Characterization of Prostate Tissues using MREIT Conductivity Imaging: *In Vivo* Canine Study

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Target audience

This study may provide new contrast information of the male pelvis imaging. It might be helpful to the people who are interested in the clinical applications of electromagnetic tissue property mapping.

Purpose

The purpose of this study is to show the potential of *in vivo* MREIT conductivity imaging as a clinically useful bio-imaging modality providing new contrast information of prostate tissues.

Methods

Five healthy laboratory beagles were used for imaging experiments. 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 on the pelvis, we attached four carbon-hydrogel electrodes and placed the dog inside the bore of our 3 T MRI scanner (Fig. 1a). The experimental protocol was approved by the 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).

Using a constant current source, we injected currents in two mutually orthogonal directions between two pairs of electrodes facing each other (Fig. 1a). The injection current amplitude was 7 mA with the total pulse width of 81 ms. Multi-echo ICNE pulse sequence was used to obtain the MR magnitude and magnetic flux density (B_z) images (Fig. 1b and c).[1] The imaging parameters were as follows: TR/TE = 900/20, 40, 60 ms (3 echoes), FOV = 220×220 mm^2, matrix size = 128×128, slice thickness = 5 mm (8 slices), NEX = 8, and total imaging time = 40 min. The single-step harmonic B_z algorithm implemented in CoReHA (conductivity reconstructor using harmonic algorithms) was used for multi-slice conductivity image reconstructions.[2]

Results and Discussion

Figure 2 shows typical MREIT images of male pelvis obtained from a normal dog. The MR magnitude image in Fig. 2(a) shows the anatomical structure of the canine pelvis together with four electrodes for injection current. The reconstructed conductivity and color-coded images in Fig. 2(b) and (c) revealed different contrast in the pelvic regions including the prostate, sacrum, rectum, and surrounding muscles. Especially, conductivity images of prostate showed clear contrast between central and peripheral zone which was not apparent in the MR magnitude image. Figure 3 shows enlarged images of the canine prostates from two different normal male dogs. Figure 3(a) is an anatomical structure of the prostate, (b) and (c) show a magnified MR magnitude and corresponding conductivity image of canine prostates, respectively. Conductivity images of the prostate showed clear contrast between central and peripheral zones which are closely related with prostate diseases including cancer and benign prostatic hyperplasia.[2] Providing cross-sectional conductivity images with a spatial resolution of a few millimeters, we expect that this kind of *in vivo* animal imaging can provide conductivity information of tissues *in situ* to be utilized in diagnosis.

Conclusion

This feasibility study demonstrates that current MREIT conductivity imaging can characterize prostate tissues without using any contrast media and additional MR scan.

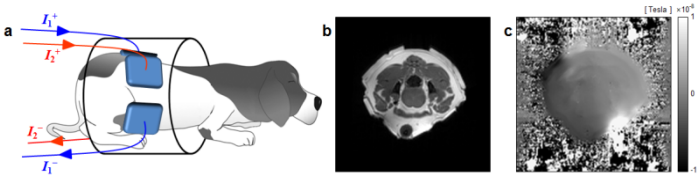

Fig. 1. (a) Experimental setup for canine male pelvis imaging experiment. (b) and (c) are measured MR magnitude and magnetic flux density image by injection current.

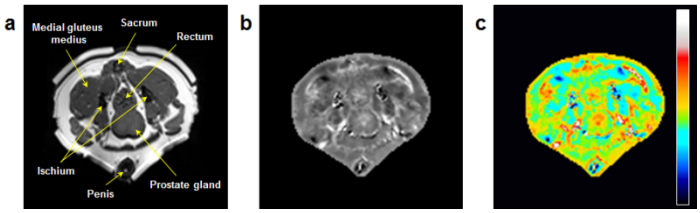

Fig. 2. Typical MREIT images of a normal canine male pelvis. (a) MR magnitude, (b) and (c) are reconstructed conductivity and color-coded images of a normal canine pelvis showing clear contrast among prostate, sacrum, rectum, and surrounding muscles.

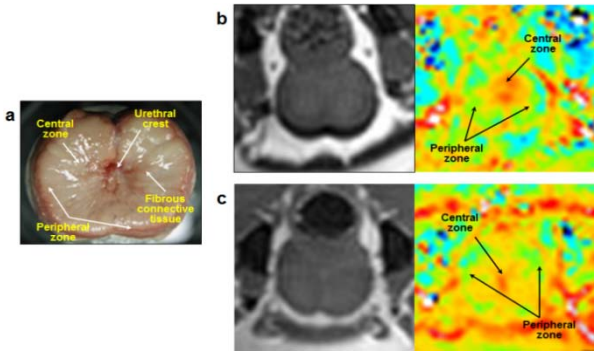

Fig. 3. (a) Anatomical structure of the prostate, (b) and (c) show a magnified MR magnitude and corresponding conductivity image of canine prostates, respectively. Black arrows indicate the zonal information of prostate tissues.

References

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