

# PECTUS CARINATUM

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## Pectus Carinatum

**Primary Disciplinary Field(s):** Medicine, Thoracic Surgery, Pediatrics, Orthopedics

### 1. Core Definition

Pectus carinatum (PC), commonly known as **pigeon chest**, is a complex congenital or acquired malformation of the anterior chest wall characterized by the abnormal protrusion of the sternum and costal cartilages. Unlike the inverse deformity, pectus excavatum (funnel chest), PC involves an outward bowing that typically causes the chest wall to project anteriorly, creating a keel-like appearance reminiscent of a bird's breastbone. This morphological abnormality results from the asymmetrical overgrowth of the costal cartilage, which subsequently pushes the **sternum** forward. Although often regarded primarily as a cosmetic defect, the severity of the protrusion can sometimes impact cardiopulmonary function, psychological health, and physical stamina, necessitating careful clinical evaluation and management.

The deformity is anatomically characterized by the relationship between the sternum, ribs, and costal cartilages. In typical presentations, the sternum is pushed forward, usually involving the entire structure or sometimes only the lower two-thirds. The ribs adjacent to the protrusion may also be deformed or rotated. Clinically, Pectus Carinatum is categorized into several subtypes based on the location of the maximal protrusion. The most common form is chondrogladiolar, or keeled pectus, where the body of the sternum is involved. Less frequently encountered is the chondromanubrial type (Pouter Pigeon Breast), characterized by the protrusion of the manubrium and upper sternum, which is often more rigid and challenging to correct. Differentiation between these subtypes is crucial as it dictates the most effective surgical or non-surgical intervention strategy.

While the primary anatomical structures affected are the cartilage and bone of the anterior thoracic cage, the condition is significant because the chest wall provides protective housing for vital organs. The rigidity and lack of normal compliance in severe PC cases can lead to restrictive physiology. Furthermore, the visual prominence of the deformity often leads to significant psychological distress, particularly during adolescence, impacting self-esteem, body image, and social interaction, which highlights the need for a holistic approach to treatment that addresses both physical and mental health outcomes.

### 2. Etymology and Historical Development

The term **Pectus Carinatum** is derived from Latin, where "**pectus**" means breast or chest, and "**carinatum**" refers to a keel, specifically describing the shape of a boat's keel or a bird's breastbone. This nomenclature aptly describes the protruding, boat-shaped appearance of the

chest wall. Historical recognition of chest wall deformities dates back centuries, but specific clinical delineation of PC as a distinct entity, separate from other skeletal dysplasias, began to solidify in the late 19th and early 20th centuries, coinciding with advances in pediatric orthopedic assessment.

Early descriptions of PC were often associated with nutritional deficiencies, notably rickets (vitamin D deficiency), where poor bone mineralization leads to structural weakness and subsequent deformation under respiratory pressure. Before effective public health measures were implemented to address malnutrition, rickets was a prevalent cause of severe chest wall abnormalities, including the characteristic "rachitic rosary" and subsequent pigeon chest formation. However, modern understanding distinguishes between secondary PC resulting from systemic disease and the far more common idiopathic, congenital form.

The development of surgical techniques for treating PC lagged behind that for Pectus Excavatum (PE). Early attempts at surgical correction were often invasive, involving large incisions and significant rib resection, leading to high morbidity rates. The refinement of modern cardiothoracic surgical approaches, particularly the introduction of minimally invasive techniques and the development of specialized sternal osteotomies and cartilage remodeling procedures during the late 20th and early 21st centuries, revolutionized the management of **Pectus Carinatum**. Simultaneously, the recognition of the efficacy of non-surgical bracing provided a less invasive option, particularly for younger patients with flexible chest walls.

### 3. Epidemiology and Etiology

**Pectus Carinatum** is considerably less common than pectus excavatum, estimated to occur in approximately 1 in 1,000 to 1,500 live births, though epidemiological data varies widely depending on the population studied and diagnostic criteria used. It exhibits a marked male predominance, with reported male-to-female ratios ranging from 3:1 to 4:1. The onset of the deformity is highly variable; while some cases are noticeable at birth, the majority become significantly pronounced during rapid adolescent growth spurts, specifically between the ages of 11 and 15, likely due to hormonal influences on cartilage growth.

The etiology of **Pectus Carinatum** remains complex, but the underlying mechanism is generally attributed to the excessive and uneven growth of the costal cartilages. In the vast majority of cases (approximately 90%), the condition is idiopathic, meaning no clear underlying cause is identified, suggesting a multifactorial inheritance pattern. There is strong evidence supporting a genetic predisposition, as familial occurrence is frequently reported, often showing autosomal dominant inheritance with incomplete penetrance. The specific genes involved in the regulation of sternal and costal cartilage development, however, are still subjects of ongoing research.

Crucially, PC can also be associated with underlying connective tissue disorders or skeletal

dysplasias, indicating a systemic failure of matrix production or organization. Conditions frequently linked to PC include Marfan Syndrome, Ehlers-Danlos Syndrome, and homocystinuria. These associated syndromes often involve defects in structural proteins like fibrillin, leading to generalized skeletal abnormalities, including scoliosis, joint hypermobility, and ocular defects, making a thorough systemic workup essential when PC is diagnosed, especially in severe or syndromic cases.

#### 4. Pathophysiology and Associated Conditions

The primary pathophysiological consequence of **Pectus Carinatum** is the reduction in the compliance of the thoracic cage. The stiff, outward-protruding sternum and cartilages restrict the normal movement required for full respiratory excursion, effectively increasing the work of breathing. This restrictive pattern is generally mild but can be exacerbated during strenuous physical activity. Patients often report symptoms related to decreased exercise tolerance, including early fatigue, shortness of breath (dyspnea) on exertion, and sometimes, exercise-induced asthma-like symptoms, although these symptoms may overlap with the psychological reluctance to engage in sports due to body image issues.

While cardiac compression is a hallmark of severe pectus excavatum, direct cardiac impairment is less common in PC. However, the rigid anterior chest wall can sometimes alter the geometry of the heart and great vessels, potentially causing minor cardiac murmurs or, in rare severe cases, contributing to mitral valve prolapse. The restrictive pulmonary function, coupled with the cosmetic distress, leads to a cycle where reduced physical activity contributes to lower overall fitness, further magnifying the perceived respiratory symptoms.

Furthermore, the association between PC and other congenital or structural defects underscores its nature as a systemic disorder of connective tissue development. Beyond the aforementioned Marfan and Ehlers-Danlos Syndromes, PC is frequently observed alongside other musculoskeletal deformities, such as scoliosis (lateral spinal curvature) and kyphosis (excessive outward curvature of the spine). These co-occurring conditions significantly complicate both diagnosis and treatment planning, often requiring a multidisciplinary team approach involving cardiologists, pulmonologists, geneticists, and orthopedic surgeons to address the totality of the patient's structural and functional needs.

#### 5. Clinical Presentation and Diagnosis

The clinical presentation of **Pectus Carinatum** varies widely, ranging from mild, barely noticeable protrusion to severe, asymmetrical deformities. The most common presenting concern is the aesthetic appearance of the chest, usually noted by the patient or their parents during the pubertal growth spurt. Physical symptoms, when present, often manifest as poor endurance, exertional

dyspnea, or mild chest pain, though careful distinction must be made between symptoms caused by the structural defect and those arising from deconditioning or anxiety.

Diagnosis is primarily clinical, based on a thorough physical examination and patient history. The physician assesses the symmetry, flexibility, and rigidity of the chest wall, classifies the subtype of the deformity (e.g., chondrogladiolar vs. chondromanubrial), and evaluates for signs of associated syndromes (e.g., tall stature, arachnodactyly, joint hypermobility). A key part of the assessment involves determining the flexibility of the chest, as this factor significantly influences the suitability of non-surgical bracing.

To quantify the severity and rule out functional impairment, several diagnostic tools may be employed. Standard imaging typically includes a posteroanterior and lateral chest X-ray to measure the degree of sternal angulation and to evaluate the underlying lung fields. More advanced imaging, such as CT scans or MRI, is often reserved for pre-operative planning, providing a detailed, cross-sectional view of the relationship between the sternum, costal cartilages, and mediastinal structures. Pulmonary function tests (PFTs) are essential to objectively assess restrictive lung patterns, and echocardiograms or electrocardiograms (ECGs) may be utilized to rule out concomitant cardiac anomalies or impairment.

## 6. Management and Treatment Options

The management of **Pectus Carinatum** is tailored to the patient's age, the flexibility and severity of the deformity, and the presence of associated symptoms or psychological distress. Treatment approaches fall into two primary categories: non-surgical bracing and surgical repair. The preferred initial approach, especially for young adolescents whose skeletons are still maturing and whose chest walls are flexible, is often non-surgical intervention.

Non-surgical bracing involves the use of a custom-fitted external compression device designed to apply continuous, firm pressure directly to the protruding area of the sternum. The efficacy of bracing relies on the plasticity of the growing cartilage and bone. Patients typically wear the brace for many hours a day (often 18 to 24 hours) over a period ranging from 6 months to 2 years. Bracing is highly effective (success rates often exceeding 80-90%) in appropriately selected patients, offering a compelling, less invasive alternative to surgery, provided the patient demonstrates high compliance with the demanding wearing schedule.

For patients who are skeletally mature, whose deformities are rigid, who fail bracing, or who present with extreme severity, surgical correction remains the definitive treatment. The most widely accepted surgical procedure is the modified Ravitch technique, involving a subperichondrial resection of the deformed costal cartilages, mobilization of the sternum, and sternal osteotomy to reposition the sternum into a normal anatomical plane. In select cases of severe, asymmetrical protrusion, specialized techniques may be required to achieve optimal contouring. The primary

goal of surgery is not merely aesthetic correction but also the restoration of normal thoracic mechanics and improved quality of life.

## 7. Prognosis and Quality of Life Implications

The prognosis for patients with **Pectus Carinatum** is generally excellent, particularly following successful treatment, whether surgical or non-surgical. Effective intervention usually results in a permanent correction of the chest wall deformity, leading to significant improvements in both aesthetic appearance and psychological well-being. Long-term studies show that physical symptoms, such as reduced exercise tolerance, often resolve or significantly improve after the chest wall structure is normalized and the restrictions on lung expansion are mitigated.

However, the psychosocial impact of **Pectus Carinatum** cannot be overstated, often representing the primary driver for seeking treatment. Adolescents suffering from PC frequently report profound self-consciousness, avoidance of activities requiring public undressing (like swimming or gym class), and generalized social anxiety. Successful correction has been repeatedly correlated with marked increases in self-esteem, improved body image satisfaction, and greater participation in physical and social activities, underscoring the vital importance of timely and effective management.

Recurrence after correction is relatively rare but more common in bracing patients who stop treatment prematurely or in younger patients undergoing surgery before skeletal maturity is complete. Careful long-term follow-up is necessary to monitor for potential issues, including the development of scoliosis or changes in chest wall contour over time. Overall, when treated appropriately by experienced specialists, Pectus Carinatum is a highly manageable condition with excellent functional and cosmetic long-term outcomes.

### Further Reading

[Pectus Carinatum - Wikipedia](#)

[Marfan Syndrome Diagnosis and Treatment - Mayo Clinic](#)

[Non-operative management of Pectus Carinatum using an external compression device - NCBI](#)

[Rickets: Clinical Presentation, Diagnosis, and Treatment - NIH StatPearls](#)