Chapter 3

Respiratory mechanics during general anaesthesia in healthy subjects

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General anesthesia deeply influences the behavioral state, altering consciousness and sensation by the direct or indirect effects of various anesthetic drugs. However, these drugs may cause additional effects, sometimes undesirable on other organ systems. In particular, the effects on respiratory function seem to be significant. Although several studies investigated the effects of general anaesthesia on respiratory function, they were specifically performed in healthy young people, and did not include patients with different ages or anthropometric characteristics. Moreover, general anaesthesia may be performed in different positions or surgical conditions (i.e. during laparoscopy), which may further influence the respiratory function compared to the supine position. In this chapter we will discuss the effects of general anaesthesia on respiratory system mechanics in different categories of patients and surgical conditions, as well as the possible clinical implications of these findings and some therapeutic approaches.

Methods of measurement

Compliance and resistance

Airway pressure ($P_{ao}$) is usually measured proximal to the endotracheal tube or tracheostomy cannula by means of polyethylene tubing, connected to a pressure transducer. To partition the total respiratory system mechanics into its lung and chest wall components, the esophageal pressure ($P_{es}$) is usually measured with a balloon inflated with 0.5-1 ml of air. The validity of $P_{es}$ is verified using the “occlusion test” of Baydur et al. [1], and the balloon is fixed in that position. Gas flow is recorded with a pneumotachograph and volume is obtained by integration of the flow signal.

The most popular method to measure compliance and resistance is that of rapid airway occlusion during constant flow [2]. This method, when applied together with the esophageal balloon technique, allows the partitioning of lung and chest wall components of the respiratory system [3]. The rapid airway occlusion technique is appealing both for its simplicity and because it provides a comprehensive on-line assessment of respiratory mechanics. As shown in Figure 1 at end-inspiratory phase, brief (3-7 s) airway occlusions are performed. Occlusion is maintained until both $P_{ao}$ and $P_{es}$ decrease from a maximum value ($P_{max}$) to an apparent plateau ($P_{2}$). After the occlusion, an intermediate drop from $P_{max}$ to a lower value ($P_{1}$), at flow 0, is appreciable in $P_{ao}$ but not usually in $P_{es}$ [3].
The plateau pressures (P₂) of Pao and Pes are taken to represent the static end-inspiratory recoil pressures of the respiratory system (Pst,rs) and chest wall (Pst,w), respectively.

The compliance of the static respiratory system (Cst,rs) or that of the chest wall (Cst,w) is obtained by dividing tidal volume (V₁) by the difference Pst,rs - Pao or Pst,w - Pes, respectively, at end-expiratory phase. The static lung compliance (Cst,L) is obtained from Cst,rs and Cst,w according to the following equation:

\[
Cst,L = \frac{Cst,rs \cdot Cst,w}{Cst,w - Cst,rs}
\]

Total (R,rs) and interrupter (Rmin,rs) resistance of the respiratory system are computed from Pao as (Pmax' - P₂)/V and (Pmax' - P₁)/V, where Pmax' represents the new Pmax' value obtained by correcting Pao for tube resistance. V is the flow immediately preceding the occlusion. Rmin,rs represents the “ohmic” resistive component of the respiratory resistance caused by stress relaxation or time constant inequalities within the respiratory system tissues. The difference between R,rs and Rmin,rs and is termed ΔR,rs. Since usually there is no appreciable drop in Pes (i.e. P₁ in the esophageal tracings is not identifiable), immediately following the occlusion Rmin,rs essentially reflects airway resistance (Rmin,L). Minimum chest wall resistance (Rmin,w) can be considered negligi-