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Chest Pain in Children: Is It Another "Growing Pain"?

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ABSTRACT

Chest pain is a common complaint among children that has a non-cardiac origin in 99% of pediatric cases. We conducted a literature review of the different proposed etiologies of pediatric chest pain, as well as the evidence base supporting current approaches. Among the non-cardiac causes of chest pain in children, musculoskeletal causes are reported to be the most prevalent. This includes precordial catch syndrome, Tietze's syndrome, and costochondritis. However, these origins of musculoskeletal chest pain were described historically, and their labels are likely applied too broadly. It is important that providers be able to differentiate between benign chest pain that truly has a musculoskeletal origin and that which lacks an identifiable cause. To determine the cause of chest pain, providers should take a detailed history, physical examination, electrocardiogram, and any additional indicated laboratory tests. Musculoskeletal chest pain should only be diagnosed if there is an objective finding of reproducible tenderness during the physical examination or if there is a plausible history. If no cause can be identified, the chest pain may be linked to somatization. As a result, these patients may benefit from psychiatric evaluation and mindfulness-based interventions. To better inform clinical care, providers should be aware of these emerging management approaches.

1 | Introduction

Children often complain of chest pain, which can cause a great deal of worry for patients and their families. However, investigations reveal that chest pain is benign in the majority of pediatric cases. Although there is often fear of a cardiac cause, chest pain in children is rarely of cardiac origin [1]. In this article, we review different proposed etiologies of pediatric chest pain, as well as the evidence base supporting current approaches. While the focus of this literature review is on benign pediatric chest pain, we also highlight some features of cardiac causes.

2 | Chest Pain Prevalence

Chest pain accounts for 0.68% of all pediatric emergency department visits and 5.2% of all pediatric cardiology consultations [2, 3]. Children older than 12 years of age are more likely to report chest pain [1]. The causes of chest pain are also age-dependent, with a significantly higher incidence of non-cardiac chest pain among children aged 3–12 compared to adolescents aged 12–18 [4]. There is no notable sex bias in the overall prevalence of chest pain among pediatric patients, although cardiac causes are more common in females and non-cardiac causes in males [5, 6]. Within the pediatric population, female patients typically present with chest pain at a slightly older age than male patients [1].

2.1 | Causes of Pediatric Chest Pain

The most common type of chest pain in the pediatric population occurs during rest and is located centrally or just left of the midline [7]. This type of chest pain predominantly affects adolescents aged 11–16 years. While patients and their parents most often suspect chest pain to be of cardiac origin, the

diagnostic outcome is non-cardiac in 99% of pediatric cases [1]. In the literature, the etiological classifications of non-cardiac causes of chest pain among children are the musculoskeletal system (33% of total pediatric chest pain cases), psychogenic (28.4%), precordial catch syndrome (13.3%), idiopathic (11.6%), the respiratory system (7.3%), the gastrointestinal system (3.1%), and miscellaneous (2.3%) [1]. However, it can be derived that the musculoskeletal system actually accounts for 46.3% of pediatric chest pain cases, as the reasons for designating a diagnosis of musculoskeletal versus precordial catch syndrome are not typically evident in the clinical setting, nor in the literature. These classifications are often used to describe pains that are similar in nature, and there is not always agreement on their usage. Figure 1 provides a summary of the different causes of chest pain and their associated prevalences in the pediatric population.

Saleeb et al. reviewed the charts of 3,700 pediatric patients with chest pain and found that only 1% (37) had a cardiac cause of their pain [8]. Among these patients, the most commonly reported cardiac causes were supraventricular tachycardia, pericarditis, and myocarditis. Figure 2 lists the reported causes of cardiac chest pain and their relative prevalences.

3 | Differentiating Features

Pediatric chest pain of cardiac origin is often described as a crushing pain or heaviness that is located centrally, but may also radiate to the left arm and/or jaw area [6]. Cardiac chest pain may last more than a few minutes, wax and wane, vary in intensity, or worsen with physical activity [9]. The majority of pediatric patients with cardiac chest pain (92%) report that their pain is recurrent, and 80% report associated symptoms [4, 5]. The most prevalent symptoms associated with pediatric cardiac chest pain are chest tightness (67% of cases), palpitations (7.4%), fatigue (5.5%), and respiratory symptoms (1.9%) [4]. It may also be associated with cold sweats, dizziness, nausea, or vomiting [9]. Furthermore, cardiac chest pain is more likely to be accompanied by abnormalities in the history or physical examination [10].

Non-cardiac chest pain may be present for very brief periods (seconds to minutes) or be very persistent, including "always present." [9, 11] Non-cardiac chest pain is more likely to worsen when breathing deeply or coughing and/or get better or worse when changing body position [9]. Pleuritic pain, for example, is a type of non-cardiac chest pain that is exacerbated by deep breathing and alleviated by leaning forward

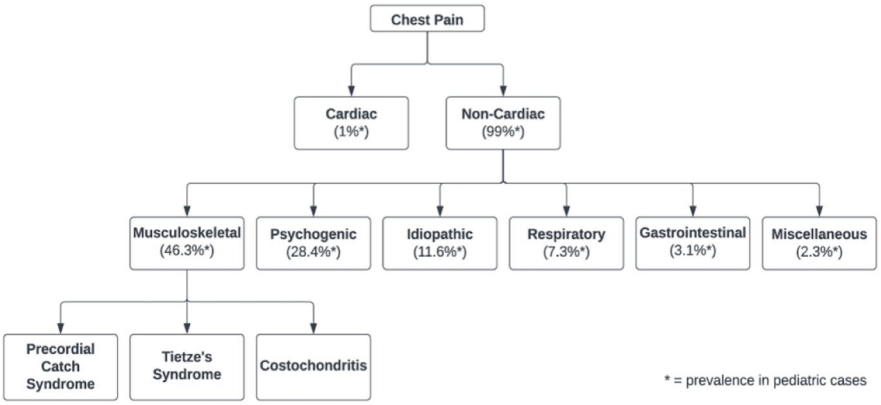

FIGURE 1 | Causes of chest pain in the pediatric population [1, 6].

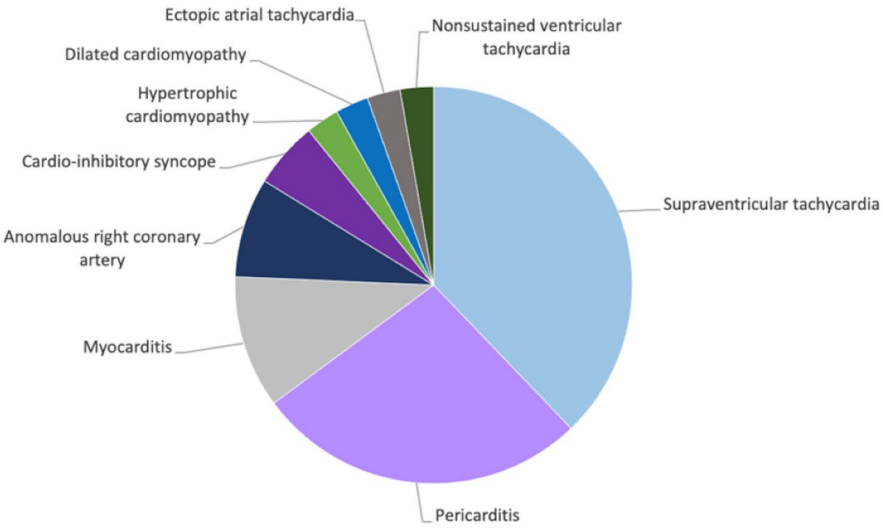

FIGURE 2 | Cardiac causes of chest pain [8].

[12, 13]. Compared to cardiac chest pain, fewer patients with non-cardiac chest pain report recurrence (44.3%) or associated symptoms (26.6%) [4, 5]. These symptoms include chest tightness (10% of cases), respiratory symptoms (8.4%), fever (3.6%), palpitations (1.5%), and gastrointestinal symptoms (1.5%) [4]. Musculoskeletal causes should be considered if associated with tenderness when pushing on the chest [9]. Gastrointestinal causes should be considered when a patient reports trouble swallowing, a sour taste, or a feeling of food reentering their mouth.

4 | Benign Forms of Chest Pain

4.1 | Musculoskeletal Chest Pain

The musculoskeletal system is reported as the most common cause of chest pain in the pediatric population, accounting for 46.3% of cases [1]. Although there are various postulated origins of musculoskeletal chest pain, there are common characteristics that the different origins share; it is typically localized, reproducible with palpation or gentle sternal pressure, and worsened by inspiration, coughing, and movement [6]. When examined, patients with musculoskeletal chest pain often demonstrate localized chest wall tenderness or pain with movement of the torso or upper extremities [5]. A musculoskeletal origin may also be indicated by a history of trauma or participating in sports [7]. We should only diagnose musculoskeletal chest pain if there is an objective finding of reproducible pain or a plausible history, including overuse injury. Three origins of musculoskeletal chest pain that were described historically and whose labels are likely applied too broadly are precordial catch syndrome, Tietze's syndrome, and costochondritis [6].

Precordial catch syndrome, also referred to as Texidor's twinge, was first described in 1955 by Miller and Texidor [14]. They described it as sudden, sharp pain localized under the left breast that lasts between 30 seconds and 3 minutes and is aggravated by deep inspiration. Common to most cases of benign pediatric chest pain, patients with precordial catch syndrome will have a normal electrocardiogram (ECG) and, if performed, a normal echocardiogram [15]. Treatment for precordial catch syndrome is reassurance and instructing the patient to take a deep breath at the onset of pain.

Tietze's syndrome was first described in 1921 by Alexander Tietze as “an initially painful, usually tender, prominence of one or more of the upper costal cartilages for which no specific etiology can be found.” [16] Swelling is a necessary diagnostic criterion of Tietze's syndrome that typically involves only one costal cartilage, most often the second costosternal junction [17]. Treatment consists of conservative therapy and reassurance, and first-line medical management is anti-inflammatory and analgesic medications, either oral or topical [16].

Costochondritis is a term that was coined in 1962 by Carabasi et al. [17] They recognized costochondritis as a variant of Tietze's syndrome that involves the middle and upper costosternal cartilages of the anterior chest wall, but lacks swelling. Furthermore, Carabasi et al. found that costochondritis tenderness extends over multiple costosternal junctions, usually involving the third and fourth junctions. Costochondritis is similar to Tietze's syndrome in terms of its unknown etiology, benign nature, duration of symptoms, and use of palpation during physical examination to elicit tenderness over the costochondral junctions [18, 19]. One limitation is the lack of data comparing whether asymptomatic individuals also complain of tenderness when palpated over the costochondral junctions. Patients with costochondritis will have normal vital signs and a normal ECG [16, 20]. Treatment consists of non-steroidal anti-inflammatory drugs (NSAIDs) and rest [6, 20].

4.2 | Psychogenic Chest Pain

Chest pain of psychogenic origin is often described as fleeting, vague, or localized over the precordium and/or left arm [6]. This pain is typically recurrent with particular stressors and is more common in females and adolescents, as well as patients with a history of stressful events or anxiety [1, 6]. The most common psychogenic causes of chest pain in children are generalized anxiety disorder and depression, present in 52.7% and 37.4% of patients, respectively [1]. Other causes of psychogenic chest pain include panic disorder (3.6% of patients), phobia (3.2%), post-traumatic stress disorder (1.3%), attention-deficit/hyperactivity disorder (0.9%), and obsessive-compulsive disorder (0.9%). Additionally, patients with psychogenic chest pain often report recurrent somatic symptoms such as headache, abdominal pain, or extremity pain [6]. In diagnosing psychogenic chest pain, it is imperative to search for stressful events in the patient's history or signs of anxiety or psychological distress in their physical examination [21]. It is also important that chest pain is not ascribed to anxiety in the absence of an anxiety disorder, so the criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision should be used to identify anxiety disorders in patients suspected to have psychogenic chest pain. Treatment for psychogenic chest pain is reassurance, with or without psychological input, depending on the case [6].

4.3 | Idiopathic Chest Pain

Idiopathic chest pain, also known as nonspecific chest wall pain, is characterized by brief periods of pain in the middle of the sternum or inframammary region that has no known etiology and persists even after a 6-month follow-up period [22]. It is not accompanied by inflammation and, similar to what is often called musculoskeletal chest pain, is aggravated by deep breathing or palpation. While idiopathic chest pain is a diagnosis of exclusion, it is one of the most common forms of chest pain. The diagnosis is made in the setting of a typical history and normal physical examination, if no other cause can be established [23].

5 | Recommended Diagnostic Approach

When a child presents with chest pain, the following standardized clinical assessment and management plan (SCAMP) should be followed. First, a thorough history, physical examination, and ECG should be taken [10]. This will provide sufficient information to make a diagnosis or determine whether additional testing is needed. If the patient has a negative history, exam, and ECG, an

echocardiogram is only indicated if the chest pain is exertional and has no alternative explanation. This can help rule out coronary anomalies. An echocardiogram or exercise stress test should also be performed if a cardiac origin is indicated by a concerning past medical history, positive family history, abnormal physical examination, or abnormal ECG. Pre-existing diagnoses that indicate the need for further testing include myopathies, systemic inflammatory diseases, malignancy, and thrombophilia. A first-degree family history of cardiomyopathy, pulmonary hypertension, sudden or unexplained death, or aborted sudden death are concerning. On physical examination, presence of pathologic murmur, gallop, pericardial rub, abnormal second heart sound, distant heart sounds, hepatomegaly, decreased femoral or peripheral pulses, peripheral edema, painful or swollen extremities, tachypnea, or fever (oral temperature 38.4°C) may suggest a non-benign cause of chest pain. An ECG is designated as abnormal if there is evidence of ventricular hypertrophy, atrial enlargement, ventricular or atrial ectopy, high-grade atrioventricular block, pathologic ST-segment or T-wave changes, axis deviation, or other miscellaneous findings. A Holter or event monitor is only suggested if the patient complains of palpitations. A summary of the recommended diagnostic approach to chest pain in the pediatric population can be found in Figure 3.

While 2.8% of patients have an echocardiogram that reveals positive findings, Jaafreh et al. demonstrated that all patients with cardiac chest pain have a history and/or physical examination that indicate the cardiac origin of their pain [24]. Friedman et al. found that using this SCAMP to determine when additional testing is necessary reduces the cost spent on unnecessary testing by over $245 000 per year (21%) at their institution through reducing the use of echocardiography, Holter monitors, and event monitors by approximately 20%, and eliminating the use of exercise stress tests [10].

6 | Etiology of Idiopathic Chest Pain

In the literature on pediatric chest pain, it is not always clear how idiopathic and various types of musculoskeletal chest pain are differentiated. We only make a diagnosis of musculoskeletal pain if there is a reproducible tenderness on exam consistent with the clinical complaint, or if there is a probable overuse injury. Applying a more rigorous definition like this will likely render musculoskeletal chest pain quite uncommon, as it becomes clear that most patients with recurrent chest pain actually have idiopathic chest pain, presumably lacking a somatic cause.

We hypothesize that idiopathic chest pain may be similar to the well-known "growing pains" due to numerous commonalities between the two, including their unknown etiology [25]. Like idiopathic chest pain, growing pains is a diagnosis of exclusion, as clinical assessments generally indicate no objective history, physical findings, or reproducibility [26]. Patients with growing pains also demonstrate normal laboratory testing [27].

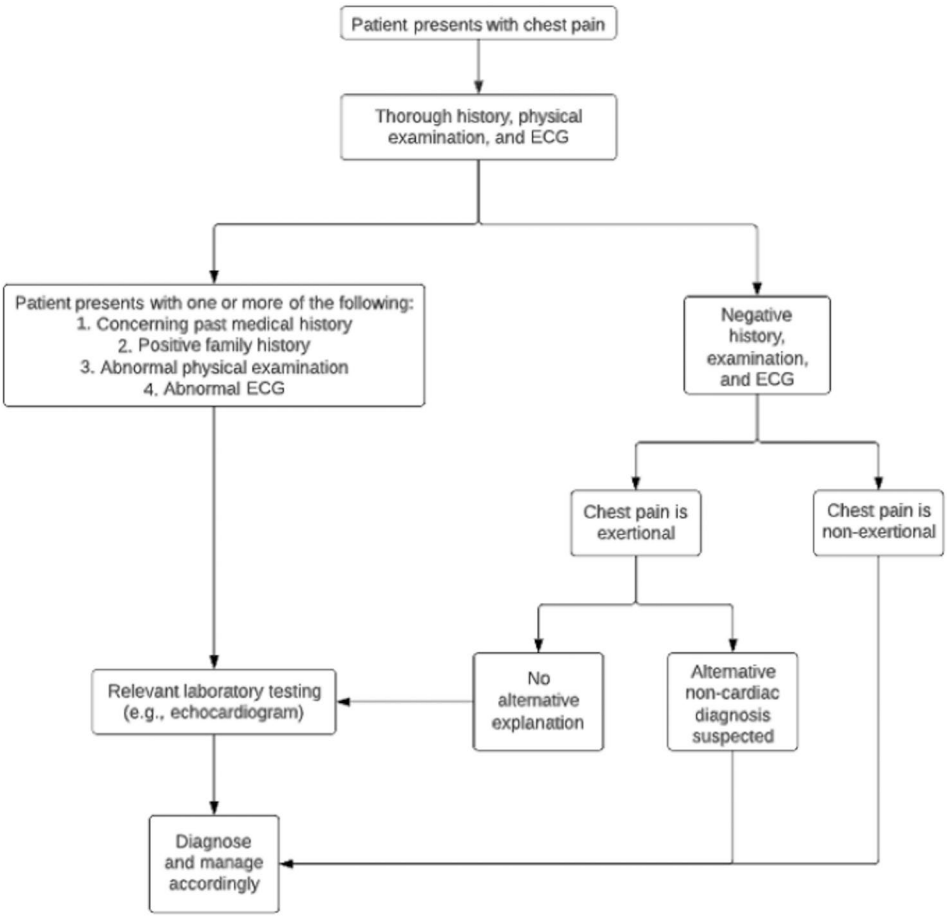

FIGURE 3 | Recommended diagnostic approach.

It is possible that idiopathic chest pain in children is linked to somatization, wherein psychological distress, which may simply be a normal process of adolescence, manifests as physiological symptoms [28, 29]. This is supported by the finding that children with non-cardiac chest pain experience greater somatic symptoms of anxiety [29]. Furthermore, it has been found that 17% of the reported variance in pediatric non-cardiac chest pain severity is attributable to somatization and 15% is attributable to fear of physiological arousal [30]. The tendency of children with non-cardiac chest pain toward somatization may be learned through observation and modeling from their parents [31].

7 | Management Approaches to Benign Chest Pain

Treatment for benign chest pain has traditionally involved reassurance, rest, and/or NSAIDs [6]. It is essential for the patient and their family to be informed and reassured about the benign nature of the patient's chest pain, which should be done in a compassionate manner, given the anxiety often experienced by patients and their parents [23, 32]. When doing so, it is also important to recognize that the pain is very real for these patients, even for those without a cause or who only experience it during times of anxiety. Rest is only indicated if there is a traumatic cause of chest pain and may be ensured by advising patients to avoid strenuous activity for a period of time [7]. To effectively manage certain types of chest pain, including Tietze's syndrome, costochondritis, and pericarditis, patients may be instructed to take NSAIDs three times per day for 3 days [32]. Along with the standard of care, patients may benefit from psychiatric evaluation and mindfulness-based interventions.

7.1 | Psychiatric Evaluation

If there is evidence of significant anxiety or depression, children with non-cardiac chest pain may benefit from psychiatric evaluation. Kenar et al. found that children with non-cardiac chest pain experience higher anxiety levels in terms of both prevalence and severity when compared to healthy controls [33]. The general practitioner should consider referring patients to a qualified mental health professional, such as a psychiatrist or clinical psychologist, for a psychiatric evaluation when clinically indicated. Outpatient clinics with screening tests such as the Beck Anxiety Inventory will allow patients with benign chest pain who suffer from an anxiety disorder to be identified and receive the necessary treatment. Psychiatric evaluation should also involve other screening tests such as the Child Depression Inventory and the Conners Parent Rating Scale to identify the presence of psychiatric disorders that require management. With this approach, benign chest pain due to somatization may be identified and reduced.

7.2 | Mindfulness-Based Interventions

Children and adolescents with non-cardiac chest pain may also benefit from mindfulness-based interventions (MBIs). Mindfulness-based stress reduction was found to be effective in decreasing complaints of musculoskeletal pain, juvenile fibromyalgia, and other widespread chronic pains among adolescents [34]. Mindfulness-based cognitive therapy has proven to be effective in improving chest pain stability and frequency in adults with non-cardiac chest pain [35]. Furthermore, Ruskin et al. demonstrated that an MBI adapted for adolescents can improve pain acceptance, which is a strong predictor of outcome, for adolescents with chronic pain conditions [36].

8 | Conclusion

Pediatric chest pain is a frequent complaint that is almost always benign and of non-cardiac origin. Investigations, although rarely needed, should be driven by positive findings on the patient's history, family history, physical examination, and ECG. In many cases, the cause of chest pain is not found, which may result from the pain lacking a somatic origin, and rather being a manifestation of somatization. As such, interventions should focus on reassurance, psychiatric evaluation, and mindfulness.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable—no new data generated, or the article describes entirely theoretical research.

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