Freely-Behaving Videofluoroscopic Characterization of Dysphagia in Canine Degenerative Myelopathy

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Introduction
Canine Degenerative Myelopathy (DM) has recently been proposed as a naturally occurring disease model for human amyotrophic lateral sclerosis (ALS). In both DM and familial ALS, the disease phenotype is attributed to a mutation in the superoxide dismutase 1 (SOD1) gene. Clinical signs observed in DM dogs are similar to those seen in ALS patients. Dysphagia (swallowing impairment) develops in almost all patients with ALS at some point in the disease process. Likewise, clinical signs of dysphagia have been reported in DM as the disease progresses to end-stage [Table 1]. Previous work in this laboratory developed a protocol for a freely-behaving videofluoroscopic swallow study (VFSS) that allows dogs to consume foods and liquids containing either barium or Omnipaque™ (iohexol) contrast agents while standing unrestrained in a custom-designed polycarbonate, radiolucent kennel. The kennel setting eliminates the need for physical restraints and force-feeding techniques that may result in unnatural feeding activity, which is a common complaint reported in the canine VFSS literature. Using our freely-behaving VFSS protocol, we hypothesize that several biomarkers for dysphagia will be identified in DM-affected dogs, compared to unaffected control dogs. Correlations between dysphagia phenotype and histopathology in DM can then be explored and compared with human ALS. This research is necessary to validate canine DM as a disease model of ALS.

Materials and Methods

VFSS Protocol
1. Overnight food restriction
2. Prepare test items with oral contrast agent immediately prior to use
3. Position kennel in fluoroscope
4. Place first test item in kennel and position it at desired height
5. Allow dog to freely enter kennel to consume test item from bowl
6. Record 4 consecutive swallows with head and neck in field of view
7. Follow 4th swallow to stomach
8. Repeat steps 6 & 7
9. Replace bowl with next test item
10. Repeat steps 6 - 9 until all items have been tested
11. Allow dog to freely exit kennel
12. Clean kennel

Swallow Parameters Measured
We measured 2 swallow parameters using thin liquid and kibble swallows in 8 healthy dogs for comparison with published values for lateral and sternal recumbency (Bonita et al., 2009).

- Time to maximal pharyngeal constriction: The time from start of swallow until pharyngeal muscles are maximally constricted.
- Time to upper esophageal sphincter (UES) closure: The time from start of swallow until complete UES closure after passage of bolus into esophagus.

Goals and Objectives
- Evaluate key swallow parameters in healthy dogs of similar anatomical size using the freely-behaving VFSS protocol.
- Establish normative values for comparison with DM-affected dogs and other diseases that cause dysphagia.
- Create a protocol for freely-behaving VFSS to use in the clinical setting as a diagnostic tool.

Results

Maximal Pharyngeal Constriction

<table>
<thead>
<tr>
<th>Swallow Parameter</th>
<th>Thin Liquid</th>
<th>Kibble</th>
</tr>
</thead>
<tbody>
<tr>
<td>UES Closure</td>
<td>1.5 ± 0.5 s</td>
<td>2.0 ± 0.7 s</td>
</tr>
<tr>
<td>Pharyngeal Constriction</td>
<td>1.8 ± 0.4 s</td>
<td>2.2 ± 0.8 s</td>
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Summary and Conclusion
- A summary of indications and contra-indications for use of barium and Omnipaque™ contrast agents was created as a clinician-friendly tool for this freely-behaving VFSS protocol.
- Current literature recommends use of Omnipaque™ for VFSS as a safe alternative and is often preferred over commonly used barium.
- To date, 8 controls and 3 DM-affected dogs have been evaluated using this freely-behaving VFSS protocol. However, video analysis of DM-affected dogs is being deferred until normative data is established.
- Average times for both swallow parameters during freely-behaving trials were longer compared to prior publications. Differences may be attributed to the natural feeding position promoted by this VFSS protocol.

Future Directions
- Continue to recruit DM-affected dogs for evaluation using the freely-behaving VFSS protocol.
- Identify specific videofluoroscopic biomarkers of dysphagia in canine DM.
- Establish the freely-behaving VFSS protocol as an alternative diagnostic tool in veterinary clinical practice.

Study Limitations
- The fluoroscopy machine used for this study is outdated and was incompatible with available digital technology at the time of data collection. Therefore, digital video recording was accomplished using a hand-held video camera focused on the fluoroscopy monitor. However, recent improvements will allow direct digital recordings of the fluoroscopic videos. We anticipate clearer images that will allow us to investigate additional swallow parameters in future testing.
- All dogs do not eat all food consistencies; therefore, the amount of data for each swallow parameter may be variable.

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