Disorders of the Chest Wall
Clinical Manifestations

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KEYWORDS

• Chest wall • Rib cage • Kyphoscoliosis • Ankylosing spondylitis • Flail chest • Pectus excavatum

KEY POINTS

- Chest wall disorders impair breathing without affecting the lungs themselves.
- Restrictive defect is the physiologic hallmark of chest wall disorders.
- Chest wall disorders decrease total lung capacity (TLC) to variable degrees; deformities of the thoracic cage with no (or minimal) spinal involvement have modest effect on respiratory efficiency.

INTRODUCTION

Chest wall disorders comprise a group of diseases and deformities that affect the rib cage (thoracic spine, ribs, sternum), respiratory muscles (diaphragm, intercostal muscles), and abdomen. These disorders may impair breathing without affecting the lungs themselves. The physiologic hallmark of these disorders is restriction caused by a poorly distensible chest wall. The reduced chest wall compliance places an elastic load on the respiratory muscles, which increases the work of breathing and predisposes these individuals to fatigue of the respiratory muscles. The respiratory system adapts to increased elastic load by intrinsic (muscular training) and/or extrinsic (increased central drive) mechanisms.[1] This article focuses on disorders that affect the bony parts of chest wall (ie, spine and rib cage). The most common disorder that affects the abdomen (obesity) is discussed elsewhere in this issue (See Imran H. Iftikhars' article, "Obesity Hypoventilation Syndrome," in this issue), as is the pathophysiology of disorders affecting the chest wall (See George E. Tzelepis' article, "Chest Wall Diseases: Respiratory Pathophysiology," in this issue).

ANATOMY AND MECHANICS OF THE THORACIC CAGE

Knowledge of the normal structure and function of the thorax in relation to the spine is essential in understanding chest wall disorders. The anterolateral rib cage is comprised of the sternum and 10 pairs of ribs attached at the costosternal junctions. The posterior boundary of the rib cage consists of the thoracic spine and 12 pairs of ribs articulated at the costovertebral junctions (**Fig. 1**). The diaphragm forms the inferior boundary. The costosternal and costovertebral junctions represent true synovial joints with synovial spaces that facilitate expansion of the chest wall during inspiration. Mobility of the upper thoracic cage is somehow limited because the true ribs (one through seven) are attached anteriorly to the sternum and posteriorly to the spine. The lower rib cage is more mobile because the false ribs (8–10) are attached to the long costal cartilages. The greatest mobility is at the lower part of the rib cage at the level of floating ribs (11 and 12), which are not attached to the sternum at all. Therefore, inspiration normally results in cephalad motion of the upper ribs and greater lateral motion of the lower rib cage.

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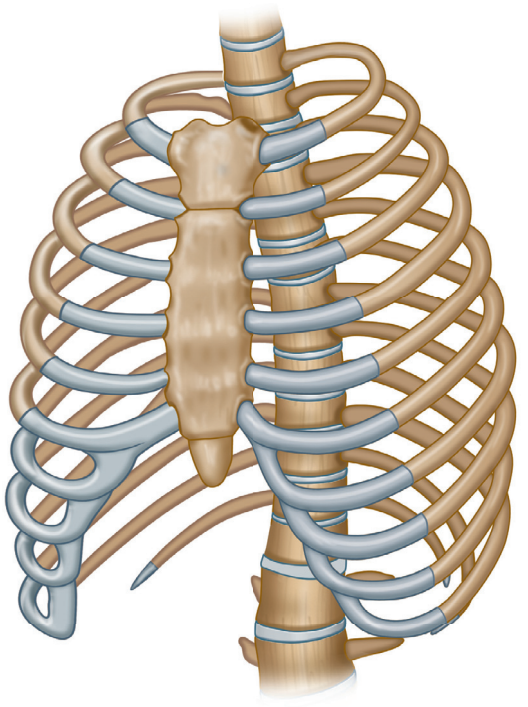

Fig. 1. Normal anatomy of the thoracic cage.

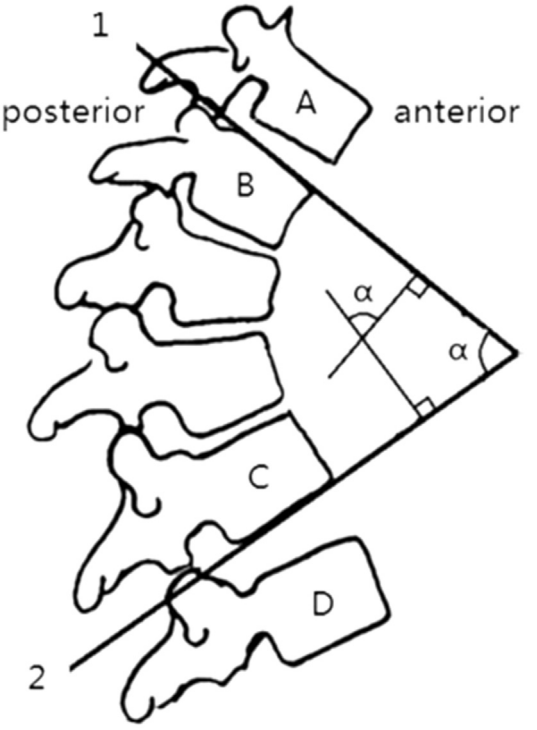

Fig. 2. Measurement of the Cobb angle on standing radiograph at the intersection of the line parallel to the end plate of the superior end vertebra and the line parallel to the end plate of the inferior end vertebra. (*From* Lin N, Li Y, Bebawy JF, et al. Abdominal circumference but not the degree of lumbar flexion affects the accuracy of lumbar interspace identification by Tuffier's line palpation method: an observational study. BMC Anesthesiol 2015;15:9; with permission.)

KYPHOSCOLIOSIS

The term scoliosis describes lateral deformation of the spine in the coronal plane with an angle of spinal curvature greater than 10° (Cobb angle) (**Fig. 2**). Scoliosis can affect the thoracic, lumbar, or thoracolumbar vertebrae. Kyphosis represents excessive forward curvature and commonly complicates scoliosis. The reported prevalence of kyphoscoliosis (KS) varies considerably. This variation reflects inconsistency in defining scoliosis and differences in studied populations. Nevertheless, KS is the most common spinal deformity, affecting 4% of the population worldwide. The prevalence of clinically significant scoliosis that is severe enough to impair chest mechanics (>100°) or result in alveolar hypoventilation (>120°) is 1 in 10,000 people.[2]

KS affects females more than males (female-to-male ratio of 3–4:1) and is primary (idiopathic) in more than 80% of patients. Less commonly it is secondary to neuromuscular disease (dysfunction of the central or peripheral nervous system) or caused by congenital defects (failure of vertebral formation or segmentation, impaired osseous development), or related to trauma or tumors (**Box 1**).[3] The prevalence of KS is higher in first-degree relatives of patients with scoliosis.[4,5]

Pulmonary Function

KS is the leading cause of respiratory failure among all chest wall disorders.[6] Scoliosis starts with vertebral rotation in the axial plane, causing displacement of the ribs in the posterior and outward direction. This leads to unequal load on the ventral and dorsal aspects of the vertebral column and subsequent lateral curvature to counterbalance the primary curve.

Lung volumes have been extensively studied in KS. In 1854, Schneevogt[7] reported a significant reduction in vital capacity (VC). This finding was confirmed by several other investigators.[8,9] The reduction in VC was most notable when the dorsal spine was affected and is worse in patients with Cobb angle greater than 100°.[10] Later, several studies demonstrated reduction in total lung capacity (TLC) in those patients.[11] The reduction in VC generally is proportional to the reduction in TLC. Residual volume (RV) is usually