Compliance of the Total Respiratory System in Normal Cats

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Compliance of the total respiratory system (Crs) is an indicator of the elasticity of the lung and the thorax [1, 3, 7, 10, 13]. Crs is derived from unit change in lung volume and the corresponding unit change in alveolar-oral pressure difference. In this study, Crs was determined from the volume (integration of the flow) and alveolar pressure using a pneumotachograph obtained flow-volume curve. This paper describes the outline of the results.

Fifteen male and 28 female healthy adult cats, 29–41 cm length (mean, 34.6 cm) measured at shoulder point buttock point and 1.9–3.9 kg body weight (mean, 2.8 kg), were used in this study. They were normal with regards to hematology, blood chemistry, and plain chest X-ray. The cats were anesthetized with intramuscular injection of ketamine hydrochloride (0.1–0.2 mg/kg/min). Muscle relaxation was obtained by i.v. administration of pancuronium bromide (0.1 mg/kg) before endotracheal intubation was carried out. A pediatric positive-pressure mechanical ventilator was connected to the endotracheal tube in order to maintain controlled ventilation.

Crs was measured by the following procedure. After stabilization of various vital signs, the trachea was suctionsed. Then, mechanical positive-pressure ventilation was changed to manual ventilation via a T-piece with 100% O2. Through the T-piece, the lungs were gently pressurized manually three times with an alveolar pressure of +30 cm H2O which is considered to be the maximum in inspiratory level. At the time of the fourth pressurization, the pressure was reduced from +30 cm H2O to +10 cm H2O, and an occlusion valve between the T-piece and the Fleisch #0 pneumotachograph (measurement range 0–500 m/sec) connected to the animal was closed. After observing a pressure plateau, which is considered to reflect the stabilization of the alveolar pressure, the occlusion valve was opened to atmospheric pressure. The expiratory volume was calculated by integrating the expiratory flow. Crs was obtained by dividing the expiratory volume by +10 cm H2O. Correlation was examined between body weight and Crs, and also between body length and Crs (p<0.05). Statistical significance was tested for sex and Crs using Student’s T-test (p<0.05).

A positive correlation was found between Crs and the body weight (y=6.3+2.5x, r=0.77) (p<0.01) (Fig. 1), and also between Crs and the body length (y=−8.4+0.6x, r=0.73) (p<0.01) (Fig. 2). A significant difference between the sexes was demonstrated with a confidence level

![Fig. 1. Correlation between compliance of the total respiratory system (Crs) and body weight.](image-url)
of 99% (p<0.05) (Table 1). Repeated measurement in the same cats produced no significant differences in value. The reproducibility was satisfactory.

Crs consists of two compliance values, namely, compliance of the lung (C\textsubscript{L}) and that of the chest wall (C\textsubscript{CW}). The following relation holds for these three parameters.

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\frac{1}{\text{Crs}} = \frac{1}{\text{C}_L} + \frac{1}{\text{C}_{CW}}
\]

C\textsubscript{L} is determined by a change in lung volume and a difference between intrathoracic and intraoral pressure [2, 4, 8, 9, 12]. Intrathoracic pressure is measured using an esophageal balloon catheter. C\textsubscript{CW} is generally calculated from C\textsubscript{L} and C\textsubscript{L} [4, 8].

Since the accuracy of esophageal balloon-catheter measurement of intrathoracic pressure and hence the accuracy of C\textsubscript{L} are doubted, Crs measurement is the recommended method.

In studies on compliance in cats, Crosfill and Widdicombe [4] have measured C\textsubscript{L} and C\textsubscript{CW} in inspiration based on the pressure-volume (P-V) curve. Comroe \textit{et al.} [3] have measured Crs in expiration by a spirometer method and that in inspiration using a body plethysmograph. Nissel and Dubois [10] have measured Crs in inspiration using the body plethysmograph. Agostoni \textit{et al.} [1] and Zin \textit{et al.} [13] have measured Crs in inspiration using the pressure and volume obtained by integration of the flow. Mortola [9] has measured C\textsubscript{L} by the expiratory P-V curve in kittens. All the data except that by Comroe \textit{et al.} [3] and Mortola [9] are the compliances in inspiration. C\textsubscript{L} and Crs measured in inspiration and Crs measured in expiration from tidal volume level can not be comparable. One of the reason is that in the P-V curve the volume at the same pressure is larger in expiration than in inspiration due to hysteresis. Another reason that the volume in the previous reports is smaller than that in our case is possibly due to that we have inflated all alveoli that have the large time constant by adequately pressurizing the lung, though some are left incompletely open in the previous studies. In fact, the value of Crs obtained in this experiment was higher compared to those in inspiration and expiration with tidal volume level described earlier.

The values obtained in this experiment were positively correlated to body weight as well as to body length. In our previous experiments, we have demonstrated that body weight and body length are related to Functional Residual Capacity [6] and that body weight is related to Forced Vital Capacity (FVC) [5]. Moreover, from our experi-

![Figure 2. Correlation between compliance of the total respiratory system (Crs) and body length.](image-url)
measurement, we demonstrated that body length is also related to FVC. Namely, in normal, the lung volume is related to both body weight and body length. So this confirmed that Crs, which is an indicator of the elastic contractility of the lung and thorax, is related to the lung volume since Crs is related to body weight and body length. A significant difference between the sexes was also demonstrated. The mean value was higher in males than in females. This indicates that the position of the P-V curve in males is higher than that in females. Other factors associated with Crs include age, pulmonary blood flow, anesthesia and body position [11]. The effect of age on Crs could not be investigated, because ages of the cats used were unknown. However, it is known that Crs increases with age, because the elastic contractility of lung decreases with age. Anesthesia may decrease Crs due to possible changes in the elastic contractility of the whole respiratory system. Measurement in animals is impossible without an anesthesia. It is, therefore, considered justifiable to regard the value obtained under a certain level of anesthesia as a clinically acceptable value. Influences of other factors on Crs need further studies for clarification.

In conclusion, measurement of Crs from the flow-volume curve in the anesthetized and muscle-relaxed cats was considered to be a highly reproducible and clinically applicable method.

REFERENCES