

# Potential of MREIT Conductivity Imaging to Evaluate Brain Abscess: In Vivo Canine Model

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## Purpose

The purpose of this study is to show the potential of *in vivo* MREIT conductivity imaging as a new clinically useful bio-imaging modality through animal disease model experiments.

## Materials and Methods

Brain abscess was induced in 10 healthy beagles (2-3 years old, weighing 8-15 kg) by a direct inoculation method. The organism used to produce the abscess was *Staphylococcus pseudintermedius* from the cultured blood sample of the dog with endocarditis. To prevent dribbling during experiments, we injected 0.1 mg/kg of atrophine sulfate. Ten minutes later, we anesthetized the dogs with intramuscular injection of 0.2 ml/kg Tiletamine and Zolazepam (Zoletil 50, Virbac, France). After clipping hair at four locations (dorsal, ventral and bilateral surfaces) on the head, we attached four carbon-hydrogel electrodes and placed the dog inside the bore of our 3 T MRI scanner (Magnum3, Medinus, Korea). The experimental protocol was approved by the Institutional Animal Care and Use Committee (IACUC) of Konkuk University, Seoul, Korea.

Inside the shield room, we intubated the dog using an endotracheal tube and began the general anesthesia using a veterinary anesthesia machine system (VME, MATRX, USA). We used 2% isoflurane mixed with oxygen at 800 ml/min flow rate. Ventilation was machine-controlled by using a ventilator (M-2002, Hallowell EMC, USA) with the respiration rate of 15 bpm and tidal volume of 200 ml. Using our custom-designed MREIT current source, we injected the first current  $I_1$  between one opposing pair of electrodes. The injection current amplitude was 5 mA with the total pulse width of 81 ms. The multi-echo pulse sequence was used with TR/TE = 900/30 ms, 3 echoes, FOV = 180×180 mm<sup>2</sup>, slice thickness = 3 mm, NEX = 16, matrix size = 128×128, number of slices = 8, and total imaging time = 120 min. After acquiring the first magnetic flux density ( $B_z$ ) data set for  $I_1$ , the second injection current  $I_2$  with the same amplitude and pulse width was injected through the other pair of opposing electrodes to obtain the second data set. We used the single-step harmonic  $B_z$  algorithm implemented in CoReHA (conductivity reconstructor using harmonic algorithms) for multi-slice conductivity image reconstructions.

## Results and Discussion

Figure 1 shows typical MR magnitude (a), reconstructed conductivity (b), and color-coded conductivity images of a canine head at 12 hrs after induction of brain abscess. Figure 2(a), (b), and (c) are contrast-enhanced T1weighted MR, T2 weighted MR and reconstructed conductivity images of the canine brain before and after induction of brain abscess. Compared with the conventional MR image technique, the present MREIT technique shows variation of conductivity contrast pattern corresponding to the degree of malignancy of brain abscess.

Figure 3 represents the results of three *in vivo* imaging experiments. The relative conductivity contrast ratio (% rCCR) of brain abscess significantly increased up to 12 hours after induction of abscess. However, the rCCR was slowly decreased after 18 hours. Different time-course variations of rCCR values between normal and abscess regions stem from the fact that the reconstructed conductivity value of abscess region reflects the tissue condition according to the inflammatory cell infiltration, edema, hemorrhage, and necrosis.

## Conclusion

In this study, we performed *in vivo* disease model animal experiments to validate the MREIT technique in terms of its capability to produce conductivity contrast pattern corresponding to the degree of malignancy of brain abscess. Reconstructed conductivity images do not provide absolute conductivity values but show unique contrast between normal and abnormal tissues compared with conventional MR imaging techniques. We expect that this kind of *in vivo* animal imaging can provide conductivity information of tissues *in situ* to be utilized in diagnosis and also modeling studies.

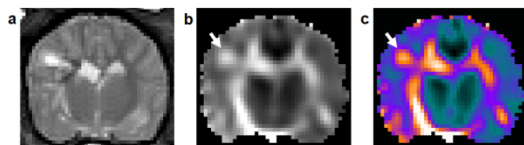


Fig. 1. (a) MR magnitude, (b) reconstructed conductivity and (c) color-coded images of a canine brain abscess model.

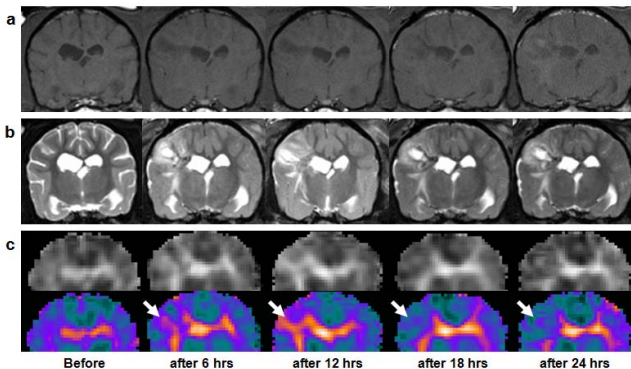


Fig. 2. Time-course images of a canine brain before and after induction of brain abscess. (a) contrast-enhanced T1 weighted, (b) T2 weighted, (c) conductivity images. Arrows indicate the abscess region.

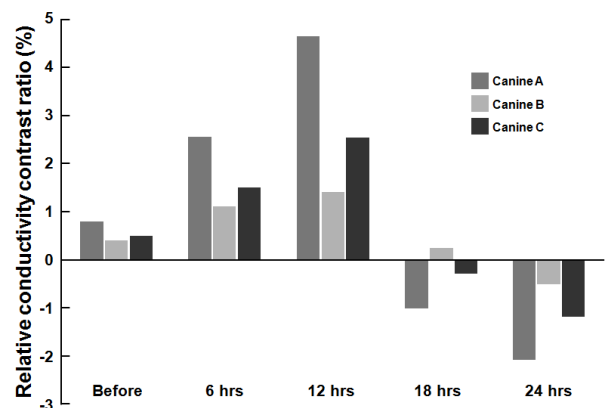


Fig. 3. Relative conductivity contrast ratio (% rCCR) of brain tissues from *in vivo* abscess model imaging experiments. Since conductivity images in this study provide only contrast information, we introduce the rCCR as a quantitative criterion to compare conductivity images.

## References

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