A dual modality system for simultaneous monitoring of a bi-functional optical & MRI contrast agent for cancer detection

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Introduction : Multi-modality imaging is becoming a trend in developing new generation *in vivo* imaging techniques for diagnosis [1]. MRI is a high resolution imaging modality, while optical imaging provides essential functional information such as oxygen saturation in the diseased tissue. In addition, when the contrast agent is administrated, the sensitivity and specificity for each imaging component can be improved. For example, dynamic contrast enhanced MRI (DCE-MRI) has been proven to be the most sensitive modality in detecting breast lesions [2]. On the other hand, ICG contrast enhanced optical imaging has shown to be able to effectively reveal the vascular structural in diseased tissue [3]. Diffuse optical tomography (DOT) is a recently emerging optical imaging technique that uses arrays of sources and detectors to obtain spatially dependent optical parameters of tissue. Recently, our group has developed a hybrid MRI/DOT multi-modality imaging system [4]. This MF-DOT system is based on a unique design that incorporates a fully automated, MR-compatible, multi-frequency and multi-spectral DOT system that can acquire data up to 300MHz. In such a multi-modality system, each modality measures a different parameter set, which make it difficult to cross-validate the parameters measured by different modalities. An alternative solution is using an agent that provides contrast for both optical and MRI simultaneously.

Method : A novel polymer based bi-functional MR/optical agent was produced by GE Global Research, NY. Fisher rats bearing subcutaneous R3230 AC adenocarcinoma tumor were injected with this bi-functional agent for dual modality imaging. The molecular weight of the bi-functional agent was 400 kDa. It took about 24 hours for the agents to leak though the vascular due to its relatively large size. The MR and optical absorption images were acquired with the hybrid system before and 24 hours after the injection of the bi-functional agent. For MR imaging, T1 weighted images with 120 mm FOV was acquired at TR=520 ms and TE=15 ms.

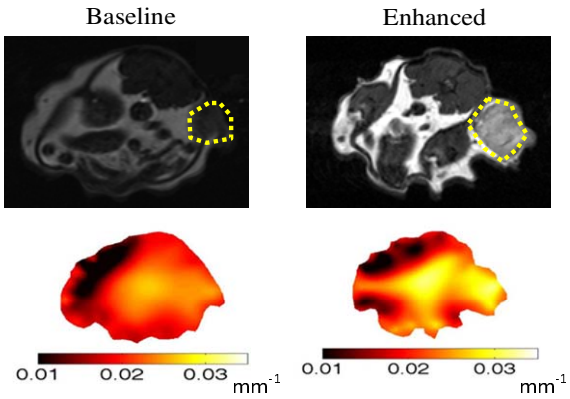

Figure 1. The first row shows the MR images, and the second row shows the optical absorption map obtained at 785 nm. The images in the left and right columns were taken before and after the administration of the bi-functional contrast agent, respectively.

Results : Figure 1 shows the T1 weighted MR anatomical images (top row) and the absorption images reconstructed from the optical data acquired simultaneously with the MR images (bottom row). It was not possible to place the animal in the interface exactly at the same position for over 24 hours. However, the enhancement in the tumor was higher in general as detected by both systems. This case was a first step towards the validation of optical imaging *in vivo*.

Discussion : Our study is the first to validate a true multi-modality system with a true multi-modality contrast agent. Usually it is difficult to quantify the absolute amount of MRI contrast agent administrated. However, the quantitative amount of optical contrast agent administered is easier to obtain from the absorption map. Hence, if the chemical ratio of the MRI and optical contrast agent components on the polymer are known, the absolute amount of MR agent used in dual modality imaging can be calculated as well. Our near future plan is to produce different molecular weight agents to have a broad range of enhancement kinetics to validate optical imaging further.

References : 1. Frangioni, J.V. J Clin Oncol. 26:24 (2008) 2. Turnbull, L.W. NMR Biomed. July (2008) 3. Valentini, G., D'Andrea, C., Ferrari, R., Pifferi, A., Cubeddu, R., Martinelli, M., Natoli, C., Ubezio, P., and Giavazzi, R. Photochem Photobiol. 84:5 (2008) 4. Unlu, M.B., Birgul, O., Gulsen, G. Phys Med Biol. 53:12 (2008)

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