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Radiographic Measurements of the Trachea in Domestic Short Haired and Persian Cats

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Tracheal Diameter in Persian Cats

Radiographic Measurements of the Trachea in Domestic Short Haired and Persian Cats

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Abstract

Tracheal diameter can be assessed from a thoracic radiograph, with assessment of tracheal diameter in dogs based on ratios between tracheal diameter and a skeletal measurement—however reference ranges are not available for the cat. Tracheal narrowing may cause significant clinical problems, although tracheal hypoplasia in dogs may be clinically silent, and is rarely reported in cats (both mesati- and brachycephalic). The tracheal diameter and trachea:thoracic inlet and trachea:rib ratios were calculated for populations of Domestic Short Haired (DSH) (n=68) and Persian (n=40) cats. This gave reference ranges for radiographic tracheal measurements in these breeds. It is proposed that the tracheal diameter in a normal DSH cat should be 18% of the diameter of the thoracic inlet, and compared to 20% in Persian cats.

Introduction

Tracheal hypoplasia is an underdevelopment of the trachea resulting in a significantly narrowed tracheal diameter, which is commonly found in brachycephalic dog breeds, most notably the English Bulldog and Boxer. Changes that may be seen include close apposition or overlapping of the ends of the tracheal cartilage rings and absence of the dorsal tracheal membrane. Hypoplastic tracheas have a stable diameter that does not vary with the phase of respiration. Tracheal hypoplasia may be regarded as a component of brachycephalic syndrome (along with stenotic nares, everted laryngeal saccules and an elongated soft palate). Although the condition may frequently be clinically silent, the narrowing of the trachea may cause exacerbation of cardiovascular or respiratory disease. Clinical presentations and conditions associated with tracheal hypoplasia may include chronic coughing and recurrent tracheitis.

In the cat dynamic tracheal collapse has been reported, both due to a congenital malformation of the tracheal cartilages and as an acquired condition associated with upper airway obstruction and neoplasms of the tracheal wall and

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Acquired narrowing of the tracheal lumen may be seen following trauma or associated with extraluminal compression or in association with thickening of the wall of the trachea. However, tracheal hypoplasia has been seldom reported in cats, where it has been reported in association with mucopolysaccharoidosis. Diagnosis of tracheal narrowing (e.g. associated with collapse or hypoplasia) is most easily made through radiography. In dogs, the most commonly used technique is to calculate the ratio between the diameter of the trachea at the level of the thoracic inlet and the inner diameter of the thoracic inlet. In most dogs, this ratio will be greater than 0.2:1 – i.e. the tracheal diameter will be at least 20% of the diameter of the thoracic inlet. In most brachycephalic breeds, this ratio has been calculated as normal if it is greater than 0.16:1, whilst in the English Bulldog, this measurement has been calculated to be normal for the breed if greater than 11% of the diameter of the thoracic inlet. Other ratios that have also been described for assessing tracheal diameter in the dog include comparing the diameter of the mid-thoracic trachea to the width of the 3rd rib, with normal ratios of trachea:3rd rib being reported as >2.0 and >3.0, with tracheal hypoplasia being defined as a ratio of less than 1.0.

Although the diameter of the trachea can be assessed endoscopically, this technique is potentially hazardous due to the risk of obstruction of the already narrowed airway.

Radiographic assessment of the tracheal diameter and calculation of ratios to skeletal structures has not been reported in either Domestic Short Haired or Persian cats. This study establishes reference ranges for these ratios in domestic short haired cats (DSH) and Persians, and investigates for differences in these ratios between the two breeds.

**Materials and methods**

The radiographic archives at the Small Animal Hospitals of the Royal (Dick) School of Veterinary Studies, University of Edinburgh and the Faculty of Veterinary Medicine, University of Glasgow were searched for thoracic radiographs of DSH and Persian cats and the associated medical records. For inclusion in the study, the patients had to be at least one year old and to have no history of respiratory or cardiovascular disease, and had to have right lateral thoracic radiographs of good diagnostic quality, including the entire thorax and thoracic inlet in the collimated area, with the neck in a neutral position (i.e. not excessively hyperextended or flexed), with the forelimbs extended cranially and not superimposed on the thoracic cavity and with no axial rotation of the thorax. Cases with radiographic evidence of thoracic disease were excluded. In addition, cases with an endotracheal tube extending beyond the mid-cervical vertebrae were also excluded.

Once the films were collected, measurements (in millimetres) were taken from the films as follows (Figure 1):

i) Tracheal diameter at the level of the thoracic inlet (TDinlet) – Figure 1a
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ii) Thoracic inlet diameter, from the dorsocranial aspect of the manubrium to the craniovelar aspect of the body of the 7th cervical vertebra (TInlet) – Figure 1a

iii) Tracheal diameter at the level of the 2nd intercostal space (TDintercostal) – Figure 1b

iv) Width of the proximal third of the 3rd rib (Rib) – Figure 1b.

The means were calculated for each group of measurements. Ratios were calculated between:

i) TDinlet divided by TInlet (Measurement points from Figure 1a)

ii) TDintercostal divided by Rib (Measurement points from Figure 1b)

The mean measurements and ratios were compared between the populations (DSH and Persians) using a two-tailed t-test.

Results

Radiographs from 68 DSH and 40 Persians were included in the study. The majority had undergone thoracic radiography for either oncological staging or investigation of systemic disease. Measurements were subjectively simple to obtain using a standard ruler. The mean measurements are presented in table 1. The mean ratios and p-values are presented in table 2.

There was no significant difference in the mean tracheal diameter at either the thoracic inlet or intercostal space locations, nor in the width of the 3rd rib between the two populations. However there was a significant difference in the measurements of the thoracic inlet, with the Persian cat population showing a significantly narrowed thoracic inlet compared to the DSH population. There was a significant difference in both of the ratios calculated, with the Persian population showing significantly greater Trachea:Thoracic Inlet and Trachea:3rd Rib ratios than the DSH population.

Discussion

Given the potential significance of tracheal hypoplasia or other causes of tracheal narrowing, coupled with the lack of reference ranges for normal radiographic tracheal measurements in the cat, the authors felt it valuable to establish reference ranges for the trachea in mesaticephalic (DSH) and brachycephalic (Persian) cat breeds.

When comparing the absolute size of the trachea between the DSH and Persian populations, there was no significant difference between the mean tracheal diameters (Table 1). However, when the trachea:thoracic inlet are compared, that of the Persian population are significantly greater than that of the DSH population. This is believed to be due to a proportional dorsoventral
compression of the thoracic inlet of the Persian cat when compared to that of the
DSH (demonstrated by the significant difference in absolute measurements of the
thoracic inlet shown in Table 1). This anatomic conformational difference is likely
of no clinical significance, but results in the alteration in the trachea:thoracic ratio,
and should be considered when assessing other structures using the thoracic
skeletal structure as a comparison (e.g. the height of the cardiac silhouette) as
this apparent flattening could result in a misinterpretation of the structure or organ
in question. The authors propose that the trachea in a DSH should be
considered of normal diameter if it is 18% of the diameter of the thoracic inlet,
and that of the Persian cat should be considered normal if it is 20% of the
thoracic inlet.

The trachea:rib ratios demonstrated a similar (although less significant)
variation between the populations. Given the similarity in absolute size of the
tracheas, this is most suggestive of thicker ribs in the DSH population
demonstrated by the absolute measurements (although this was not statistically
significant). Although the weights and sizes of the patients included in the study
was not always available, subjectively there was no significant discrepancy in
body size between the two populations of adult cats (skeletally immature cats
were excluded from the study) and so this is not thought to be an influence on the
skeletal measurements. However, it was felt that the trachea:thoracic inlet ratio
was considerably easier to obtain, and it would be the authors’ advice that the
trachea:thoracic ratio is used for assessing trachea diameter in preference to the
trachea:rib ratio.

In addition, given the fairly uniform nature of the body sizes in the study
population, it may be argued that a tracheal diameter of around 5.5mm is normal
for a cat (DSH or Persian) of average size, and this would forego the requirement
to calculate a ratio with a set skeletal measurement. However, it cannot be
guaranteed that the body sizes of the study population are typical of the
population as a whole, and in addition some cats will lie at the extremes of the
population range. It is therefore the authors’ recommendation that the tracheal
diameter is assessed using a ratio with a skeletal measurement (such as those
described above) as this should minimise variations due to absolute body size.

Tracheal hypoplasia in the dog is frequently clinically silent, but as can
significantly worsen the clinical effect of a respiratory disorder such as
pneumonia prior knowledge of its presence in a patient can be valuable. Detection is most commonly through thoracic radiography, although computed
tomography or endoscopy may also be indicative of tracheal hypoplasia. On
the basis of the results of the study, it can be shown that there was no evidence
of clinically silent tracheal hypoplasia in the population of Persian cats studied. It
is possible that tracheal hypoplasia does exist in the Persian cat, but always
results in clinically significant respiratory disease (and as a result, such cases
would have been excluded from the population used in this study). However, this
is thought unlikely by the authors, considering the frequently silent nature of
tracheal hypoplasia in the dog. This would suggest that the brachycephalic
anatomic changes seen in Persian cats are restricted to the skull and upper
respiratory tract, such as the nasopharyngeal turbinates reported to be seen in
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about 20% of brachycephalic cats\textsuperscript{11}. There is the question of whether the study population of Persian cats was truly representative of the population as a whole – unfortunately, in part due to this being a retrospective study, the possibility of a skewed population cannot be excluded. However, the authors feel that the wide range of presentations, and the inclusion of cases from two different referral hospitals reduces this possibility.

In conclusion, this study establishes reference ranges for the assessment of tracheal diameter in Persian and Domestic Short Hair Cats: for DSH cats with no evidence of cardiorespiratory disease, the tracheal diameter should be 18% of the internal diameter of the thoracic inlet, and this measurement should increase to 20% in normal Persian cats.

References


**Figure Legend:**

**Figure 1a:** Lateral feline thoracic radiograph showing measurement points for Trachea:Thoracic Inlet Ratio: * = Level to measure tracheal diameter (mm) at thoracic inlet (TDInlet); ◄ ► = Thoracic inlet diameter (mm) (Tlnlet).

**Figure 1b:** Lateral feline thoracic radiograph showing measurement points for Trachea:3rd Rib Ratio: * = Point to measure tracheal diameter (mm) in 2nd intercostal space (TDIntercostal); ◄ ◄ = Point to measure width of proximal ⅓ of 3rd rib (mm) (between arrow heads) (Rib).

**Table Legends:**

Table 1: Mean measurements and p-values for DSH and Persian study populations

Table 2: Mean Ratios and p values for DSH and Persian study populations.
<table>
<thead>
<tr>
<th>Mean Measurements</th>
<th>P value</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>DSH</td>
</tr>
<tr>
<td>Trachea – Thoracic Inlet</td>
<td>5.4mm</td>
</tr>
<tr>
<td>Trachea – Mid-Thoracic</td>
<td>5.4mm</td>
</tr>
<tr>
<td>Thoracic Inlet</td>
<td>32.5mm</td>
</tr>
<tr>
<td>Proximal 3rd Rib</td>
<td>3.5mm</td>
</tr>
</tbody>
</table>

Table 1: Mean measurements and p-values for DSH and Persian study populations

<table>
<thead>
<tr>
<th>Mean Ratios</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSH</td>
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<tr>
<td>Trachea:Thoracic Inlet</td>
<td>0.18 (Range 0.13-0.23)</td>
</tr>
<tr>
<td>Trachea:3rd Rib</td>
<td>1.59 (Range 1.20-2.33)</td>
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</table>

Table 2: Mean Ratios and p values for DSH and Persian study populations.