Validation of Quantitative MRI Measures of Intervertebral Disc Health in Client-Owned Dogs

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INTRODUCTION: Intervertebral disc degeneration (IVDD) is a leading cause of low back pain. There is a need for clinically relevant animal models with a pathogenesis similar to human IVDD to better understand the disease and test new treatments [1]. While most animal models of IVDD artificially induce disc injury (e.g., by puncturing the disc), a model of spontaneous disease would better reflect the natural course of IVDD [1]. Dogs are one of the few species to develop spontaneous IVDD with a pathogenesis similar to human IVDD [2-4]. Client-owned companion dogs that are being imaged and treated for IVDD provide a unique population within which to study naturally occurring IVDD and trial new treatments. However, the given limited access to tissue samples in client-owned dogs, noninvasive imaging tools are needed that can characterize disc health, monitor IVDD progression, and evaluate the efficacy of treatments in vivo. Thus, the purpose of this study was to assess quantitative magnetic imaging (qMRI) measures of disc health (relaxation time mapping and diffusion imaging) in vertebral columns obtained from client-owned dogs. We hypothesized that randomly selected dogs without clinical spine disease have a range of disc degeneration severity and that the qMRI measures correlate with radiological, histological, and biochemical measures of disc health. This study expands on our preliminary report of 5 dogs [5] to include more qMRI measures and analyses across 17 dogs.

METHODS: Animals: Thoracolumbar vertebral column specimens were collected from 17 client-owned dogs whose bodies were donated for research following institutional euthanasia. These dogs were a variety of signalments: 15 were nonchondrodystrophic breeds, 1 was a chondrodystrophic breed, and 1 was a known history of IVDD or other spinal disease.

RESULTS: Most dogs had both healthy and degenerated discs as assessed by Pfirrmann grade and histology score (Figure 1). NP and vAF qMRI values in the healthy discs (Pfirrmann grade ≤ 2) varied greatly across the dogs but were similar across disc levels (Figure 2). The strength of the relationships (conditional R) between each pair of qMRI and disc health measures are shown in Figure 3 using a linear mixed effects model (lme4) with dog as a random effect. The ρT2MSME, ρT2, ρT1 (conditional R) between each pair of qMRI and disc health measures are shown in Figure 3 using a linear mixed effects model (lme4) with dog as a random effect. X = non-significant (p ≥ 0.05).

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Figure 1. Distribution of Pfirrmann grades across dogs and disc levels.

Figure 2. Average NP (left) and vAF (right) T2MSME relaxation times for relatively healthy discs (Pfirrmann ≤ 2) across dogs and disc levels.

Figure 3. Correlation matrices of the quantitative MRI and disc health measures in the NP (left) and vAF (right) using linear mixed effects models with dog as a random effect. X = non-significant (p ≥ 0.05).