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The Specialist

Chest Pain in Children

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Case Presentation

A 15-year-old boy presents to the emergency department with chest pain for 1 week. The pain began as mild left chest discomfort when he was hit over the ribs while playing football. Three days ago he reported a headache, neck stiffness, and worsening chest pain, especially when walking. He described the pain as aching, stabbing, and much worse with exertion. The patient has had no fever or symptoms of an upper respiratory tract infection, but he complains of mild dizziness with standing. He vomited twice yesterday and now complains of nausea. His past medical history is noncontributory.

The physical examination reveals an alert, talkative, obese male. Vital signs are: temperature, 38.3°C (oral); pulse, 72 beats/min; respirations, 24 breaths/min; and blood pressure, 128/84 mm Hg. The heart rate increases to 96 beats/min with standing and 116 beats/min with walking. Examination of the head, eyes, ears, nose, and throat is unremarkable. The neck is mildly tender, and there is pain with flexion. The chest examination reveals mild tenderness over the sternum and no pain over the ribs. The cardiac rhythm is regular, and no murmur is appreciated. The lungs are clear, and the abdomen is soft and nontender, with no mass or organomegaly. Findings on the remainder of the physical examination are normal.

The chest radiograph shows clear lung fields, but the heart is enlarged slightly. Electrocardiography shows left axis deviation, normal sinus rhythm, possible right ventricular hypertrophy, and ST elevation in the inferolateral leads.

About 3 hours after arrival at the emergency department, the boy

becomes unresponsive, is found to have a ventricular arrhythmia, and develops cardiac arrest. He cannot be resuscitated. An autopsy reveals evidence of myocarditis.

Introduction

Chest pain is a frequent complaint among children; it occurs in 6 in 1,000 who present to an urban pediatric emergency department or walk-in clinic. Chest pain occurs equally in boys and girls and is found in children of all ages. The mean age of children who have this complaint is about 12 years. Young children are more likely to have a cardiorespiratory cause for their pain, such as cough, asthma, pneumonia, or heart disease; adolescents are more likely to have pain associated with a psychogenic disturbance.

Many patients and their families associate chest pain with heart disease, and they are understandably frightened by media reports of sudden death in young athletes. Often the symptom of chest pain disturbs the child's daily routine; about one third of children who have this complaint are awakened from sleep by the pain and one third miss school because of it. The case reported here is unusual; most studies have shown that pediatric chest pain rarely is due to serious organic pathology. However, the complaint should be taken seriously because underlying heart disease can be present. In general, a thorough history and careful physical examination can guide the pediatrician as to when to order laboratory studies and when to refer a child who has chest pain to a specialist for further evaluation.

Differential Diagnosis

CARDIAC DISEASE

Previously undiagnosed cardiac disease is a rare cause of chest pain in children (Table 1). Myocardial infarction can result from anomalous coronary arteries, and there may be no warning of this underlying condition. However, some children will have a pansystolic, continuous, or mitral regurgitation murmur or gallop rhythm that suggests myocardial dysfunction. Other children may have had a previous condition that results in a higher likelihood of angina or infarction, such as longstanding diabetes mellitus, Kawasaki disease, chronic anemias, or use of cocaine. In many cases, exercise induces the chest pain with these disorders because coronary blood flow is limited. Therefore, pain with exertion should be given careful consideration. Syncope also may be associated.

Some children may have an arrhythmia that causes signs and symptoms such as palpitations or abnormalities on cardiac examination. Supraventricular tachycardia is the most common of these arrhythmias, but premature ventricular beats or tachycardia also can lead to brief, sharp chest pain.

One structural abnormality that deserves mention is hypertrophic obstructive cardiomyopathy. This disorder has an autosomal dominant pattern of inheritance, so there often is a family history of the condition. Children who have this disorder have a murmur that may be audible when standing or performing a Valsalva maneuver. The patients are at risk for ischemic chest pain, especially when exercising. Most other

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TABLE 1. Cardiac Disorders Leading to Pediatric Chest Pain

Coronary artery disease—Ischemia/Infarction

- Anomalous coronary arteries
- Coronary arteritis (Kawasaki disease)
- Long-standing diabetes mellitus

Arrhythmia

- Supraventricular tachycardia
- Ventricular tachycardia

Structural abnormalities

- Hypertrophic cardiomyopathy
- Severe pulmonic stenosis
- Aortic valve stenosis
- Mitral valve prolapse

Infection

- Pericarditis
- Myocarditis

structural disorders of the heart rarely cause chest pain, although severe pulmonic stenosis with associated cyanosis and aortic valve stenosis can lead to ischemia. The pain in these conditions may be described as squeezing, choking, or a sensation of pressure in the sternal area. These maladies almost always are diagnosed before the child presents with pain, and the associated murmurs are found on physical examination. Finally, mitral valve prolapse (MVP) may cause chest pain by papillary muscle or left ventricular endocardial ischemia, and a midsystolic click and late systolic murmur are found in many cases. However, studies show that MVP is no more common in children who have chest pain than in the general population.

Cardiac infections should be considered as important, although uncommon, causes of pediatric chest pain. For instance, pericarditis presents with sharp, stabbing pain that improves when the patient sits up and leans forward. The child who has this infection usually is febrile; is in respiratory distress; and has a friction rub, distant heart sounds, neck vein distention, and pulsus paradoxus. Myocarditis is a more common infection and sometimes can present more subtly. The adolescent in the case report presented with many classic features of this disease. Such children have pain for several days that is mild and not dis-

ruptive. After a few days of fever and other systemic symptoms such as vomiting and lightheadedness, the patient may develop pain or shortness of breath on exertion. Examination may reveal muffled heart sounds, fever, a gallop rhythm, or tachycardia that is out of proportion to the degree of fever present. As noted in the case report, the patient also may have orthostatic changes in pulse or blood pressure (pulse

increase ≥ 30 beats/min, blood pressure decrease by >20 mm Hg when moving from supine to standing position). This often is misinterpreted as volume depletion because the children who have this infection may not be taking oral fluids well and, indeed, may be mildly dehydrated. However, this finding will not always improve with fluid resuscitation; if not, cardiogenic causes such as myocarditis should be suspected. A chest radiograph usually will show cardiomegaly in both of these infections (Fig. 1), and the electrocardiogram will be abnormal, prompting a further evaluation, such as an echocardiogram.

MUSCULOSKELETAL PAIN

This is one of the most common diagnoses in children who have chest discomfort (Table 2). Active children frequently strain chest wall muscles while wrestling, carrying heavy books, or exercising. Direct trauma to the chest may result in a mild contusion of the chest wall or, with more significant force, a rib fracture, hemothorax, or pneumothorax. In most cases there is a straightforward history of trauma, and the diagnosis is clear. Certainly, a careful physical examination will



FIGURE 1. Radiograph of a child who has myocarditis. Note the markedly enlarged heart.

TABLE 2. Noncardiac Causes of Pediatric Chest Pain

Musculoskeletal disorders <ul style="list-style-type: none">• Chest wall strain• Direct trauma/contusion• Rib fracture• Costochondritis
Respiratory disorders <ul style="list-style-type: none">• Severe cough• Asthma• Pneumonia• Pneumothorax/pneumomediastinum• Pulmonary embolism
Psychologic disorders <ul style="list-style-type: none">• Stress-related pain
Gastrointestinal disorders <ul style="list-style-type: none">• Reflux esophagitis• Esophageal foreign body
Miscellaneous disorders <ul style="list-style-type: none">• Sickle cell crises• Abdominal aortic aneurysm (Marfan syndrome)• Pleural effusion (collagen vascular disease)• Shingles• Pleurodynia (coxsackievirus)• Breast tenderness (pregnancy, physiologic)
Idiopathic

reveal chest tenderness or pain with movement of the torso or upper extremities.

Costochondritis is a related disorder that is common in children. The diagnosis is made by eliciting tenderness over the costochondral junctions with palpation. The pain may be bilateral, and it generally is sharp and exaggerated by physical activity or breathing. Such pain may persist for several months.

RESPIRATORY CONDITIONS

Children who have severe, persistent cough, asthma, or pneumonia may complain of chest pain due to overuse of chest wall muscles. The diagnosis is made by history or the findings of rales, wheezes, tachypnea, or decreased breath sounds. Some children may complain of chest pain with exercise due to exercise-induced asthma, which can be determined quite readily with a treadmill test. An occasional child will develop a spontaneous pneumothorax (Fig. 2) or pneumomediastinum and com-

plain of pain with respiratory distress. Children at high risk for these conditions are those who have asthma, cystic fibrosis, and Marfan syndrome, but previously healthy



FIGURE 2. Radiograph of a child who has tension pneumothorax on the right. Note the shift of the mediastinum to the left.

children may rupture an unrecognized subpleural bleb with minimal precipitating factors. With this condition, the patient typically would be in respiratory distress, with decreased breath sounds on the affected side (if the pneumothorax is significant) and palpable subcutaneous air. Of course, adolescents who snort cocaine are at risk for similar barotrauma and may complain of severe, sudden chest pain with associated anxiety, hypertension, and tachycardia. Finally, pulmonary embolism is extremely rare in pediatric patients, but may be considered in the adolescent girl who has dyspnea, fever, pleuritic pain, cough, and hemoptysis. The likelihood of this diagnosis is increased if she is using oral contraceptives or recently has had an abortion. Young males who have recent leg trauma also are at some risk for pulmonary embolism.

PSYCHOGENIC DISTURBANCES

Such disturbances can precipitate chest pain in both boys and girls at equal rates. Often the anxiety and stress that results in somatic complaints is not easily apparent; not all of these children present with hyperventilation or an anxious appearance. However, if the child has had a recent major stressful event, such as separation from friends, divorce in the family, or school failure that correlates temporally with the onset of the chest pain, it is reasonable to conclude that the symptoms are related to the underlying stress. The perception of pain that is a result of emotional conflict also may have its roots in unresolved chronic issues in the child or within the family. A family history of depression or a somatization disorder predisposes a child to psychosomatic symptoms. A family member or friend who has experienced chest pain, especially as a result of cardiac disease, may trigger a heightened perception of mild pain in a child that is due to a common problem such as musculoskeletal trauma or costochondritis. Recent research in neuropsychological mechanisms of apparent psychogenic pain suggests that many of these children experience or perceive mild pain in the form of an exaggerated response.

GASTROINTESTINAL DISORDERS

Such conditions as reflux esophagitis often cause chest pain in young children and adolescents. The pain is described classically as burning, substernal in location, and worsened by reclining or eating spicy foods. Many gastroenterologists believe that manometric studies are required for children who have persistent unexplained chest pain. However, this condition also can be diagnosed with a therapeutic trial of antacids. Likewise, some young children will complain of chest pain following the ingestion of a coin or other foreign body that lodges in the esophagus. In general, the child or parent may give a clear history of recent foreign body ingestion, and a simple radiograph can confirm the diagnosis. Infants and young children who have an esophageal foreign body are more likely to gag with food than complain of chest pain.

MISCELLANEOUS CAUSES

Some instances of chest pain are related to underlying diseases. For instance, sickle cell disease may lead to vaso-occlusive crises or acute chest syndrome. Marfan syndrome may result in chest pain and fatal dissection of an abdominal aortic aneurysm. Collagen vascular disorders may lead to pleural effusions, and shingles may result in severe chest pain that precedes or occurs simultaneously with the classic rash. Likewise, infection with coxsackievirus may lead to pleurodynia with paroxysms of sharp pain in the chest or abdomen. Children also may complain of chest pain when there is breast tenderness from physiologic changes of puberty or from early changes of pregnancy.

Unfortunately, in 20% to 45% of cases of pediatric chest pain, no diagnosis can be determined with certainty. The child's pain is labeled as idiopathic in many such cases.

Clinical Approach to Chest Pain

A complete history and careful physical examination will reveal the etiology of chest pain in most cases. The family history may be helpful because disorders such as hypertrophic obstructive cardiomyopathy

are familial. The medical history may reveal asthma, which places the patient at risk for more serious causes of pain. Previous heart disease or conditions such as Kawasaki disease may increase the risk for cardiac pathology.

The physician should determine if the pain is frequent, severe, or interrupts the child's daily activity. Children who wake from sleep because of the pain are more likely to have an organic etiology, although it may not necessarily be serious. Asking the patient to locate and describe the pain is not always helpful because young children are vague in their descriptions. However, burning pain in the sternal area suggests esophagitis, and sharp stabbing pain that is relieved by sitting up and leaning forward suggests pericarditis in a febrile child. The onset of pain also should be determined because children who have an acute onset are more likely to have an organic etiology. Those who have chronic pain that has gone without a diagnosis are much more likely to have idiopathic or psychogenic etiologies.

Any precipitating factors should be elicited. A history of trauma, muscle strain, or choking on a foreign body may be quite relevant. Also, chest pain that occurs with exercise should be taken seriously; it may relate to cardiac disease or, more commonly, to exercise-induced asthma. Chest pain associated with syncope, fever, or palpitations is more significant. The physician may determine that the pain is part of an underlying systemic disorder such as a collagen vascular disease if joint pain, rash, or fever has been present. The physician should inquire about possible stressful conditions at home or school, and the diagnosis of psychogenic pain should not be a diagnosis of exclusion. Finally, in adolescents who have chest pain, it is appropriate to ask about substance abuse (cocaine, in particular) or use of oral contraceptives.

A careful physical examination is likely to point to the cause of pain. A general examination should identify the child in severe distress who needs immediate treatment for life-threatening conditions such as pneumothorax. Hyperventilation should

be distinguished from respiratory distress by the absence of cyanosis or nasal flaring. Signs of chronic disease (pallor, poor growth) may suggest that the chest pain is one symptom of a more complex problem such as a tumor or collagen vascular disease. Rashes or bruises on parts distant from the chest may indicate unrecognized trauma to the torso. The abdomen deserves careful evaluation because it may be a source of pain that is referred to the chest.

A complete chest examination is essential. This is likely to reveal rales, wheezes, or decreased breath sounds if there is pulmonary pathology or murmurs, rubs, muffled heart sounds, or arrhythmias if there is cardiac pathology. The chest wall should be evaluated for signs of trauma, tenderness (suggesting musculoskeletal pain), or subcutaneous air (suggesting a pneumothorax or pneumomediastinum).

Laboratory Evaluation and Referral

The boy presented in the case report had worrisome findings of fever, shortness of breath, pain with exertion, abnormal vital signs, and an abnormal cardiac examination, which warranted laboratory evaluation and urgent treatment.

Laboratory studies usually confirm previously known disorders or abnormal findings that are suspected clinically. If the history is acute in onset (began in the past 2 or 3 days) or is indicative of pulmonary problems or cardiac disease, a chest radiograph or electrocardiogram is indicated. If there is pain on exertion, one should be particularly concerned about cardiac disease or asthma and consider referral for exercise stress tests or pulmonary function tests. If the pain is associated with syncope or palpitations, one should consider referral for Holter monitoring to look for an arrhythmia or structural heart disease. Chest pain in patients who have a history of previous heart disease usually is not serious, but the examining physician may be more comfortable reviewing the child's chest film, obtaining an electrocardiogram, or referring the patient to the cardiologist. This group repre-

sents only a small percentage of children who have chest pain.

If the physical examination is abnormal, laboratory studies are justified. A chest radiograph can be quite helpful if the patient has fever, respiratory distress, or decreased or abnormal breath sounds. Fever with chest pain is highly correlated with pneumonia. As illustrated by the case report, pericarditis or myocarditis should be considered in the febrile child who has chest pain; radiographs may reveal cardiomegaly. Moreover, an abnormal cardiac examination, including unexplained tachycardia, arrhythmia, murmur, rub, or click, warrants an electrocardiogram.

Laboratory studies are not necessary in the child who has chronic pain, a normal physical examination, and no history suggestive of cardiac or pulmonary disease. The family should be reassured that the child is unlikely to have a serious etiology for the pain and that studies would be unhelpful. If this strategy is not successful, then noninvasive studies should be considered to alleviate the family's anxiety. Likewise, it is not necessary to obtain an echocardiogram to look for mitral valve prolapse in all children who have ill-defined chest pain.

Blood counts and sedimentation rates are of limited value unless collagen vascular disease, infection, or malignancy is suspected. A drug screen may be indicated in the older child who has acute pain that is associated with anxiety, tachycardia, hypertension, or shortness of breath.

The child should be referred to an emergency department if he or she is in severe distress or has a history of significant trauma. Referral to a specialist should be considered if an esophageal foreign body is

noted or if the patient has a serious emotional problem that cannot be managed in the office. The child who has known or suspected heart disease, syncope, palpitations, or pain on exertion may be served best by referral to a cardiologist.

When a specific etiology for the pain is found, such as pneumonia, it can be treated. In most cases of musculoskeletal, psychogenic, or idiopathic pain, the child will respond to reassurance, analgesics, rest, and perhaps heat and relaxation techniques. If esophagitis is suspected, a trial of antacids may be beneficial.

Appropriate follow-up should be arranged because many children who have ill-defined pain have persistent symptoms for many months. Although serious organic pathology is unlikely to be found in the future, the physician must ascertain that the child is participating in his or her usual activities. Also, the physician should observe for significant psychoemotional problems or exercise-induced asthma that previously was unrecognized. Follow-up, with an emphasis on further exploration of the cause of pain if appropriate or an explanation for pathophysiologic pain, may prevent the development of cardiac or pulmonary "non-disease."

Summary

Chest pain is a common complaint among children of all ages. It rarely is due to cardiac disease, but deserves careful evaluation for this possibility, with laboratory tests performed in limited cases. The child who has pain of acute onset that interferes with sleep, is precipitated by exercise, or is associated with dizziness, palpitations, syncope, or shortness of breath should be evalu-

ated with the aid of laboratory tests. This includes at least a chest radiograph and electrocardiogram. Also, pain in the child who has a history of coin ingestion, trauma, previous cardiac disease, or conditions that put him or her at risk for developing cardiac pathology deserve further study. Likewise, those who have a history of conditions such as asthma, Marfan syndrome, or sickle cell disease warrant special consideration. Finally, most of those who have an abnormal physical examination (fever, respiratory distress, abnormal breath sounds, cardiac murmur, abnormal rhythm or heart sounds, palpable subcutaneous air, or obvious trauma) also require a chest radiograph and an electrocardiogram. However, the child who has chronic chest pain but appears quite well and has a normal physical examination with no worrisome history needs reassurance and careful follow-up rather than extensive studies.

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