Pulmonary Compliance

Lung compliance is defined as the change in lung volume per unit change in transmural pressure gradient (i.e. between the alveolus and pleural space).

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Physics and Modeling of the Airway

D. John Doyle, Kevin F. O'grady, in Benumof and Hagberg's Airway Management, 2013

3 Compliance

Pulmonary compliance measurements reflect the elastic properties of the lungs and thorax and are influenced by factors such as degree of muscular tension, degree of interstitial lung water, degree of pulmonary fibrosis, degree of lung inflation, and alveolar surface tension.[52] Total respiratory system compliance is given by the following calculation[40]:

(39)

where

ΔV = change in lung volume

ΔP = change in airway pressure

This total compliance may be related to lung compliance and thoracic (chest wall) compliance by the following relation:

(40)

where

C_T = total compliance (e.g., 100 mL/cm H_2O)

C_L = lung compliance (e.g., 200 mL/cm H_2O)

C_{Th} = thoracic compliance (e.g., 200 mL/cm H_2O)

The values shown in parentheses are some typical normal adult values that can be used for modeling purposes.[40] *Elastance*, the reciprocal of compliance, offers notational advantage over compliance in some physiologic problems. However, its use has not been popular in clinical practice.

Compliance may be estimated using the pulmonary time constant, τ. If a linear resistance of known value (ΔR) is added to the patient's airway, the time constant will change to τ′, as follows[27]:

(41)

Therefore, if ΔR is known and τ and τ′ are determined experimentally, one can solve for C_L and then for R_L:

(42)

Upper Airway Structure

Thomas H. Shaffer, ... Marla R. Wolfson, in Fetal and Neonatal Physiology (Fifth Edition), 2017

Measurements of Airway Function During Tidal Breathing

Dynamic pulmonary compliance as measured by the esophageal balloon and pneumotachometry technique is significantly lower in infants in whom chronic lung disease develops subsequently than in normal infants or those who recover uneventfully from neonatal respiratory distress.[74-76] Although such measurements reflect the elastic properties of the lung to some degree, they also are influenced by maldistribution of ventilation associated with regions having differing time constants (frequency dependence of compliance).[75] Thus dynamic compliance measurements in infants with chronic lung disease probably also reflect some degree of airway obstruction. Quasi-static methods of measuring respiratory system compliance in infants with BPD have verified that alterations in the elastic properties of the lung contribute significantly to the observed decrease in compliance.[77] Studies comparing static and dynamic compliance measurements in this group of infants, however, have not been performed. Thus it is not clear whether the improvement in dynamic compliance seen in infants with moderate to severe BPD studied longitudinally[74,76] represents a change in the characteristics of the lung parenchyma, or if it is reflective of a coexistent decrease in respiratory rate or improvement in airway obstruction. Of interest, both static and dynamic measurements of compliance have been shown to have predictive value regarding the development of BPD in mechanically ventilated preterm infants.[78,79]

Resistance measurements, including airway resistance as determined by plethysmography, pulmonary resistance measured by the esophageal balloon and pneumotachometry technique, and respiratory system resistance determined by the airway occlusion technique, are significantly elevated in infants with BPD.[74,76,80-82] When measurements of resistance or its reciprocal, conductance, have been made serially, values have approached normal levels in the first 2 to 3 years of life.[74,76] Longitudinal changes in resistance can reflect either resolution of airway obstruction or merely an increase in airway diameter related to growth. To eliminate the influence of growth or changes in lung volume on these measurements, investigators have also reported size-corrected values for resistance or conductance—namely, *specific conductance,* defined as the conductance divided by lung volume at functional residual capacity. Data reported in this way confirm the presence of airway obstruction in infants with BPD.[74,76] In the relevant study, although pulmonary resistance decreased to only one fourth of the original measurement in the first 3 years of life, specific conductance rose only minimally and remained below the normal level at the end of the study period. Arad and colleagues[83] found that specific conductance rose from 57% ± 7% of that predicted in infancy to 90% ± 8% of that predicted by the age of 5 to 7 years, although the children who required mechanical ventilation in infancy demonstrated air trapping and small airway obstruction at the time of