A multimodality protocol combining endoscopic MRI and confocal endomicroscopy for mice colorectal lesions assessment

Hugo Dorez[1], Raphaël Sablong[1], Laurence Canaple[2], Hervé Saint-Jalmes[3], Sophie Gaillard[1], Hélène Ratiney[1], Driffa Moussata[1,4] and Olivier Beuf[1]

[1]Univ. Lyon, INSA-Lyon, Université Claude Bernard Lyon 1, UJM-Saint Etienne, CNRS, Inserm, CREATIS UMR 5220, U1206, F-69621 Lyon, France
[2]Institut de Génomique Fonctionnelle de Lyon, Université de Lyon 1, UMR 5242 CNRS, Ecole Normale Supérieure de Lyon, Lyon, France
[3]LTSI; INSERM U642; Université Rennes 1, Rennes, France
[4]Hôpital Régional Universitaire de Tours - Service hépato-gastroentérologie, Tours, France

Purpose/Introduction: Patients with inflammatory bowel disease (IBD) are at higher risk to develop colorectal cancer (CCR) [1]. An early diagnosis and characterization of abnormalities can help to adapt therapeutic responses and increase treatments efficiency. Endoscopy and confocal endomicroscopy (CEM) are used to characterize macroscopic features and vascular network architecture of the parietal surface. By contrast, MRI, performed with endoluminal coils (EC) [2], allows to image deeper colon-wall layers and visceral fat. The aim of this work was to follow colon tissues infiltration on a mouse model of colitis during a six months period time using endoluminal optics and MRI.

Subjects and Methods: A total of 20 mice (divided in five groups from 1 to 5), chemically treated with a combination of AOM and DSS [3], and 12 healthy mice (control group, divided in three groups from 6 to 8) were followed during a six months period after 6, 12, 18 and 25 weeks of treatment. A commercial CEM system was combined to a dedicated endoscope to perform the endoscopic examination of mice colon walls. Also, dedicated EC were designed and built for the purpose of this project. First, endoscopic examination with a conventional dye (crystal violet) was performed to assess the entire colon and locate suspicious areas, then, characterized by CEM. Finally, endoscopic MRI was carried out on a 4.7 T Bruker system. CEM and MR anatomical images were sequentially compared. T1- and T2-maps were also computed to discriminate expected interfaces from suspicious structures.

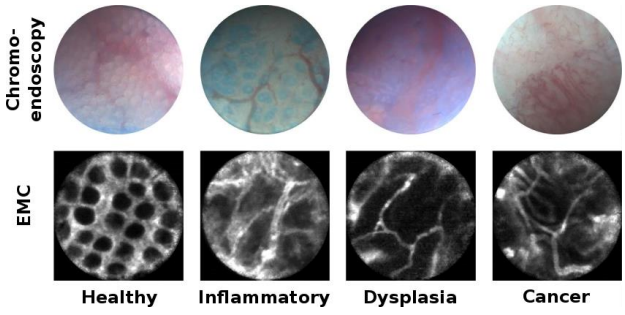

Figure 1 – CE images (above) and CEM images (beneath) of healthy, inflammatory, dysplastic and cancerous tissues. The vascular network architecture seen in CE is confirmed with the CEM modality.

Results: Endoscopy is helpful to locate suspicious areas and after for co-localization of data from optical modalities and MRI. CEM images clearly show specific vascular network patterns which enable to qualify tissues as healthy, inflammatory and tumorous tissues (figure 1). Endoscopic MRI provides high spatial resolution images (typically 80x80 µm²) to assess the infiltration of lesions inside colon walls. Early inflammation, unnoticed in endoscopy, was depicted with MRI (figure 2). T1 relaxation times values tend to decrease as a function of pathologic state for the group 4, ranging from 649.5±117 ms for healthy colon wall, to 480.3±91 ms for inflammatory areas and 279.2±49 ms for tumors (figure 3).

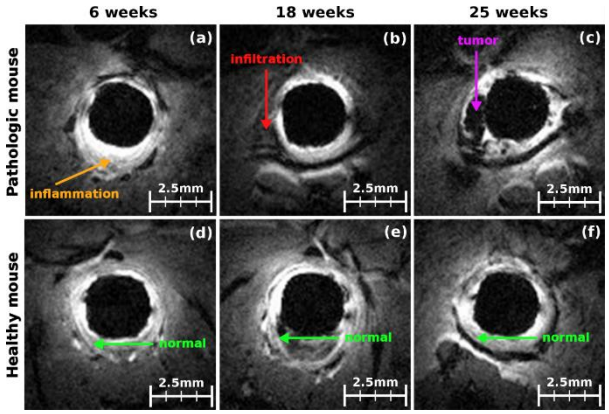

Figure 2 – images of pathologic mouse (a to c) and healthy mouse (d to f) at 6, 18 and 25 weeks after the beginning of the treatment (no treatment for the healthy mouse). On (a) inflammation is clearly visible with a colon wall thicker and a serosa layer hardly visible. On (b) the lesions observed on (a) has evolved and has begun to infiltrate inside the colon walls. Finally on (c) a tumor has grown and is clearly visible. The size of the tumor is approximately 1mmx3mm.

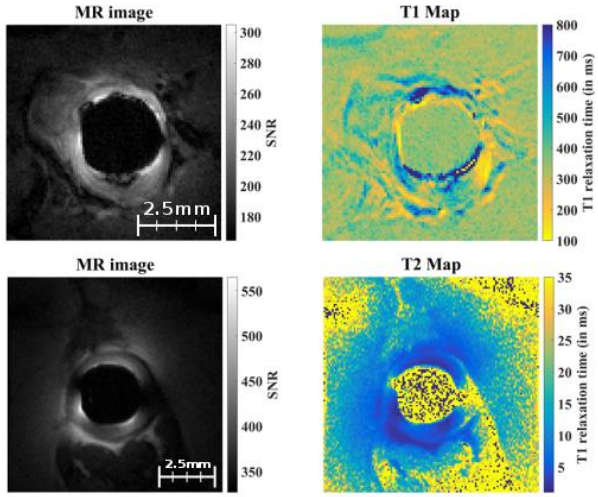

Figure 3 – From anatomical images (center) T1- and T2-maps can be computed to flatten the SNR profile of the EC. The gain in SNR provided by the EC is used to increase in-plane spatial resolution up to 40x40 µm².

Discussion/Conclusion: The gain in SNR provided by the EC helps to increase the spatial resolution of NMR images up to (39x39x234 µm³) without acquisition times penalties (about 10 minutes). It has been possible to follow and characterize the sequence inflammation-dysplasia-cancer using endoluminal MRI. The combination of optical modalities and endoscopic MRI into the same protocol provides complementary information that can be co-located to improve the diagnosis and characterization of suspicious areas.

References:

1. Van Der Kraak L, Gros P, Beauchemin N (2015) Colitis-associated colon cancer: Is it in your genes? World J Gastroenterol 21:11688–11699.

2. Dorez H, Sablong R, Canaple L, Saint-Jalmes H, Gaillard S, Moussata D, Beuf O (2016) Endoluminal high-resolution MR imaging protocol for colon walls analysis in a mouse model of colitis. Magn Reson Mater Phys Biol Med 1–13.

3. Tanaka T, Kohno H, Suzuki R, Yamada Y, Sugie S, Mori H (2003) A novel inflammation-related mouse colon carcinogenesis model induced by azoxymethane and dextran sodium sulfate. Cancer Sci 94:965–973.