Evaluation of a new multi-modality visualization tool for investigation of hepatic metastases from colorectal cancer

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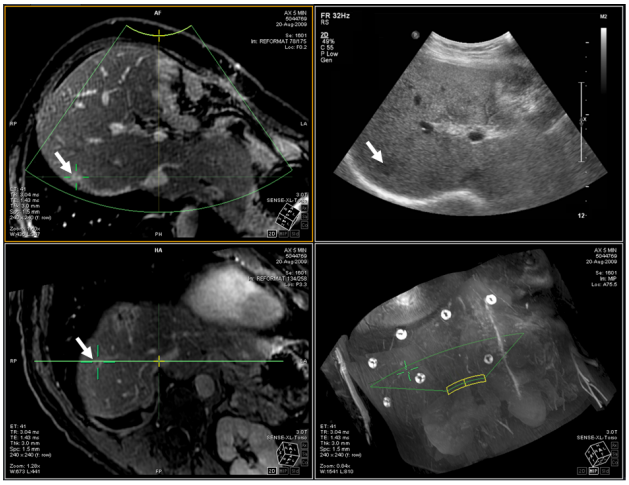
Background and Purpose: Colorectal cancer is a common and frequently fatal disease. Up to 50% of those who die from colorectal cancer have liver metastases at autopsy, making hepatic metastases the leading cause of death in these patients.[1] Unlike many other types of cancer, the presence of distant metastases from colorectal cancer does not preclude curative treatment. Five-year survival rates following resection of isolated liver metastases from colorectal cancer have been reported between 30% to 48%.[2] Benign lesions of the liver are frequent in patient with liver metastases, and accurate characterization of all hepatic lesions is necessary before surgical resection. Ultrasound and MRI are frequently used in pre-operative planning, and provide complimentary information. Ultrasound is the first line of investigation for differentiating metastases from benign lesions, but provides equivocal information in certain cases (e.g., chemo-therapy induced fatty infiltration of the liver). MRI provides high sensitivity, and provides accurate information regarding fatty infiltration of the liver parenchyma.[3] The present study investigates the value of real-time co-registration of preoperative MRI and ultrasound images to determine if this method improves the ability to localize suspicious targets under ultrasound, using MRI as a gold standard.

Material and Methods: This is an ongoing prospective study approved by the research ethics board at Sunnybrook Health Sciences Centre. Pre-operative patients diagnosed with hepatic metastases from colorectal cancer are first screened using the standard MRI protocol for surgery planning on a clinical 3T MRI system (Achieva, Philips, Andover, MA). Images are reviewed by a team (staff radiologist, fellow radiologist, and senior ultrasound technologist) and suspicious MR-visible targets are identified. Patients then undergo two consecutive ultrasound examinations (iU22, Philips, Andover, MA). The first examination is a clinical ultrasound study performed by a technologist with 20 years of experience in abdominal ultrasound imaging. The second examination is performed by a staff radiologist using a software tool to display co-registered MR images (contrast-enhanced T1-weighted gradient-echo and T2-weighted fast spin-echo images) from the MRI acquisition alongside the real-time ultrasound images (Aegis Navigation, Sentinelle Medical, Toronto, Canada). In this procedure, the position and orientation of the ultrasound transducer are monitored using a 3D tracking system (Polaris Vicra, Northern Digital, Waterloo, Canada). The MRI dataset is then dynamically reformatted to correspond to the current ultrasound field of view. In each ultrasound session, 2 outcome measures (target localization success and target localization time) were collected for all previously identified targets. Lesion size, morphological characteristics and anatomic location were also recorded. Saved ultrasound images of each successfully localized target were reviewed by the team after each procedure and false positives (determined by consensus) were excluded. The proportion of MRI identified targets successfully localized using conventional ultrasound compared to co-registered imaging was compared (Fisher's exact). For targets localized in both conventional ultrasound and the co-registered imaging procedure, target localization time was compared using a paired Student's *t* test.

Results: Eight patients underwent the imaging protocol described above. A total of 67 suspicious targets were identified on MRI. Under conventional ultrasound, 43 (64%) of these targets were successfully localized (30 colorectal metastases, 10 cysts, 1 hemangioma, 2 indeterminate masses, mean lesion size 13 ± 11 mm). Under co-registered ultrasound/MRI guidance, 60 (90%) of these targets were successfully localized (33 colorectal metastases, 24 cysts, 2 hemangiomas, 1 indeterminate mass, mean lesion size 10 ± 8 mm). The target localization success rate was higher for co-registered imaging than conventional ultrasound ($P < 0.001$). For the 17 targets successfully localized by co-registered imaging but not by conventional ultrasound, mean lesion size was 4.6 ± 1.8 mm. The target localization time was 2.0 ± 1.82 min for co-registered imaging, compared to 1.86 ± 2.15 for conventional ultrasound exam (not significant). **Figure:** Top right, ultrasound image; Top left, dynamic MRI reformat corresponding to ultrasound image; Bottom left, perpendicular MRI view; Bottom right, 3D maximum intensity projection view of MRI data. Arrows indicate the location of the selected target (in this case, a colorectal metastasis).



Conclusion: Co-registration of hepatic MRI and ultrasound images significantly improves the ability to localize suspicious targets identified on MRI, particularly for small lesions. This technique allows real-time correlation of the complimentary information provided by MRI and ultrasound, and may prove useful in planning the surgical management of patients with hepatic metastases from colorectal cancer.

References: 1. Yoon et al, Oncologist, 1999; 2. Lodge et al, Cancer Imaging, 2000. 3. Schima et al, Cancer Imaging, 2005.