Forced Vital Capacity in Cats

Michio FUJITA, Hiromitsu ORIMA, Motoko SHIMIZU, Shigekatsu MOTOYOSHI, Masao KATAYAMA, and Katsuyuki MIYASAKA.
Departments of Radiology and Internal Medicine, Nippon Veterinary and Zootechnical College, 1-7-1, Kyo nan-cho, Mu ashino-shi, Tokyo 180 and National Children’s Medical Research Center, 3-35-31, Taishido, Setagaya-ku, Tokyo 154, Japan
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Pulmonary function tests (PFT) are important in determining the pathogenesis and the severity of respiratory system disorders, and yet such tests have still been difficult to administer in veterinary medicine because of lack of concensus on the methodology or the measuring apparatus. Even basic PFT, such as the representative vital capacity, are based on the premise that the subjects cooperate and have therefore only been used in humans whose cooperation could be obtained, i.e. not in children under school age. The authors have in the present study measured the forced vital capacity (FVC) by means of a technique to obtain deflation flow volume (DFV) curve [6] by the forced deflation of the lung in cats which are intubated and under controlled ventilation.

Twenty five healthy adult cats (12 males and 13 females) were used. They were normal with regard to hematology, blood chemistry, and plain chest X-ray.

The animals weighed 1.9–5.6 kg (mean, 3.1 kg) and ranged 27–35 cm in body length (mean, 32.5 cm). They were anesthetized with intramuscular injection of ketamine hydrochloride (15 mg/kg) and continuous intravenous infusion of ketamine hydrochloride (0.1–0.2 mg/kg/min). Muscle relaxation was obtained by administration of pancuronium bromide (0.1 mg/kg) before endotracheal intubation and a pediatric positive pressure artificial ventilator was connected to the endotracheal tube in order to maintain controlled ventilation.

Under 100% oxygen FVC was measured according to the DFV Method as follows; once the vital signs had been stabilized and the airways freed of secretion through tracheal suctioning, positive pressure ventilation was switched to a standard anesthesia T-piece. The cats were ventilated manually and the intrapulmonary pressure was raised to +30 cmH₂O, which is considered to be the maximum inspiratory level [1, 2, 3]. The lungs were inflated for the forth time to +30 cmH₂O and then the forced expiration was obtained by opening a pneumatic driven 3-way valve in order to direct the expiratory gas to a forced negative pressure source of -30 cmH₂O. The flow and volume were measured during this procedure by a pulmonary function test system (Aivision VM-8400) using a Fleisch #0 pneumotachograph (Measurable range : 0–500 ml/sec) (Fig. 1).

Correlation was studied between body weight and FVC, and statistical analysis was performed on sex and FVC using Student’s t-test.

A positive correlation was observed between body weight and FVC (y=84.8×+66.3, r=0.75) (Fig. 2). No significant difference in FVC was observed between both sexes (Table 1).

Reports on the slow vital capacity (i.e. vital capacity) not using the forced expiration have been made by Drorbaugh et al. [2] in dogs, mice, rats and rabbits, and by Agostoni et al. [1] in dogs, cats, rabbits, guinea pigs and rats. Starting from the lung volume at rest, those authors used a volume syringe to inflate or deflate the lungs. Their methods thus differ from the present study.

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Fig. 1. Deflation flow-volume curve in cats lungs and bronchi. In this graph, the flow-volume curve is indicative of tracheal and bronchial occlusion.
Table 1. Average values of the forced vital capacity in male and female cats

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. of subjects</th>
<th>Body weight kg</th>
<th>FVC ml</th>
<th>FVC ml/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>12</td>
<td>3.31±1.13</td>
<td>325.8±81.5</td>
<td>102.5±18.1</td>
</tr>
<tr>
<td>Female</td>
<td>13</td>
<td>2.98±0.69</td>
<td>262.3±71.8</td>
<td>89.3±22.3</td>
</tr>
</tbody>
</table>

Values are means±SD.

Fig. 2. Correlation between the forced vital capacity (FVC) and body weight.

in that they either measured the intrapulmonary pressure and calculated the vital capacity (VC) from the changes in lung capacity brought about by pressure change, or calculated the VC by measuring the pressure changes brought about by pulmonary injection or withdrawal of a given air volume. The vital capacity values of present study were very close to those obtained by Agostoni et al. [1] although their method was different from ours. This is probably because the animals had normal lungs without airway obstruction. Measurement of the FVC by applying the negative pressure under the forced expiration from -40 cmH₂O to -30 cmH₂O, -25 cmH₂O, -20 cmH₂O, -15 cmH₂O, -10 cmH₂O and -5 cmH₂O did not reveal significant differences in the FVC between each negative pressure level. However, a larger negative pressure would yield FVC values dependably in restrictive lung disease. The other purpose of the DFV curve i.e. detection of airway obstruction requires negative pressure of at least -10 cmH₂O in order to produce dynamic compression [4]. In the present result, FVC increased with body weight. The data scatter, however, was large and could be secondary to the variability in the chest wall characteristics in cats. The correlation between age and FVC was unavailable since the exact age of the cats was unclear. In addition to obtaining FVC and hence diagnosing restrictive disorders, the diagnostic usefulness of DFV curve regarding detection of airway obstruction has been confirmed in humans [5], further study is necessary in order to establish its usefulness in cats.

REFERENCES


要約

猫の制御肺活量（短報）：藤本達郎・織田博光・清水幹子・本好茂一①・片山正夫②・宮坂勝之②（日本獣医薬産大学獣医学放射線学教室，①獣医内科学教室，②国立小児医療研究センター）——麻醉下の猫に対し、陽圧で最大吸気を行った後、陰圧を用いて努力呼気と類似である制御呼気を行わせ、その際の流量と容量の曲線から強制肺活量（FVC）を求めた。その結果、FVCと体重との間には正の相関を認めたが性差は認められなかった。