NCI/ISMRM Workshop on
Higher Field (1.5 T and UP) in Oncology:
Strategic Frontiers in Cancer Diagnosis and Treatment

Glasgow, Scotland
April 20, 2001

Purposes

1. To identify current and future clinical opportunities for oncological imaging using higher field MRI and MRS (1.5 T and up), including the use of MR contrast agents, for both pre-clinical animal models and human investigations.

2. To identify the technological challenges that need to be met to address these clinical opportunities in terms of:
   (a) MRI and MRS system design and components, including hardware and software.
   (b) Development of targeted or activatable MR contrast agents.

3. To review the importance of higher field MRI/MRS and potential impact of field dependence issues on the following: (a) molecular imaging, (b) MR contrast imaging, (c) perfusion and diffusion imaging/dynamic imaging, (d) parallel coil, real-time and interventional imaging, (e) multi-modality imaging, and (f) proton and multi-nuclear spectroscopy.

4. To provide recommendations to NCI on: (a) areas of clinical opportunity and potential technological solutions, (b) means to better promote higher field MRI and MRS for oncological studies, and (c) efficiencies potentially available from research partnerships among academic, industrial and small business researchers for full exploitation of opportunities identified and dissemination of technology.

Expected/Deliverable Outcomes

1. Formulation of recommendations by the end of the workshop.
2. Publications of Workshop Results to include the Journal of Magnetic Resonance Imaging and NCI Biomedical Imaging Program (BIP) webpage.

Participants

1. Fifty-five scientists from molecular biology, cancer biology, oncology, bioengineering, imaging physics, clinical imaging, commercial firms, NCI staff, and ISMRM Study Group Leaders.
2. Representatives from 23 universities or laboratories, 12 commercial firms and NCI.

Charge to Participants

1. Identify key scientific and clinical questions in cancer biology, diagnosis and treatment, together with the technological implications for higher field MR systems development.
2. Questions identified should drive the development of new, not-yet-available technology, and should not be limited to a view of what is technologically possible at this time.

Recommendations

1. Explore the role of higher field MRI/MRS relative to other imaging modalities in functional genomics & proteomics. Potential opportunities for human and animal investigations include:

   •Facilitating identification and spatio-temporal localization of molecular targets in vivo.
   •Identifying components of the molecular microenvironment in vivo.
   •Integrating imaging modalities with molecular discoveries from CGAP (Cancer Genome Anatomy Project).

2. Further develop MRI/MRS (at 3T and up) for small animals and transfer knowledge for in-vivo human investigation:

   •Support additional small animal units at a variety of higher field strengths and encourage the participation of small businesses for development of system components (RF coils, animal probes, and contrast agents etc.).
   •Explore approaches to stimulate the transfer of techniques from higher field animal MRI/MRS to in vivo human studies.

3. Support the development of clinically usable whole body systems (3T and up):

   • Develop imaging/spectroscopy protocols for cancer detection, diagnosis, and therapy (IGT, IGS)
   • Support needed hardware development such as: automated shimming capability, fast gradients (localized and whole body gradient coils), transmit and receive coils, and related hardware for image-guided therapy and surgery (IGT, IGS).
   • Support necessary software development such as: pulse sequence development in support of coil development, automated shimming and fast gradients.
   • Support system optimization. Higher field units will "inherit" limitations of lower field systems when created by adaptation processes. System optimization is field-dependent and thus specifically needed for higher field systems.

4. Establish safety standards and criteria:

   •Fund comprehensive safety evaluation of devices such as metallic implants and physiological monitoring systems.
   •Review safety (SAR and B_0) guidelines and adjust criteria for higher field MRI/MRS based on current knowledge.

5. Exploit the synergy between MR field strength and contrast reagents. At higher fields, low contrast agent concentrations become detectible because of increased effects of contrast agents on shortening the relaxation times.

   •Further explore the understanding of contrast mechanisms for field strengths of 3T and higher.
   •Explore advantages of higher field strengths in reducing the complexity of modeling bolus tracking data.
   •Further develop activatable contrast reagents.

6. Increase access to higher field, large bore MRI/S units for in vivo human oncology research:

•Provide Shared Instrumentation Grants
•Provide Supplementary awards for Cancer Centers, or other centers of excellence to promote oncology applications of higher field MRI/MRS.

7. Support resources to enable effective clinical translation research and multi-center clinical trials of higher field MRI/MRS:

•Support the development of systems with small markets that are unattractive to vendors, but essential for translation.
•Support the development of user-friendly interfaces for clinical research, as many specialized acquisition and post-processing tools are cumbersome to use in a busy clinical environment.
•Support development of tools necessary for multi-center trials, such as specialized MR coils, or imaging methods and software on commercial platforms. For example, harmonization of imaging and spectroscopy protocols would facilitate the computation of metrics for image-based surrogate outcomes.
•Support partnerships between academia and industry to facilitate these translational efforts.
•Increase support for early phase clinical trials of higher field MR oncology.

8. Establish the validity of imaging surrogate markers with higher field MRI/MRS:

•Compare tumor volume and its limitations vs. newer physiological and morphological markers.
•Further explore diffusion MRI, perfusion MRI and diffusion MR spectroscopy as surrogate markers.
•Explore the use of higher field MRI to evaluate the systemic effects of therapies, e.g., effects of cancer therapies on liver, kidney, heart, etc.

9. Coordinate NCI/industry/academic/regulatory interaction to facilitate commercial development of higher field MR systems:

•Facilitate the development and accelerated approval of MR diagnostic agents, methodologies, and devices. For example, coordinate NCI/industry/academia input to the FDA/CMS, including attention to issues such as safety, or accelerated IDE/510k's approval.
•Encourage MRI OEM's (original equipment manufacturers) to share system interfaces. Facilitate small business efforts to build MR system components with appropriate interface documentations.

10. Improve communication among communities of MR basic science, clinical oncology, industry and NCI:

•Promote effective partnerships between oncologists and MR scientists to facilitate the development of MRI/MRS systems for oncology applications.

•Improve dissemination of the oncological research progress in higher field MR, to encourage oncologists to promote the development of this area. AACR, ASCO, ASTRO meetings are important venues.
•Organize annual workshops to highlight promising research opportunities for MRI/MRS.