with bradycardia should be monitored closely and the cause corrected. For instance, if the child has acidosis, the cause of acidosis needs to be determined and promptly corrected. Symptomatic children, on the other hand, should be treated with atropine or isoproterenol. These drugs should only be used temporarily in children with a complete heart block until a permanent pacemaker is implanted.

When the cause of bradycardia is obvious such as hypothyroidism or an electrolyte imbalance, correction of the cause can also be adequate in the treatment of the bradycardia.

Patients with a ventricular arrhythmia should be started on verapamil or diltiazem, especially if the cause of the arrhythmia can be attributed to hypertrophic cardiomyopathy. Amiodarone can also be used for the treatment of ventricular arrhythmia in children. It should be noted that the pharmacological treatment of ventricular arrhythmia in children has not to be associated with a decreased mortality rate.

Patients with recurrent ventricular tachycardia and hypertrophic cardiomyopathy may be candidates for the implantation of an implantable cardioverter-defibrillator. The use of these devices have proven to be lifesaving in children with hypertrophic cardiomyopathy and have been linked to a decreased risk of sudden cardiac death.

Children who have sinus tachycardia due to dehydration or febrile illness usually respond well to the treatment of the etiology. For instance, the use of adequate analgesia and antibiotic therapy for an infectious etiology is known to bring down the fever in the child, which in turn may correct the sinus tachycardia.

Patients who have a frequent atrial arrhythmia or supraventricular tachycardia should be evaluated for possible automaticity of the atria and myocardium. Ablation of the automatic focus may be curative in some patients. Beta-blockers and calcium channel blockers can also be used in the treatment of supraventricular tachycardia, but care must be taken to exclude Wolf-Parkinson-White syndrome before the administration of calcium channel blockers such as verapamil which has a selective effect on the AV node.

By slowing conduction at the AV node in patients with an accessory atrioventricular pathway, conductance is usually improved in the accessory pathway. This can explain the increased risk of ventricular arrhythmias after the use of calcium channel blockers in patients with atrial fibrillation and Wolf-Parkinson-White syndrome.

References

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