Hearing Loss in Dogs After Routine Neurological MRIs

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Target Audience: Physicians, physician scientists, MR researchers/scientists and veterinarians.

Purpose: The auditory brainstem response (ABR) test is the accepted method for detecting hearing loss in dogs. Current standards in veterinary medicine do not require hearing protection for canines undergoing MRI. The purpose of this study was to determine whether a single, routine MRI study at 1.5 T generated sufficient acoustical noise to create cochlear damage in client-owned dogs. In addition, the study assessed whether or not earplugs placed in canine ears could mitigate any potential effects of acoustic MRI noise.

Methods: This study was approved by the Institutional Animal Care and Use Committee. ABR testing (Cadwell Sierra II Wedge system) was performed in each ear on 15 client-owned anesthetized dogs before and after a single MRI scan. ABR recordings were performed to obtain 1000 signal averages per ear using inserted earphones at a stimulation rate of 21.1 stimuli/second. The stimulus was an alternating (rarefaction and condensation) broadband click at a stimulus intensity of 75 dB with white noise masking of the contralateral ear at a stimulus intensity of 45 dB. All dogs received the same anesthetic protocol: sedation with fentanyl (5 mcg/kg, IV), induction with midazolam (0.25 mg/kg, IV) followed by propofol (3-4 mg/kg IV, to effect). Each dog was intubated and maintained on isoflurane anesthesia (1.5-2%) in oxygen with mechanical ventilation. Earplugs were placed in the horizontal ear canal bilaterally in 13 of the 15 dogs studied. MRI was performed on a 1.5T scanner (Espree, Siemens) with each dog maintained on general anesthesia. MRI studies included scans for brain, cervical spine, and/or thoracolumbar spine. Core body temperature was recorded during pre- and post-MRI ABR testing. The time for the entire MRI study and total anesthetic time for each animal were recorded. Sound levels were measured using a Larson-Davis LxT sound level meter fitted with a ½-inch free field microphone for all of the MRI sequences to determine levels of acoustic noise.

Waveforms from the ABR test (Fig 1) were digitized and transferred to a PC for analysis. Statistical analysis for changes in the waveform pre- and post-MRI was performed using Stata. Changes in body temperature pre- and post-MRI were evaluated using a paired t-test. Values are reported as mean ± standard deviation. A P value <0.05 was considered statistically significant.

Results: Canine breeds in the study included Beagle (2), Bassett Hound (1), Dachshund (4), Maltese (1), mixed-breed (1), Shih Tzu (1), German Shepherd (1), Labrador Retriever (2), and Papillon (2). Mean body weight was 16 ± 12 kg (range 4-39 kg). Mean MRI study duration was 72 ± 28 minutes (range 41-139 min). Core body temperature decreased after MRI scan (38.0 ± 0.4 °C pre-MRI vs. 36.2 ± 1.3 °C post-MRI, P<0.002 [range 33.4-38.8 °C]). One animal was found to be deaf in one ear and its data was excluded; all other animals demonstrated normal hearing prior to MRI based on pre-MRI ABR testing. Qualitative analysis of the ABR waveforms in the animals with earplugs showed a decrease in amplitude and a delay of the secondary amplitudes in the post-MRI ABR test relative to the pre-MRI test. Acoustic noise generated by the MRI sequencing scans ranged between 80.0-96.1 dB.

Discussion: Our study demonstrates changes in canine hearing based on ABR testing after standard 1.5T MRI neurological scans. Previous studies indicate that hearing could be affected in dogs and pigs at 3T.[2] Since the acoustic noise at 1.5T is decreased relative to 3T, one would anticipate that the potential for cochlear damage and hearing loss might be reduced at 1.5T. However, the acoustic noise measured in this study using conventional spine and brain MRI scans often exceeds NIOSH standards. Prior work has shown that isoflurane anesthesia and reductions in core body temperature may also cause alterations to the amplitudes and latencies of ABR waveforms.[4] Since we demonstrated more profound changes in ABRs in dogs that did not receive hearing protection, it is likely that earplugs may provide some degree of hearing protection.

Conclusion: While it is common to use hearing protection in human patients during MRI, earplugs are used infrequently in canine studies. Our study demonstrates changes in ABR testing pre- and post-MRI; this study also demonstrates that the acoustical noise in a clinical 1.5T scanner has the potential to cause cochlear damage. Future testing is necessary to assess whether these changes in hearing are temporary or permanent. In addition, further assessment is needed to determine the extent that decreases in body temperature during isoflurane anesthesia influence ABR results in the absence of MRI.

References:

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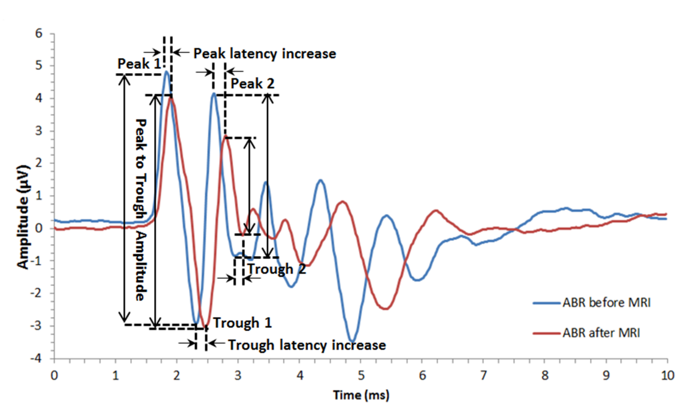

Fig 1: Representative ABR waveforms obtained before (blue) and after (red) an MRI scan showing decreased peak amplitude with increased latency.